ANNUAL REPORT

2015-16

INDIAN NATIONAL SCIENCE ACADEMY

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BRIEF HISTORY

The Indian National Science Academy (INSA) was established in January 1935 with the object of promoting science in India and harnessing scientific knowledge for the cause of humanity and national welfare. The foundation of the Academy, earlier known as the National Institute of Sciences of India (NISI), was the outcome of joint endeavours of several individuals and organizations, with the Indian Science Congress Association (ISCA) playing a leading role.

Towards the end of 1930, the then Government of India wrote to various State (then provincial) Governments, Scientific Departments, Learned Societies, Universities and the ISCA seeking their opinion on the desirability of forming a National Research Council that would adhere to and cooperate with the International Research Council and its affiliated Unions. Simultaneously, during a visit to India, Sir Richard Gregor, the Editor of Nature also held discussions with the Editor of Current Science on the promotion of an Indian Academy of Sciences. The proposal was considered by various eminent scientists whose views regarding the composition and functioning of such a national council were put up in the form of a resolution to the ISCA during its Pune Session.

At a special meeting of ISCA held in Mumbai in January 1934 to consider the proposal, the President of the ISCA, Professor MN Saha, made a strong plea in support of an Indian Academy of Sciences on the model of the Royal Society, London. The General Committee of the ISCA unanimously accepted the proposal for the formation of a national scientific society and formed an 'Academy Committee', which was requested to submit a detailed report for consideration at the next session of the ISCA. The Committee submitted the report in January 1935 incorporating (i) the aims and objectives of the national scientific society to be formed; (ii) the draft constitution; (iii) names of 125 Foundation Fellows selected by a Special Committee of Specialists; and (iv) names of 25 scientists as members of the provisional Council of the Academy.

The report of the Academy Committee was placed by Dr LL Fermor (President, 22nd Session, ISCA) before a Special Meeting of the Joint Committee on January 3, 1935. The recommendations of the Academy Committee were accepted by unanimous resolution by the ISCA, thus laying the foundation of the National Institute of Sciences of India as an all-India body of scientists. An inaugural meeting of the National Institute of Sciences of India (NISI) was held on January 7, 1935 under the Chairmanship of Dr JH Hutton (President, 23rd Session, ISCA) in Calcutta. The first President of NISI, Dr LL Fermor, delivered the Inaugural Address. The Institute, thus, started functioning with its Headquarters at the Asiatic Society of Bengal, 1 Park Street, Calcutta, from that day.

After ten years of its foundation, the Government was urged to recognize the NISI as the representative body of scientists. In October 1945, after due deliberations and discussions, the Government decided to recognize the National Institute as the premier scientific society representing all branches of science in India. The Headquarters moved over to Delhi in May 1946, and the Government commenced providing increased grants to meet expenses on travel, publications, research fellowships, and for allocating grants-in-aid to other scientific societies for bringing out their publications. The Government also sanctioned a capital grant for the Headquarters building in 1948.

On April 19, 1948, Pandit Jawaharlal Nehru, the then Prime Minister of India, laid the foundation stone of the building. The office of NISI moved to its present premises on Bahadur Shah Zafar Marg, New Delhi in 1951. In January 1968, it was designated as the adhering organization in India to the International Council for Science (ICSU) on behalf of the Government of India.

The National Institute of Sciences of India was renamed the Indian National Science Academy (INSA) in February 1970.

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Indian National Science Academy
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Highlights

- The Academy elected 34 Fellows, three Foreign Fellows and two Pravasi Fellows to the Fellowship during the year 2015-16.
- 29 Young researchers were selected by the Academy for the INSA Medal for Young Scientists and two young historians for INSA Young Historian of Science Award for the year 2015.
- The Academy established Indian National Young Academy of Sciences (INYAS).
- 12 outstanding teachers were honoured with INSA Teachers Award for the year 2015.
- Three general and nine subjectwise medals/ lectures awards were announced by the Academy.
- The Academy supported 53 scientists/ researchers for attending various ICSU/ Non-ICSU sponsored conferences abroad.
- 52 researchers from abroad were awarded with INSA JRD-TATA, DBT-TWAS Post Graduate and Post-Doctoral and ISRF Fellowships and 713 Indian scientists/researchers were awarded with INSA-CSIR-DAE/BRNS-CICS Travel Fellowship during the year 2015.
- The Academy supported 88 Indian scientists to work in overseas laboratories and R & D institutions and facilitated 75 overseas scientists to work in India under various Exchange/ International Programmes.
- The Academy supported several national and international joint bilateral meeting/workshop/ symposium such as IAP/IAC/IAMP, INSA-German National Academy of Sciences Leopoldina Symposium.
- Under the Science Promotion Programme, the Academy supported 91 Senior Scientists, 72 Honorary Scientists and 57 Young Scientists Awardees for advanced research in their specialized disciplines.
- 67 Conferences/Seminars/Symposia/Workshops which were held in different parts of the country were financially supported.
- Under the History of Science Programme, the Academy supported 26 research projects during the year.
- 13 award lectures under the aegis of different local chapters of the Academy were delivered under Science and Society Programme.
- 59 popular lectures were delivered to young students and teachers of schools and colleges by the Fellows in remote/rural areas.
- All the 41 volumes of *Biographical Memoirs of Deceased Fellows of the Academy* were digitised and uploaded on Academy's website.

Contents

Foreword

I have immense pleasure in presenting the Annual Report of the Indian National Science Academy for 2015-16. It gives a brief account of all the activities including several new programmes of the Academy.

A major responsibility of the Academy is to recognize and promote excellence in science and technology by electing the most eminent Indian scientists and distinguished overseas scientists to the Fellowship. We added 34 distinguished Indian scientists as Fellows, three overseas scientists as Foreign Fellows and two scientists as Pravasi Fellows during 2015-16.

As nurturing the young scientific talent is yet another responsibility of the Academy, the Academy recognised the performance and dedication of 29 scientists below the age of 35 years with the award of INSA Medal for Young Scientists. Two young scholars were also awarded with the INSA Young Historian of Science Award.

Under INSA Teachers Award scheme, which was launched a few years ago to honour meritorious science teachers, 12 outstanding science teachers from across the country were selected.

During the year under report, the Council of the Academy initiated new programmes with a view to enhance its societal role. One of them is to induct into the INSA Fellowship such scientists and scholars who have made significant contributions to technology missions of national importance and in the area of History and Philosophy of Science.

As a continuing effort to promote international interactions and to project Indian science abroad, several new initiatives were undertaken. These include designing of several new bilateral agreements with foreign Academies and organization of bilateral symposia/ workshops. The Academy has also made significant progress in its relationship with top global scientific organizations such as TWAS, AASSA, IAP and IAC by being on Executive Committees/Boards of each of these bodies.

I am now in the last year of my three-year term as President of INSA. It has been a very exciting and fulfilling experience. I feel singularly fortunate to enjoy strong support and participation of Vice-Presidents and all Members of the Council. It is through this joint endeavour that several new activities could be initiated and successfully implemented.

Raghavendra Gadagkar
President, INSA

Council and Meetings

The management of the affairs of the Academy is entrusted to its Council, which is composed of a President, six Vice–Presidents and 20 Members representing different branches of science. These members are elected for a period of three years. In addition, four INSA Fellows representing each of the cooperating organizations, namely, the Asiatic Society, Kolkata; the National Academy of Sciences (India), Allahabad; the Indian Science Congress Association, Kolkata and the Government of India, make the Council a 31–member body. The Council is assisted by the Commission, Advisory/Standing Committees and subject–specific Sectional/ National Committees and special Committees. One of the prime responsibilities of the Council is to recognize excellence in science by electing scientists as Fellows, Foreign Fellows, Pravasi Fellows and Young Scientists Medal Awardees of the Academy.

*INSA COUNCIL–2016

President

Professor Raghavendra Gadagkar, FNA, JC Bose National Fellow Centre for Ecological Sciences, Indian Institute of Science, Bengaluru.

Vice–Presidents

Professor Kankan Bhattacharyya, FNA, Department of Physical Chemistry, Indian Association for the Cultivation of Science, Jadavpur, Kolkata.

Professor SC Lakhotia, FNA, INSA Senior Scientist, formerly Professor Emeritus (BHU) & Raja Ramanna Fellow (DAE), Cytogenetics Laboratory, Department of Zoology, Banaras Hindu University, Varanasi.

Professor JP Mittal, FNA, formerly Director, Chemistry and Isotope Group, Bhabha Atomic Research Centre, Mumbai.

Professor Rajendra Prasad, FNA, Director, Amity Institute of Integrative Sciences and Health & Amity Institute of Biotechnology, Amity University Haryana, Gurgaon.

Dr Chandrima Shaha, FNA, Director and Head, Cell Death and Differentiation Research Laboratory, National Institute of Immunology, New Delhi.

Professor LS Shashidhara, FNA, Coordinator (Biology), Indian Institute of Science Education & Research, Pune.

Members

Professor Manindra Agrawal, FNA, N Rama Rao Chair Professor, Department of Computer Science, Indian Institute of Technology, Kanpur.

Professor US Bhalla, FNA, Professor, National Centre for Biological Sciences, Bengaluru.

Professor VS Borkar, FNA, Department of Electrical Engineering, Indian Institute of Technology, Mumbai.

** Due to the resignation of Professor R Ramaswamy, the strength of the Council for the year 2016 is 30.*

Professor Subhasis Chaudhuri, FNA, Professor and Deputy Director (AIA), Department of Electrical Engineering, Indian Institute of Technology, Mumbai.

Dr VS Chauhan, FNA, Chairman NAAC, Malaria Group, International Centre for Genetic Engineering & Biotechnology, New Delhi.

Dr SK Ghosh, FNA, Theoretical Chemistry Section, Chemistry Group, Bhabha Atomic Research Centre, Mumbai.

Professor Rajesh Gopakumar, FNA, Senior Professor and Centre Director, International Centre for Theoretical Sciences of Tata Institute of Fundamental Research, Bengaluru.

Professor Nibir Mandal, FNA, Department of Geological Sciences, Jadavpur University, Kolkata.

Professor Deepak Mathur, FNA, Distinguished Professor, Atomic and Molecular Sciences, Tata Institute of Fundamental Research, Mumbai.

Professor IBS Passi, FNA, Honorary Professor, Indian Institute of Science Education & Research, Mohali.

Professor KN Pathak, FNA, INSA Senior Scientist & Professor Emeritus, Department of Physics, Panjab University, Chandigarh.

Professor Rengaswamy Ramesh, FNA, Outstanding Scientist and Project Director, ISRO–GBP, Geosciences Division, Physical Research Laboratory, Ahmedabad.

Dr AJ Rao, FNA, INSA Senior Scientist, Department of Biochemistry, Indian Institute of Science, Bengaluru.

Professor Ashutosh Sharma, FNA, Secretary to the Government of India, Department of Science & Technology, New Delhi.

Professor VK Singh, FNA, Director, Indian Institute of Science Education and Research, Bhopal.

Professor BK Thelma, FNA, Department of Genetics, University of Delhi, South Campus, New Delhi.

Professor SP Trivedi, FNA, Director, Tata Institute of Fundamental Research, Mumbai.

Professor JS Tyagi, FNA, Department of Biotechnology, All India Institute of Medical Sciences, New Delhi.

Professor K Veluthambi, FNA, UGC–BSR Faculty Fellow, School of Biotechnology, Madurai Kamaraj University, Madurai.

Representatives of Co–operating Academies and Government of India

Asiatic Society

Professor BC Sinha, FNA, INSA Honorary Scientist, DAE Homi Bhabha Professor, Variable Energy Cyclotron Centre, Department of Atomic Energy, Kolkata.

Indian Science Congress Association

Dr SS Katiyar, FNA, formerly VC, Chhatrapati Shahu Ji Maharaj University and Chandra Shekhar Azad University of Agriculture & Technology, Kanpur.

National Academy of Sciences (India)

Professor Paramjit Khurana, FNA, JC Bose National Fellow, Department of Plant Molecular Biology, University of Delhi, South Campus, New Delhi.

Government of India (DST)

Dr Indranil Manna, FNA, Director, Indian Institute of Technology, Kanpur.

COUNCIL MEETINGS

The Council met three times during 2015: July 27–30 (INSA, New Delhi); October 13–14 (Indian Institute of Science Education & Research, Mohali) and December 28–30 (Indian Institute of Science Education & Research, Bhopal). The Annual General Meeting and the Anniversary General Meeting were held along with the October and December meetings of the Council, respectively.

ANNIVERSARY GENERAL MEETING

December 28–30, 2015

Participants at the Anniversary General Meeting at IISER Bhopal

Inaugural Event

The 81st Anniversary General Meeting was held at Indian Institute of Science Education & Research, Bhopal during December 28–30, 2015.

During the three day event, two mini–symposia, four award lectures, two special lectures and one public lecture, besides the anniversary address by President, INSA, were organized as detailed below.

Mini–Symposia

To Celebrate International Year of Light 2015 (*Conveners:* Professor JP Mittal, FNA and Professor Kankan Bhattacharyya, FNA).

Research at IISER Bhopal: Quest for Some New Frontiers
(*Convener:* Professor Vinod K Singh, FNA).

Summaries of the lectures delivered are enclosed in ***Annexures–I and II***, respectively.

Vice–Presidents, Professor Kankan Bhattacharyya & Professor JP Mittal (left); Professor Vinod Singh, FNA (right) addressing the gathering during the mini symposia

INSA Award Lectures

The following four award lectures were delivered during the Anniversary meeting:

1. **INSA Medal for Promotion & Service to Science Lecture (2014)** on *Evolving Approach of Biology to Ayurveda* by Professor MVS Valiathan, FNA.
2. **The Aryabhata Medal Lecture (2015)** on *Exotic Organisms and Novel Biology: World of Parasites* by Professor Alok Bhattacharya, FNA.
3. **Dr Nitya Anand Endowment Lecture (2015)** on *Epigenetic Regulation of Chromatin Dynamics and Gene Expression: Implications in Differentiation, Disease and Therapeutics* by Professor TK Kundu, FNA.
4. **The Sunder Lal Hora Medal Lecture (2008)** on *Genome Editing and Tissue Fabrication: Emerging Approaches to Designing Life Forms* by Dr Rakesh Tuli, FNA.

Summaries of the above lectures are enclosed in ***Annexure–III***

Special Lectures

- *Making Sense of Science, an Indian Science Journalist's Perspective* by Mr Pallava Bagla, Editor, Science, New Delhi Television.
- *Long Non–coding RNAs Play Fundamental Roles in Cell Regulation* by Professor SC Lakhotia, FNA.

Public Lecture

Rock Paintings in Central India by Professor GL Badam (Retd), Deccan College, Pune.

Summaries of the special and public lectures are given in ***Annexure–IV.***

Professor Valiathan receiving the citation from Professor Gadagkar, Professor Mittal is on left

Professor Alok Bhattacharya delivering the medal lecture during AGM

Professor TK Kundu receiving the award from President INSA

Dr Rakesh Tuli delivering the SL Hora Medal Lecture at AGM

Mr Pallava Bagla, Editor, Science, New Delhi Television delivering a special lecture on Making Sense of Science, an Indian Science Journalists Perspective

Professor SC Lakhotia, Vice–President INSA, delivering a special lecture on Long Non–coding RNAs Play Fundamental Roles in Cell Regulation

Anniversary Address by Professor Raghavendra Gadagkar, President, INSA

The Anniversary Address on ***Is the Peacock merely Beautiful or also Honest?*** was delivered by Professor Raghavendra Gadagkar, President INSA.

Professor Gadagkar delivering the Anniversary Address

INSA Medal for Young Scientists and INSA Young Historian of Science Award

The Academy instituted the INSA Medal for Young Scientists in 1974 and INSA Young Historian of Science Award in 2014 with the aim of honouring young scientists of extraordinary promise and creativity who have made notable research contributions in Science and Technology and in areas related to History of Science, respectively.

Professor GL Badam (Retd), Deccan College, Pune being felicitated by President INSA after his public lecture

These awards, considered to be the highest recognition of promise, creativity and excellence at a young age, are given annually to distinguished young scientists, selected on the basis of their research work carried out in India. The award includes a medal, a certificate and a cash prize of Rs. 25000/–. So far 737 young scientists and 3 young historians have been thus recognized. Many of them have established a rewarding scientific career and continue to make outstanding contributions winning further honour both within and outside the country. 103 young scientists have been elected as Fellows of the Academy. This year (2015), 29 young researchers were honoured with INSA Medal for Young Scientists and two young historians with

INSA Young Historian of Science award. The awards were presented by Professor Raghavendra Gadagkar, President of INSA at the Anniversary General meeting on December 30, 2015. The Young Scientist and Young Historian of Science Awardees and their respective research contributions are as follows:

INSA Medal for Young Scientist Awardees

Dr B Anand (*b* 06.01.1981), PhD, Department of Biosciences and Bioengineering, Indian Institute of Technology Guwahati, Guwahati.

For his novel insights into mode of action of GTPases and diverse cellular functions that they regulate. His work on CRISPR–cas system has potential applications in genome engineering.

Dr Rehna Augustine (*b* 18.05.1981), PhD, National Institute of Plant Genome Research, New Delhi.

For her significant work on the manipulation of glucosinolate pathway in oilseed mustard (*Brassica juncea*). Her transgenics for *MYB2* gene could be of high agronomic value in developing low glucosinolate varieties and hybrids.

Dr Jyotishman Bhowmick (*b* 05.11.1981), PhD, Stat Math Unit, Indian Statistical Institute, Kolkata.

For his outstanding results on quantum isometry groups of compact quantum groups which have attracted the attention of, and been put to good use by, established experts in the area.

Dr Arup Kumar Das (*b* 18.04.1980), PhD, Department of Mechanical and Industrial Engineering, Indian Institute of Technology Roorkee, Roorkee.

For development of computational algorithms for dispersed two phase flow with complex interfaces and its experimental validation.

Dr Rajendra Singh Dhaka (*b* 10.06.1980), PhD, Department of Physics, Indian Institute of Technology Delhi, New Delhi.

For his unique and significant experiments on rare–gas nanobubbles in metallic surfaces and establishing a general relation between the nanobubbles and the binding energies of the rare gas atoms.

Dr Sumit Ghosh (*b* 01.05.1980), PhD, Department of Plant Biotechnology, CSIR–Central Institute of Medicinal and Aromatic Plants, Lucknow.

For having cloned and functionally characterized novel amyrin synthase genes from sweet basil for the biosynthesis of medicinally important pentacyclic triterpenes. He also engineered slow ripening of tomato by silencing genes that control N–glycan processing.

Dr Jitender Giri (*b* 01.07.1980), PhD, National Institute of Plant Genome Research, New Delhi.

For discovering rice genes for stress–associated proteins (SAP 1 and SAP 11) and receptor–like cytosolic kinase (RLCK 253) that confer abiotic stress tolerance in rice and in transgenic *Arabidopsis* plants.

Dr Ashish Gupta (*b* 22.08.1980), PhD, Department of Life Sciences, Shiv Nadar University, Greater Noida.

For discovering functional characterization of the homologue of eukaryotic Origin Recognition Complex (ORC) subunits in *Plasmodium* and for identifying the presence of proliferating cell nuclear antigen (PfPCNA) Interacting Protein (PIP) motif in PfOrcl and confirming the physical interaction between PfORC and PfPCNA by interaction studies and complementation assay.

Dr Nilesh Prakash Gurao (*b* 11.03.1983), PhD, Department of Materials Science and Engineering, Indian Institute of Technology Kanpur, Kanpur.

For his outstanding work in elucidating deformation mechanisms at multiple length scales (from nanometer to millimeter), in particular, his demonstration of the similarity of deformation mechanisms in coarse grained and nanocrystalline Nickel on the basis of misorientation angles determined by electron back scattered diffraction.

Dr Tanvi Jain (*b* 17.05.1981), PhD, Indian Statistical Institute, New Delhi.

For her contribution in Matrix Analysis and proof of the variational principle for symplectic eigenvalues of strictly positive real matrices of even order.

Dr Vikas Jain (*b* 06.02.1980), PhD, Department of Biological Sciences, Indian Institute of Science Education and Research Bhopal, Bhopal.

For his understanding of the interactions that occur between a bacterium and its phage. And for developing expression vectors for the rapid cloning and expression of proteins with hexahistidine tag at either termini.

Dr Sameena Khan (*b* 23.05.1984), PhD, Translational Health Science and Technology Institute, Faridabad.

For her outstanding work about the structural basis of aminoacylation of tRNA in *Plasmodium falciparum* which has potential application in development of novel therapies against Malaria.

Dr Hima Bindu Kudapa (*b* 22.04.1980), PhD, Center of Excellence in Genomics, International Crops Research Institute for the Semi–Arid Tropics, Greater Hyderabad.

For her excellent contributions on gall midge and legume transcriptome which is of high value and useful for breeding of chickpea.

Dr Biman Behari Mandal (*b* 07.07.1981), PhD, Department of Biosciences and Bioengineering, Indian Institute of Technology, Guwahati.

For developing innovative use of silk fibre base scaffolds for human tissue engineering and for demonstrating their versatility in applications ranging from skin repair to scaffolds for bone repair.

Dr Athi Narayanan Naganathan (*b* 28.11.1980), PhD, Department of Biotechnology, Indian Institute of Technology, Madras.

For developing statistical mechanical models for computational prediction of folding thermodynamics and for comparing predictions with experimental results on biologically important proteins like ACBP, 1kβα, RNaseH etc.

Dr Rajesh V Nair (*b* 24.05.1980), PhD, Department of Physics, Indian Institute of Technology Ropar, Punjab.

For synthesizing and studying high quality photonic crystals in the visible and near infrared wavelength ranges and for obtaining photonic band edge lasing from Si–nanophotonic structures.

Dr Santanu Kumar Pal (*b* 18.03.1981), PhD, Indian Institute of Science Education and Research, Mohali.

For his significant contributions on liquid crystal based sensors in detection of cellular analytes.

Dr Vivek Vijay Parkar (*b* 06.09.1980), PhD, Nuclear Physics Division, Bhabha Atomic Research Centre, Mumbai.

For his outstanding contributions on experimental measurements of fusion cross sections of weakly–bound nuclei on a range of targets which has opened novel possibilities for studying nuclei away from the line of stability.

Dr Anbarasan Pazhamalai (*b* 03.06.1982), PhD, Department of Chemistry, Indian Institute of Technology, Madras.

For his notable work on transition metal catalyzed methodology for synthesis of pharmaceutical and useful molecules through cross coupling reactions.

Dr Vijay Kumar Prajapati (*b* 05.07.1984), PhD, Department of Biochemistry, School of Life Sciences, Central University of Rajasthan, Ajmer.

For his important work on nanonization of amphoteresin B, a newer experimental approach in hamster animal model to increase the antileishmanial efficacy.

Dr Upasana Ray (*b* 11.10.1982), PhD, National Cancer Institute, National Institutes of Health, Bethesda, USA.

For establishing the existence of switch from translation to replication of HCV RNA and for designing peptide based antivirals that target La protein and HCV NS3 protein and which could inhibit the HCV RNA function.

Dr Nitin Saxena (*b* 03.05.1981), PhD, Department of Computer Science and Engineering, Indian Institute of Technology Kanpur, Kanpur.

For his renowned contributions in the area of algebraic complexity theory and significant studies of the development of important deterministic algorithms for primality testing, polynomial identity testing and construction of hitting sets.

Dr Maheswaran Shanmugam (*b* 01.06.1980), PhD, Department of Chemistry, Indian Institute of Technology Bombay, Mumbai.

For his comprehensive studies of the electronic and magnetic properties of molecular nanomagnets.

Dr Narendra Pratap Singh (*b* 23.03.1981), PhD, Stowers Institute for Medical Research, Kansas City, Missouri, USA.

For elucidating the divergence of the developmental roles of Drosophila Abd–a and Abd–b in determining segment identity and proliferation in body segments where they are co–expressed.

Dr Pankaj Kumar Singh (*b* 03.02.1980), PhD, Department of Translational Medicine and Neurogenetics, Institut de Genetique et Biologie Moleculaire et Cellulaire (IGBMC), France.

For unravelling cellular functions of Lafora disease proteins and proposing inhibition of SGK 1 as a potential therapeutic strategy for the treatment of the Lafora disease.

Dr Hari Sridhar (*b* 28.04.1982), PhD, Centre for Ecological Sciences, Indian Institute of Science, Bengaluru.

For his significant studies leading to the understanding of the relative roles of predation and forging success in driving multi–species flocking in birds.

Shri Shashi Kant Tiwari (*b* 10.07.1985), MSc, PhD (Thesis Submitted), Developmental Toxicology Division, Indian Institute of Toxicology Research, Lucknow.

For demonstrating the mechanisms by which Bisphenol A (BPA) affects the endogenous neural stem cells and oligodendrocyte progenitor cells which lead to the identification of means of its amelioration by curcumin.

Dr Gyana Ranjan Tripathy (*b* 05.07.1981), PhD, Earth and Climate Sciences, Indian Institute of Science Education and Research, Pune.

For his significant work on ^{187}Os /^{188}Os isotope ratios of the black shale and usefulness of this technique in estimating the atmospheric oxygen levels in the geological past and for focusing on low temperature weathering in the Himalayas and its linkage to the tectonic processes.

Dr Shri Ram Yadav (*b* 09.07.1980), PhD, Department of Biotechnology, Indian Institute of Technology, Roorkee.

For his outstanding contributions on the molecular mechanism of action of a gene that regulated floral organ specification and development in rice and for demonstrating the role of gene duplication and diversification of function during evolution of rice floral development.

INSA Young Historian of Science Awardees

Dr K Mahesh (*b* 31.12.1980), PhD, Research Associate, Science & Heritage Initiative–SandHi, Cell for Indian Science and Technology in Sanskrit, Indian Institute of Technology Bombay, Mumbai.

For his excellent appraisal of the proof of the Surface Area of a Sphere given by Bhaskaracharya in his famous work *Siddhantasiromani* (12 Century CE).

Dr Rohit Sharma (*b* 19.07.1986), PhD, Assistant Professor, Abhilashi Ayurvedic College and Research Institute, Abhilashi University, Mandi, Himachal Pradesh.

For his analytico–pharmaco–clinical studies on the role of *Bhavana Samskara* on *Guduchi* (*Tinospora cordifolia*) *Churna* and its effect in controlling *Madhumeha* (Type 2 Diabetes) based on ancient Indian texts.

INSA Teachers Award

To recognize and value excellence, consistency and high level of teaching in Indian Colleges, Universities and Institutions, the Academy instituted INSA Teachers Award in 2012. These annual awards recognize and honour teachers for providing guidance, inspiration and mentoring to students to take up careers in Science and Technology. All disciplines of Science and Technology including Medical & Engineering Sciences are included under the purview of this award. The award includes a scroll, a cash award of Rs. 50,000/– and a onetime book grant up to Rs. 20,000/–. The maximum number of awards per year is 12. This year, 12 outstanding teachers were honoured with INSA Teachers Award. Professor Raghavendra Gadagkar, President INSA presented the awards to the honoured teachers during the Anniversary General meeting on December 30, 2015. The Teacher Awardees and their contributions are as follows:

INSA Teachers Awardees

Professor Sanjeeva Reddy Cherkupally (*b* 01.08.1955), Department of Chemistry, Kakatiya University, Warangal.

Professor Cherkupally Sanjeeva Reddy's innovative and inspiring teaching and meticulous organization of seminars motivated the students to take up careers in science and technology. His utmost care in shaping the young minds of economically/socially backward students through awareness programs conducted in rural areas about health, environment, girls' education, and eradication of religious/superstitious beliefs, demonstrate his interest in propagating science.

Professor Seema Jaggi (*b* 11.09.1965), Principal Scientist, ICAR–Indian Agricultural Statistics Research Institute, New Delhi.

Professor Seema Jaggi has introduced several innovative methods of teaching which includes use of audiovisual aids and on–line resources. She has developed an 'eLearn Agriculture' portal and a number of other e–resources. She has published quality research papers and teaching/ training manuals.

Dr Sushama Dilip Joag (*b* 12.10.1953), Associate Professor & Head, Department of Chemistry, P.E.S's Modern College of Arts, Science and Commerce, Pune.

Dr Sushama Joag took up teaching profession with a lot of enthusiasm and has tried to imbibe interest and passion for science in undergraduate and postgraduate students through integrated approach to teaching using modern pedagogy, self–developed teaching aids, and innovative co–curricular programmes.

Professor Prakash Keshavamurthy (*b* 14.07.1960), Head, Department of Civil Engineering, Sri Jayachamarajendra College of Engineering, Mysuru.

Dr K Prakash has practiced many novel methods of teaching through which he also tries to establish a close link between teaching and research. Teaching and research have become inseparable parts of his professional life. He has co–authored a book titled *Geotechnical Engineering Characterisation of Coal Ashes*, which is well received and is considered as a valuable reference book for post graduate studies.

Professor Rabindra Kishore Mishra (*b* 08.09.1963), Electronic Science Department, Berhampur University, Odisha.

Professor Rabindra Kishore Mishra is an excellent teacher who involves students totally in his subject through careful preparation and enthusiasm, with personal warmth, intellectual vigour and pleasure in teaching. Despite being busy with research and administration he never gives the impression of not having time to help students.

Professor Joydip Mukhopadhyay (*b* 17.08.1963), Head, Department of Geology, Presidency University, Kolkata.

Professor Joydip Mukhopadh–yay has been teaching geology for nearly three decades. He follows an intense interactive mode of teaching in order to develop the skill of scientific reasoning among his students. He has made fundamental contributions in understanding the oxygenation of Earth's atmosphere. His students unequivocally reaffirm his contribution as teacher, guide and mentor.

Dr Tushar Chaitanya Pandya (*b* 19.08.1961), Associate Professor, Department of Physics, St. Xavier's College, Ahmedabad.

Dr. Tushar Pandya is an excellent teacher and good research worker. His popularity among the students is a reflection of the quality of his teaching and his commitment to them. He is always approachable and inspires the students to take up careers in science. He is a fellow of Gujarat Science Academy and has been working for the popularization of science since many years.

Professor Ravi Parkash (*b* 04.03.1950), Professor Emeritus (CSIR), Department of Genetics, Maharshi Dayanand University, Rohtak.

As a teacher, Professor Ravi Parkash has inspired his students to develop scientific temper or 'junoon' and has worked to ensure correct oral as well as written communication of scientific concepts. He has devoted his entire career of 38 years for the achievements of students at different levels from school to the university.

Professor Abbas Akbarali Rangwala (*b* 16.04.1938), Adjunct Faculty, Department of Physics, University of Mumbai, Mumbai.

Professor Abbas Akbarali Rangawala has interacted strongly with students, in and outside the classroom, encouraging, arguing, and challenging their ideas on physics and life. He is an inspiration to others not only for teaching but also about how to give maximum to the students and to society within all constraints of the system.

Professor Teegavarapu Ramakrishna Rao (*b* 09.08.1939), Visiting Professor, Department of Biological Sciences, Indian Institute of Science Education and Research, Mohali.

Professor Rao in his 35–year teaching career has transformed Ecology courses, which were traditionally viewed as dull and descriptive by biology students, into exciting and challenging subjects by his innovative teaching methods. He credits his teaching skills and the quality of the courses taught by him to the constructive feedback that he receives from the students.

Professor Ramajayam Sahadevan (*b* 26.07.1955), Ramanujan Institute for Advanced Study in Mathematics, University of Madras, Chennai.

Professor Ramajayam Sahadevan is an inspiring and passionate teacher who instills in students a desire to study and learn mathematics. He is also an active scholar and has made seminal contributions to the theory of nonlinear differential equations. He is passionate about helping students who struggle to understand the discipline's abstract concepts.

Professor Krishna Kumar Vellat (*b* 05.11.1948), Visiting Professor, National Institute of Science Education and Research, Bhubaneswar.

Professor Krishna Kumar Vellat worked closely with his students at University of Calicut, grooming and motivating many of them to pursue research of high standards in mathematics. This also improved the quality of mathematics education in North Kerala through his students who entered the teaching profession. Professor Krishna continues to teach at NISER, Bhubaneswar passionately, inspiring his students in this fortieth year of teaching.

Fellows, Foreign Fellows and Pravasi Fellows

The Academy elects, through a careful evaluation, Fellows, Foreign Fellows and Pravasi Fellows each year from amongst the nominations made by the existing Fellows. The election to the Fellowship is restricted to Indian citizens only and is limited to a maximum of 40 each year. Election to the Fellowship of the Academy is recognition of the excellent scientific contributions made by a scientist.

Foreign Fellows are eminent scientists who have been elected for their contributions to science and are domiciled outside the territorial limits of India. These scientists have contributed and enriched the scientific progress of India through their direct involvement.

Pravasi Fellows are eminent scientists who have been selected for their contributions to science and are Persons of Indian Origin with foreign passport (residing within or outside territorial limits of the country) or with Indian passport (residing outside the territorial limits of India). These scientists also have contributed and enriched the scientific progress of India through their direct involvement.

During the period 2015–16, the Academy elected 34 scientists as Fellows, 3 overseas scientists as Foreign Fellows and 2 scientists as Pravasi Fellows. The number of Fellows at present is 902 out of a total of 1735 elected since inception. Similarly, presently there are 93 Foreign Fellows out of a total of 273 elected so far. There are 4 Pravasi Fellows out of a total of 4 elected till date. The newly elected fellows were invited for admission to the Fellowship on December 30, 2015 at Indian Institute of Science Education & Research, Bhopal.

Fellowship Induction

The following elected Fellows were inducted to the Fellowship during Anniversary General meeting on December 30, 2015. Some of the earlier elected Fellows were also inducted to the Fellowship during this meeting.

Fellows (w.e.f. January 1, 2016)

Anuranjan Anand (*b* 05.04.1965), PhD, Professor and Chair, Molecular Biology and Genetics Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru.

For his discovery of genetic loci behind epilepsy and hearing loss specific genes like *EIG8* and *HWE3* and for showing the involvement of mutations in non–channel genes in epilepsy.

Tariq Aziz (*b* 02.04.1953), PhD, Senior Professor (I), Tata Institute of Fundamental Research, Mumbai.

For his contributions to b–tagging at LEP and establishing neural networks for particle physics analyses.

Vikraman Balaji (*b* 15.09.1962), PhD, Professor, Chennai Mathe–matical Institute, Kelambakkam.

For his major contributions to the theory of moduli of vector bundles over curves and algebraic varieties and for extending to higher dimensions the celebrated work of MS Narasimhan and CS Seshadri about the unitary representations of the fundamental groups of algebraic curves and vector bundles over them.

Sanghamitra Bandyopadhyay (*b* 17.04.1968), PhD, Director, Indian Statistical Institute, Kolkata.

For her contributions to genetic algorithm based clustering with applications to image processing and computational biology.

BV Rajarama Bhat (*b* 16.01.1966), PhD, Professor & Head, Stat–Math Unit, Indian Statistical Institute, Bengaluru.

For his work relating to the theory of E–0–semigroup to Hilbert C*–modules and for his subsequent work on sum systems that led to significant extensions of Tsirelsen's probabilistic constructions of such semigroups of type 2 and 3.

Renee Maria Borges (*b* 25.02.1959), PhD, Professor and Chairperson, Centre for Ecological Sciences, Indian Institute of Science, Bengaluru.

For her novel findings in sensory ecology of nocturnal bees and

significant contributions to the chemical ecology of figs and fig wasps.

Vani Brahmachari (*b* 06.06.1955), PhD, Professor, Epigenetics and Developmental Biology Group, Dr BR Ambedkar Center for Biomedical Research, University of Delhi, Delhi.

For her understanding of epigenetic mechanisms of genomic imprinting and for discovering a novel chromatin remodeling gene, INO 80.

Asit Kumar Chakraborti (*b* 15.08.1954), PhD, Professor & Head of Department, Department of Medicinal Chemistry, National Institute of Pharmaceutical Education and Research, Punjab.

For his notable contribution in unraveling the function of ionic liquids in catalysis and green synthetic methodologies.

Niranjan Chakraborty (*b* 24.02.1958), PhD, Staff Scientist–VII, National Institute of Plant Genome Research (NIPGR), New Delhi.

For his work, using proteomics approach, on molecular mechanisms underlying plant responses to adverse environmental conditions leading to the identification of differentially regulated organelle–specific proteins for modulating responses of crops for better adaptation to stress.

Charusita Chakravarty (*b* 05.05.1964), PhD, Professor, Department of Chemistry, Indian Institute of Technology Delhi, New Delhi.

For her significant contributions in the area of order–disorder phase transitions and use of energy landscape analysis in phase transition in bulk liquids and finite clusters as well as implementation of quantum effects in path–integral Monte Carlo calculation.

Gautam Kumar Dey (*b* 08.06.1957), PhD, Professor & Dean–Academic (Engg. Sciences), Homi Bhabha National Institute, BARC, Mumbai.

For his monumental work on zirconium based amorphous alloys and engineering materials such as zirconium and nickel based alloys and for employing a variety of novel TEM techniques to unfold complex microstructures.

Suman Kumar Dhar (*b* 06.03.1968), PhD, Professor, Special Centre for Molecular Medicine, Jawaharlal Nehru University, New Delhi.

For his fundamental contributions to DNA replication in two human pathogens, *Plasmodium falciparum* and *Helicobacter pylori* leading to identification of unique replicating helicase of *H. pylori* as a potential drug target and for identifying key molecules in replication of *P. falciparum* and drugs that have shown promise in both *in vitro* and animal models.

Kanak Lata Dikshit (*b* 01.07.1951), PhD, former Chief Scientist, CSIR–Institute of Microbial Technology, Chandigarh.

For her life time contributions in the area of microbial hemoglobin through characterization of HbO in *Mycobacterium tuberculosis* and her applied work on thrombolytic proteins leading to the development of a process which has been licensed to industry.

Balasubramanian Gopal (*b* 31.08.1970), PhD, Professor, Molecular Biophysics Unit, Indian Institute of Science, Bengaluru.

For his contributions to understanding of structure–function mechanisms controlling transcription in prokaryotes, using extra–cytoplasmic function sigma factors of *Mycobacterium tuberculosis* as model.

Gagandeep Kang (*b* 03.11.1962), PhD, Professor and Head, The Wellcome Trust Research Laboratory, Division of Gastrointestinal Sciences, Christian Medical College, Vellore.

For her outstanding investigation in community trial of the Rota virus vaccine and being the key person in generating data relevant for policy makers, on disease burden, vaccine efficacy and safety.

Pulugurtha Bharadwaja Kirti (*b* 15.09.1953), PhD, Professor, Department of Plant Sciences, University of Hyderabad, Hyderabad.

For his work on somatic hybridization involving Indian mustard and its wild relatives that resulted in useful male sterile lines, two of which have been utilized for developing commercial mustard hybrids and for his contribution to characterisation of defence related gene in wild species of *Arachis*, which provided novel insights in defence response and has practical relevance.

Kalobaran Maiti (*b* 21.10.1967), PhD, Professor H, Department of Condensed Matter Physics and Materials Science, Tata Institute of Fundamental Research, Mumbai.

For his outstanding contributions in materials research using state–of–the–art electron spectroscopic instrument and for discovering new routes to study correlated electron systems which has unraveled many long–standing issues in materials science.

Sangita Mukhopadhyay (*b* 01.01.1966), PhD, Staff Scientist VI, Centre for DNA Fingerprinting and Diagnostics, Hyderabad.

For her pioneering contributions to mechanistic understanding of hijacking of host signaling pathways by *M. tuberculosis* proteins for its own benefit.

Amlan Jyoti Pal (*b* 26.05.1960), PhD, Senior Professor, Department of Solid State Physics, Indian Association for the Cultivation of Science, Kolkata.

For his research on low dimensional structures– both 'soft' organic materials, as well as inorganic structures that has shown how these molecules can be organized by supramolecular engineering and how these molecular arrangements may be exploited for applications ranging from solar photovoltaics to organic transistors and memory devices.

Amit Kumar Patra (*b* 20.04.1966), PhD, Scientist–SG, National Atmospheric Research Laboratory, Tirupati.

For his outstanding contri–butions towards the influence of the coupled processes between the E and F regions on the development of plasma irregularities in the low latitude ionospheric E region and for observing new class of 150–km echoes due to small scale structures in the low latitude ionosphere and for proposing an interchange instability process involving a descending metallic ion layer as a generation mechanism.

Thalappil Pradeep (*b* 08.07.1963), PhD, Institute Professor, Department of Chemistry, Indian Institute of Technology Madras, Chennai.

For his significant contributions in the area of material chemistry, specially in the area of metal nanoparticles and the novel applications of these for catalysis, water purification and other areas.

Trivandrum Ramakrishnan Ramadas (*b* 30.03.1955), PhD, Distinguished Professor, Chennai Mathematical Institute, Kelambakkam.

For his path–breaking contributions to mathematical physics, algebraic geometry and their

varied intersections and for some of his influential works in the areas of Chern–Simons gauge theory, Jones polynomials, moduli of vector bundles and Frobenius splitting.

Vivek Vinayak Ranade (*b* 15.10.1963), PhD, Deputy Director and Chair, Chemical Engineering & Process Development Division, CSIR–National Chemical Laboratory, Pune.

For his contribution to studies of multiphase flows in a variety of reactors.

Chebrolu Pulla Rao (*b* 13.05.1954), PhD, Institute Chair Professor, Department of Chemistry, Indian Institute of Technology Bombay, Mumbai.

For his significant contribution in bio–inorganic mimetics using carbohydrate and calixarene based ligands.

Khareedu Venkateswara Rao (*b* 10.02.1958), PhD, Professor, Centre for Plant Molecular Biology, Osmania University, Hyderabad.

For his outstanding research on the development of transgenic crops resistant to pests and pathogens and for isolating stress–inducible genes from pigeon pea which would be useful for protecting crop plants against abiotic stress.

Rajendra Prasad Roy (*b* 26.01.1962), PhD, Staff Scientist VII, National Institute of Immunology, New Delhi.

For his innovative contributions in the area of chemical biology & biochemistry to develop novel chemo–enzymatic strategies for applications in protein engineering, elucidating the mechanistic details of sortase–catalyzed reactions and for revealing that macromolecular crowding can act as a driving force for reverse proteolysis.

Arvind Kesarilalji Sahu (*b* 19.06.1963), PhD, Scientist G, National Centre for Cell Science, Pune.

For his seminal contributions to the understanding of how virally encoded complement regulator–like proteins protect viruses against the host's complement attack and for mapping the functional determinants and species specificity in viral complement regulators.

Chitra Sarkar (*b* 11.09.1955), MBBS, MD, FRC (Path), Professor, Department of Pathology, All India Institute of Medical Sciences, New Delhi.

For her outstanding work on the pathobiology of brain tumors, particularly gliomas and has identified unique molecular alterations in pediatric glioma and oligodendroglioma.

Srikanth Sastry (*b* 01.05.1964), PhD, Professor, Theoretical Sciences Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru.

For his seminal contributions to the study of glass–forming liquids, glasses, and other structurally arrested states and to the phase behavior of liquid water and silicon.

Surinder Mohan Sharma (*b* 15.04.1952), PhD, DAE Distinguished Scientist & Director, Physics Group & Head, High Pressure & Synchrotron Radiation Physics Division, Purnima Laboratories, Bhabha Atomic Research Centre, Mumbai.

For his sustained work on studying materials under extreme environments that has established some unique phase transitions, particularly high pressure amorphization and for developing three synchrotron beam lines, namely X–ray diffraction under extreme conditions, protein crystallography and IR absorption.

Dinesh Kumar Srivastava (*b* 20.06.1952), PhD, Distinguished Scientist & Director, Variable Energy Cyclotron Centre, Kolkata.

For his pioneering work on the electromagnetic signatures of the formation of quark–gluon plasma in relativistic collisions of nuclei and for the formation of quark–gluon plasma, evaluation of its temperature and the understanding of its spectra.

Kumarasamy Thangaraj (*b* 02.06.1963), PhD, Senior Principal Scientist, CSIR–Centre for Cellular and Molecular Biology, Hyderabad.

For his major contributions to origin of Indian populations that can be classified into two divergent groups and for discovering association of *MyBp3* mutation to cardiac myopathy and the association of *RAF1* mutation with childhood cardiomyopathy among South Asians.

Gaddemane Dyavappa Veerappa Gowda (*b* 20.07.1955), PhD, Professor, TIFR–Centre for Applicable Mathematics, Bengaluru.

For his fundamental work in the areas of hyperbolic conservation laws, control theory and numerical approximation of conservation laws and for obtaining an explicit formula for the entropy weak solution of convex conservation laws with boundary conditions, extending the earlier work of Hopf and Lax for the initial value problem.

Sandeep Verma (*b* 24.06.1966), PhD, Head, Department of Chemistry, Indian Institute of Technology Kanpur, Kanpur.

For his significant contributions in conceptualizing new approaches to bio–mimetic soft materials and synthetic models of protein aggregation.

Induction of Fellows Elected in Previous Years

Fellows (w.e.f. January 1, 2015)

Usha Kant Misra (*b* 10.04.1952), MD, DM, Professor & Head, Department of Neurology, Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow.

For his significant and novel contributions in the field of neurological disorders due to Japanese encephalitis and dengue and emphasizing the importance of thalamus and its connection in the movement disorder.

Kavassery Sureswaran Narayan (*b* 26.01.1964), PhD, Professor and Dean (R&D), Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru.

For his significant contributions to the design of small molecules and polymers for the development of polymer based–semiconductor materials and devices. His research efforts have focused on a microscopic understanding of the underlying phenomena which has led to the improved designs.

Conjeevaram Srirangachari Rajan (*b* 21.05.1961), PhD, Professor (H), School of Mathematics, Tata Institute of Fundamental Research, Mumbai.

For his recent work on the interface of Lie groups, Representation Theory, Number Theory and Arithmetic Geometry which received high praise from leading experts in the subject.

Valipe Ramgopal Rao (*b*16.08.1965), PK Kelkar Chair Professor, Department of Electrical Engineering, Indian Institute of Technology Bombay, Mumbai.

For his fundamental contributions in the development of sub–100nm silicon nanoelectronics. His work has laid the foundation for understanding of circuit behavior with lateral asymmetric channel devices.

Shobhona Sharma (*b* 05.02.1953), PhD, Senior Professor (I) and Chair, Department of Biological Sciences, Tata Institute of Fundamental Research, Mumbai.

For her major contributions towards the identification of novel protective proteins of

Plasmodium falciparum and serum biomarkers of cerebral malaria.

Fellows (w.e.f. January 1, 2014)

Budaraju Srinivasa Murty (*b* 13.02.1964), PhD, Professor, Department of Metallurgical and Materials Engineering, Indian Institute of Technology Madras, Chennai.

For his contribution in the synthesis of advanced materials by mechanical alloying and in understanding of nanocrystallization and thermodynamics of glass formation.

Mohd. Ayub Qadri (*b* 30.12.1960), PhD, Staff Scientist VI, National Institute of Immunology, New Delhi.

For his significant contributions on the pathogenesis of *Salmonella typhi* and non–typhoidal *S. typhimurium*. His discoveries of vi–mediated immune suppression by prohibitin protein and immune regulation at the regional level are considered path– breaking.

Bhim Singh (*b* 01.01.1956), PhD, Professor, Department of Electrical Engineering, Indian Institute of Technology Delhi, New Delhi.

For his pioneer work in active power filters and power quality improvement with significant impact on rural electrification and renewable energy conversion.

The elected Fellows took the oath, signed the Fellowship Register and received the Scroll from President, INSA.

Foreign Fellows (w.e.f. January 1, 2016)

Jonathan R Ellis (*b* 1946), Scientist, Clerk Maxwell Professor of Theoretical Physics, Physics Department, King's College, London, UK.

For his contributions in the research fields of particle physics, astrophysics, cosmology and quantum gravity. His novel ideas helped in the discovery of the gluon. He pioneered phenomenological studies of supersymmetry and dark matter, string models, quantum gravity and the Higgs boson, and helped to set up the CERN India Cooperation Programme with DST.

Mriganka Sur (*b* 1953), Newton Professor of Neuroscience and Director, Simons Center for the Social Brain, Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology, Cambridge, USA.

For his work on plasticity dynamics of the cerebral cortex, experimental and computational approaches to neural networks and processing, cognitive neuroscience and developmental disorders of the brains. His demonstration of the visual and auditory system complementarily is a path breaking event in neuroscience.

Ronald Vale (*b* 1959), Professor and Chair, Department of Cellular and Molecular Biology Investigator, Howard Hughes Medical Institute (HHMI), The University of California, San Francisco, USA.

For his pioneer discovery of motor proteins and understanding of their structure and function using single molecule biophysics. He is deeply committed to developing high quality resources for science education and has pioneered iBioseminars, a source for online lectures in biology by eminent scientists from all over the world and "microscopy4kids", a project to supply microscope with digital camera for school education.

Pravasi Fellows (w.e.f. January 1, 2016)

Arogyaswami Joseph Paulraj (*b* 1944), Professor Emeritus, Department of Electrical Engineering, Stanford University, Stanford, USA.

For his contributions in wireless communications, in particular the development of MIMO technology, a practical technique for simultaneously sending and receiving several data signals on the same radio channel. This has revolutionized high speed wireless

services, and is at the core of the current high speed WiFi and 4G mobile phones.

Amit Prakash Sharma (*b* 1968), Staff Scientist & Group Leader, International Centre for Genetic Engineering and Biotechnology, New Delhi.

For his contributions in understanding the structural principles that define molecular functions of malarial parasite's proteins. His work on exploring novel targets for structure based drug design against malaria is commendable.

Presentation of Memento to Retiring Council Members

Professor Raghavendra Gadagkar, President, INSA presented shawls to the following retiring members of the Council: Dr DM Salunke, Vice President, Professor Kunal Ghosh, Professor RL Karandikar, Professor Archana Bhattacharyya, Members, who were present at the Anniversary Meeting at Bhopal. Professor Gadagkar profusely thanked the members of the Council for their continued support in carrying out the programmes of the Academy. As a token of gratitude, Professor Gadagkar also presented a shawl to Professor Vinod K Singh, Director, IISER, Bhopal on behalf of the Academy for making the Anniversary General Meeting of INSA a very successful one.

President and Vice–President, INSA inducting the newly elected fellows to the Fellowship of the Academy

President, INSA awarding the Young Scientists with Medal and Citation

President, INSA awarding the Young Historians with Medal and Citation

President, INSA honoring distinguished teachers with INSA Teachers Award

Professor R Gadagkar, President INSA, bidding farewell to the outgoing Council members

Fellows and Foreign Fellows Deceased during 2015–16

With profound regret the Academy reports the sad demise of the following esteemed Fellows and Foreign Fellows during 2015–16:

Fellows

Taracad Narayanan Ananthakrishnan, formerly Director, Zoological Survey of India, Kolkata.

Haridas Banerjee, formerly Senior Professor, Saha Institute of Nuclear Physics, Kolkata.

Sarmukh Singh Bir, Professor Emeritus, Department of Botany, Punjabi University, Patiala.

Charusita Chakravarty, Professor Department of Chemistry, Indian Institute of Technology, New Delhi.

Maharani Chakravorty, Honorary Scientist, National Institute of Cholera and Enteric Diseases, Kolkata.

Biswa Nath Das, formerly Professor, Department of Electronics & Electrical Communication Engineering, Indian Institute of Technology, Kharagpur.

Satyendra Nath Ghosh, formerly Sir Rashbehary Ghose Professor of Applied Physics, Calcutta University, Kolkata.

Parameswaran Hariharan, retired Chief Research Scientist, Commonwealth Scientific and Industrial Research Organization (CSIRO), Sydney.

Venkataraman Jagannathan, formerly Head of Biotechnology, The Energy and Resources Institute (TERI), New Delhi.

Sethunathasarma Krishnaswami, Geosciences Division, Physical Research Laboratory, Ahmedabad.

Paramasivan Natarajan, formerly Director, CSIR–Central Salt and Marine Chemicals Research Institute (CSMCRI), Bhavnagar.

Sohan Singh Prihar, former Professor of Soils, Punjab Agricultural University, Ludhiana.

Syed Zahoor Qasim, formerly Member (Science), Planning Commission, New Delhi.

Srinivasacharya Raghavan, formerly Senior Professor of Mathematics, TIFR, Mumbai.

Kanakanahalli Ramachandra, formerly Senior Professor, School of Mathematics, TIFR, Mumbai.

Subramania Ranganathan, Honorary Professor, Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru.

Vallurupalli Sita Raghavendra Rao, formerly Professor, Indian Institute of Science, Bengaluru.

Chintala Raja Ram Mohan Reddy, Consultant, Pathologist Care Hospital, Hyderabad.

Suhas Chandra Sanyal, formerly Professor & Head, Department of Microbiology, Banaras Hindu University, Varanasi.

Pidaparty Seshadri Sastry, retired Professor and Chairman, Department of Biochemistry, Indian Institute of Science, Bengaluru.

Soumitra Kumar Sen, Advanced Laboratory for Plant Genetic Engineering, Indian Institute of Technology, Kharagpur.

Govindaswamy Shanmugam, formerly Director of Oncophyta Labs, Madurai.

Kamal Nath Sharma, Executive Director, Gokula Education Foundation (Health Sciences), MS Ramaiah Medical Institutions and Hospitals, Bengaluru.

Vinod Prakash Sharma, formerly ADG, Indian Council of Medical Research and Founder Director, National Institute of Malaria Research, New Delhi.

Churya Sivaraman, formerly Deputy Director, CSIR–National Chemical Laboratory, Pune.

Adusumilli Srikrishna, Professor, Department of Organic Chemistry, Indian Institute of Science, Bengaluru.

Chiryathumadom Venkatachalier Subramanian, formerly Senior Professor & Director, CAS in Botany, Madras University, Chennai.

Krishna Swarup, formerly Professor and Head, Department of Zoology, Gorakhpur University, Gorakhpur.

Bhalchandra Madhav Udgaonkar, formerly Senior Professor, TIFR, Mumbai & Chairman, Homi Bhabha Centre for Science Education, Mumbai.

Ram Kumar Varma, Emeritus Professor, formerly Director, CSIR–Physical Research Laboratory, Ahmedabad.

Foreign Fellows

Robin Holliday, formerly Head, Genetics Division, National Institute for Medical Research, London.

Vladimir G Kadyshevsky, Scientific Leader, Joint Institute for Nuclear Research, Moscow.

Alan Roy Katritzky, Kenan Professor of Chemistry, University of Florida, Gainesville, USA.

Otto Kinne, Director, International Ecology Institute, President Inter–Research Science Center, Germany.

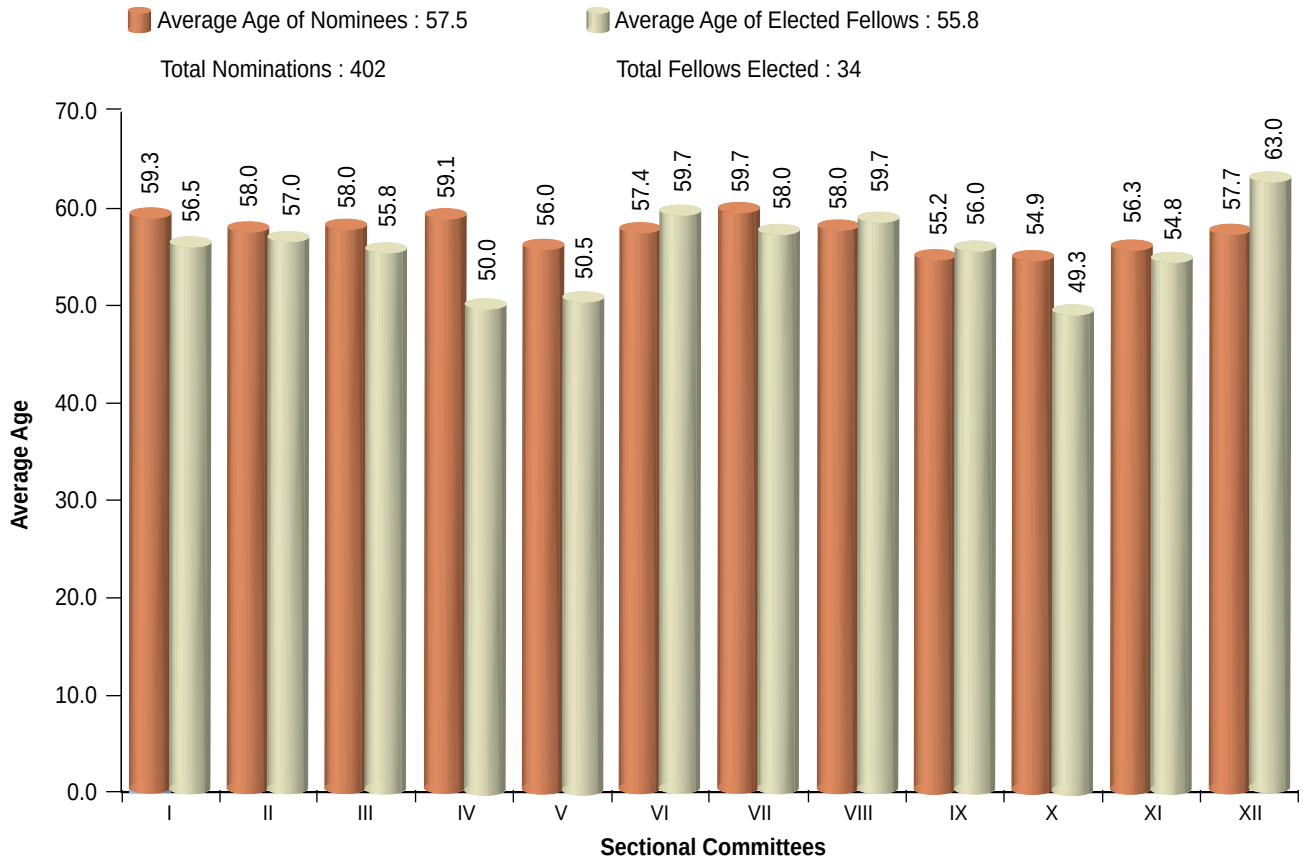
Lord of Newnham Jack Lewis, formerly Warden Robinson College, Cambridge, UK.

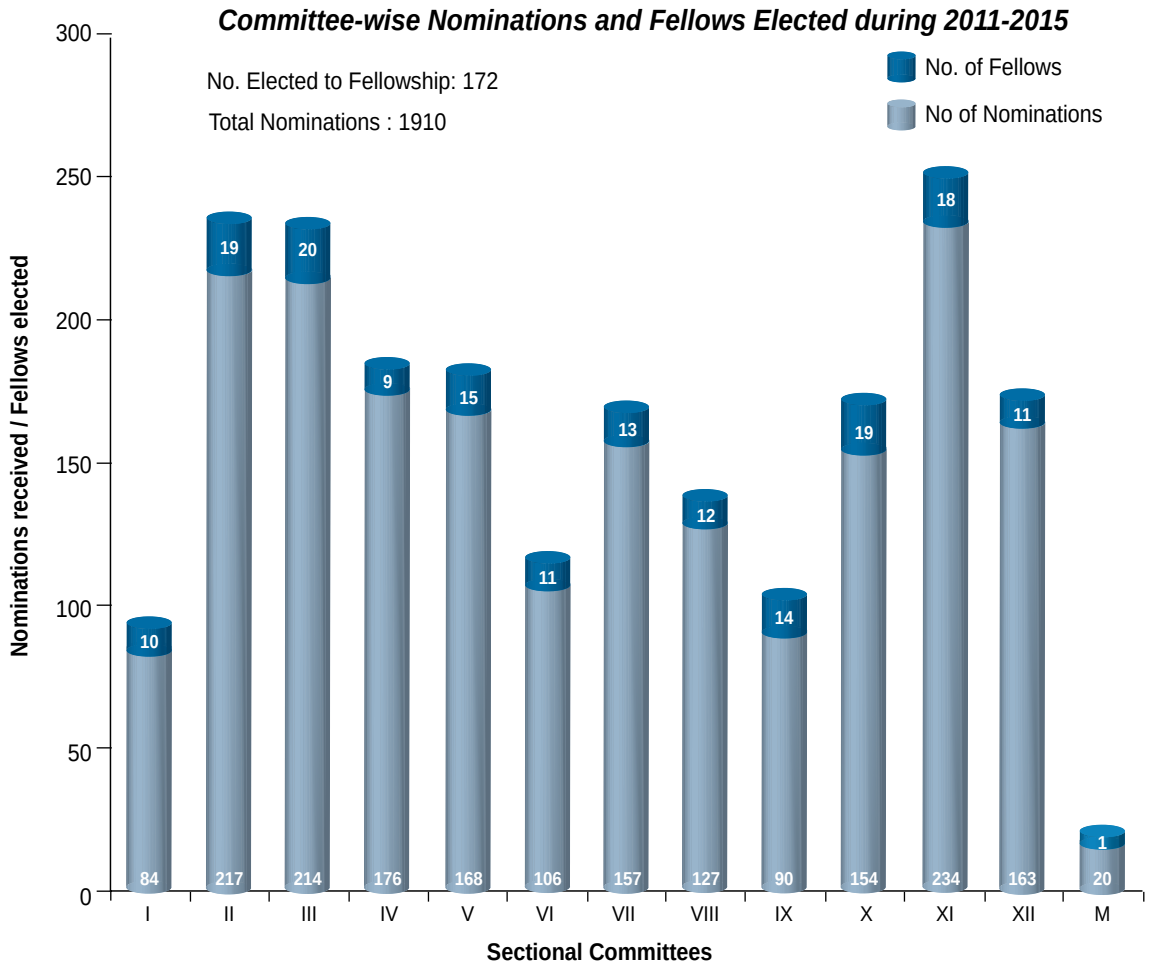
Charles Hard Townes, Professor, Department of Physics, University of California, Berkeley, USA.

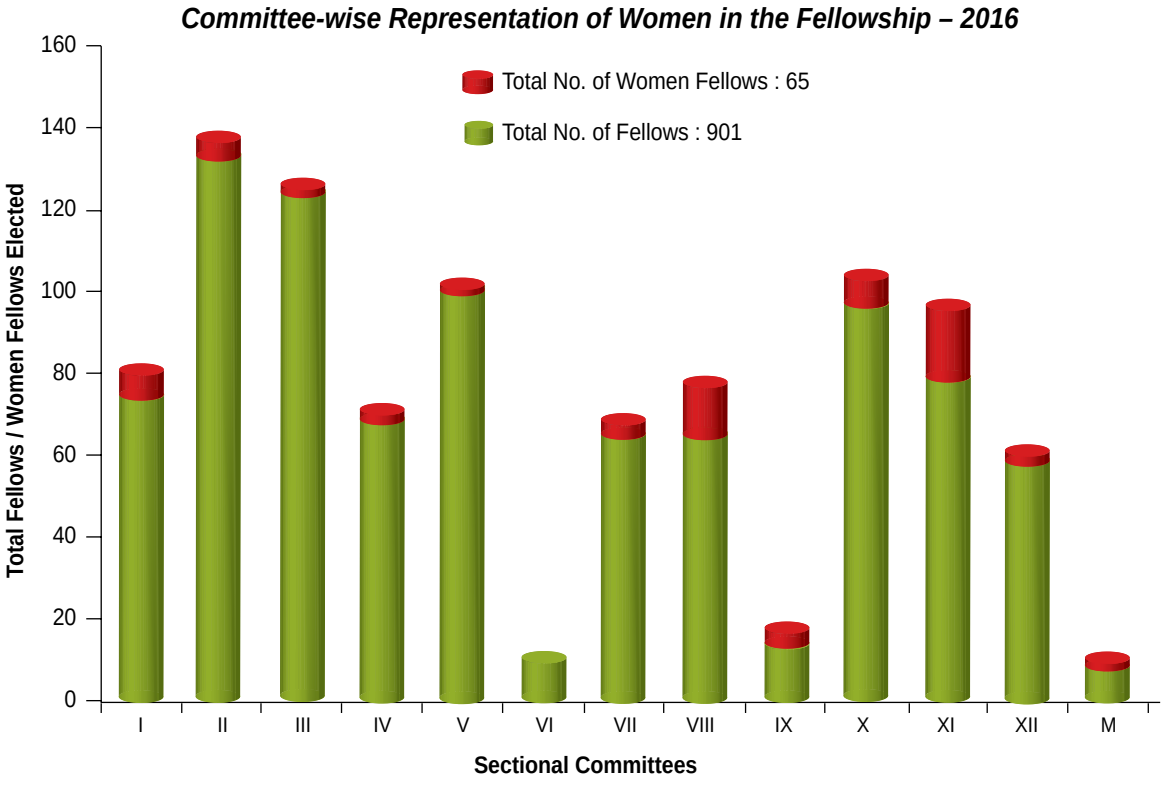
STATISTICS OF NOMINATIONS AND ELECTION TO FELLOWSHIP

Data relating to the nominations received and Fellows elected during the period 2011–2015 are given in the following graphs. The average age of the Fellows is 67.5 years. Only 20 out of 901 Fellows are below 50 years. Likewise, at present, only 65 women are Fellows of the Academy. Out of a total of 380 nominations, only 44 nominations of women scientists were received by the Academy for consideration of Fellowship in 2015. The Academy is deeply concerned about the age profile and the gender dis–equilibrium of the Fellowship.

Committee-wise Average Age of Nominees and Fellows Elected in 2015



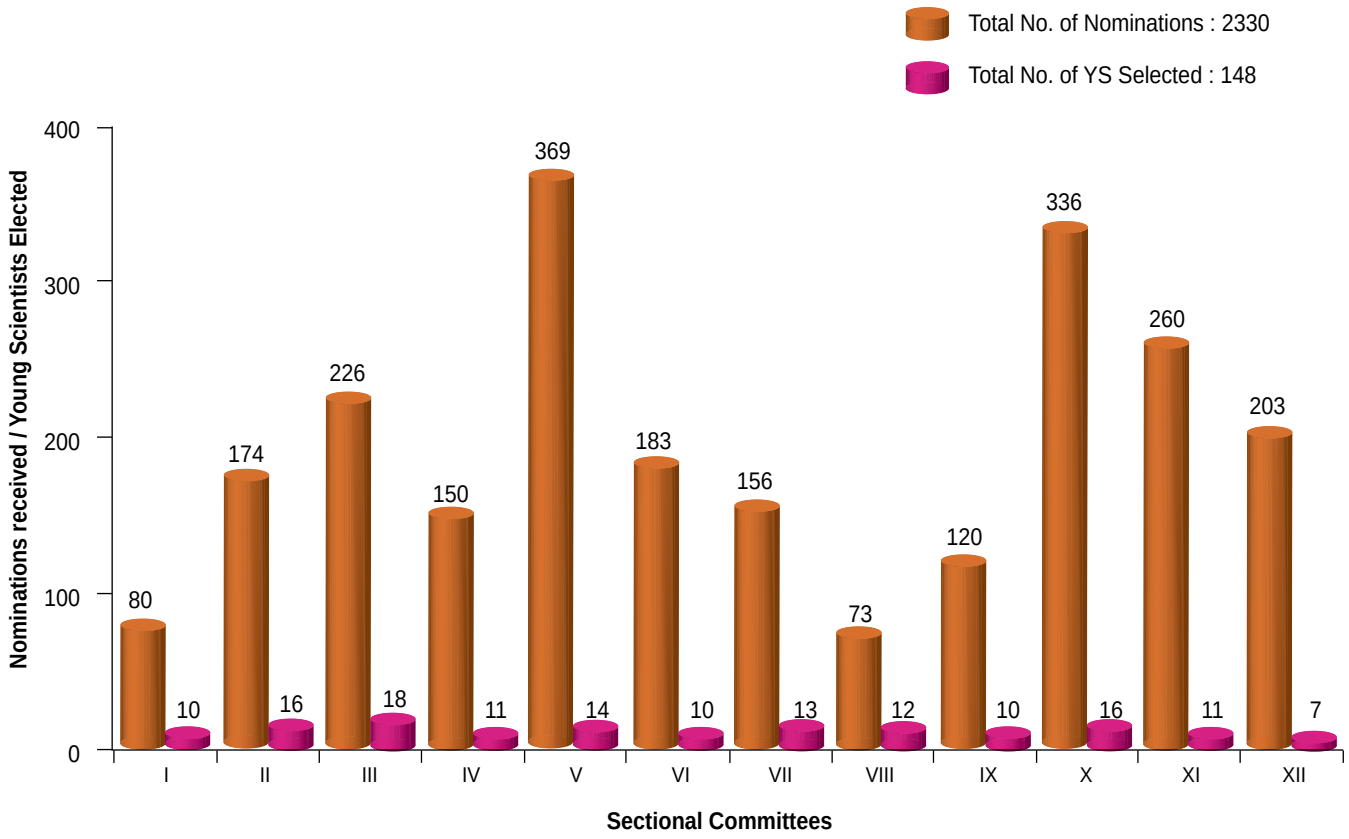

Committee-wise Nominations and Fellows Elected during 2011-2015
No. Elected to Fellowship: 172
Total Nominations : 1910
No. of Fellows
No of Nominations
Nominations received / Fellows elected
Sectional Committees
I II III IV V VI VII VIII IX X XI XII M
10 19 20 9 15 11 13 12 14 19 18 11 1
84 217 214 176 168 106 157 127 90 154 234 163 20


Committee-wise Representation of Women in the Fellowship – 2016
Total No. of Women Fellows : 65
Total No. of Fellows : 901
Total Fellows / Women Fellows Elected
Sectional Committees
I II III IV V VI VII VIII IX X XI XII M

STATISTICS OF NOMINATIONS AND SELECTION OF YOUNG SCIENTISTS

The graph below showing the large numbers of nominations for the YOUNG SCIENTIST awards and the numbers actually awarded during 2011–2015 period indicates the popularity of these awards.

Committee-wise Nominees and Young Scientists Selected during 2011–2015



Awards and Honours

The Academy plays a leading role in rewarding and encouraging excellence through a number of awards that it has instituted in different categories like International Awards, General Medal/Lecture Awards and Subject–wise Medal/Lecture Awards. The total number of these awards is 65.

Awards announced during the period under report are as follows:

(A) GENERAL MEDALS/LECTURES (2016)

1. **The Chandrasekhara Venkata Raman Medal** to **Professor N Sathyamurthy,** FNA, Director, Indian Institute of Science Education and Research, Mohali.
2. **The Shanti Swarup Bhatnagar Medal** to **Professor V Ravindranath,** FNA, Chair, Centre for Neurosciences, Indian Institute of Science, Bengaluru.
3. **The Kariamanikkam Srinivasa Krishnan Memorial Lecture** to **Professor Sudha Bhattacharya,** FNA, School of Environmental Sciences, Jawaharlal Nehru University New Delhi.

(B) SUBJECTWISE MEDALS/LECTURES/ AWARDS (2015)

a) Medals Instituted by the Academy

1. **The Satyendranath Bose Medal** to **Professor J Maharana,** FNA, Institute of Physics, Bhubaneswar.
2. **The Darashaw Nosherwanji Wadia Medal** to **Professor S Sengupta,** FNA, INSA Senior Scientist & Professor, Department of Geological Science, Jadavpur University, Kolkata.
3. **The Golden Jubilee Commemoration Medal (Animal Sciences)** to **Professor MD Gadgil,** FNA, DD Kosambi Visiting Research Professor, Goa University, Goa.

b) Endowed Medals

4. **Vishwakarma Medal** to **Dr AB Pandit,** FNA, UGC Research Scientist C (Professor Grade), Chemical Engineering Department, Institute of Chemical Technology, Mumbai.
5. **Professor GN Ramachandran 60th Birthday Commemoration Medal** to **Dr Amitabha Chattopadhyay,** FNA, JC Bose National Fellow and Outstanding Scientist (Director Level), CSIR–Centre for Cellular & Molecular Biology, Hyderabad.
6. **Professor Krishna Sahai Bilgrami Memorial Medal** to **Dr Yadvinder Singh,** FNA, INSA Senior Scientist, Department of Soils Science, Punjab Agricultural University, Ludhiana.

c) Endowment Lectures

7. **Dr Nitya Anand Endowment Lecture** to **Professor TK Kundu,** FNA, Transcription and Disease Laboratory, Molecular Biology and Genetics Unit, Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru.
8. **Professor Vishnu Vasudeva Narlikar Memorial Lecture** to **Professor SK Khanduja,** FNA, Professor of Mathematics, Indian Institute of Science Education and Research, Mohali.
9. **Professor Vishwa Nath Memorial Lecture** to **Professor Subrata Sinha,** FNA, Director, National Brain Research Centre, Manesar (Haryana).

International Programmes

The Academy has been pursuing several programmes for promotion of international relations. The international activities may be classified under two categories, viz., i) adherence to the ICSU and ii) bilateral exchange/collaboration with overseas academies.

INTERNATIONAL COUNCIL FOR SCIENCE (ICSU)

The Academy is the adhering body in India to the International Council for Science (ICSU) and to its 26 international Unions/Committees. The Academy has constituted National Committees to coordinate with ICSU activities in India. The National Committees are responsible for projecting the achievements of Indian science abroad and liaise with their international Unions/Committees.

The Academy facilitates participation of eminent Indian scientists to present achievements of Indian science in ICSU–sponsored General Assemblies/ Congresses and also to deliberate on policy matters that affect the International Science & Technology environment. On recommendation of the National Committees, the Academy nominates Indian scientists for executive positions in the ICSU bodies. The National Committee also recommends hosting of General Assembly/Congress/International Conferences of the International Unions in India.

Indian Scientists Elected in Various Executive Positions of ICSU

Dr Ranjini Bandyopadhyay, Raman Research Institute, Bengaluru as a Member of ICSU Committee on Freedom and Responsibility in the Conduct of Science for the term 2015–2018.

Professor AK Singhvi, Physical Research Laboratory, Ahmedabad, as Vice–President, International Union of Quaternary Research (INQUA) for the term 2015–2019.

Professor Ajit K Kembhavi, Inter University Centre for Astronomy and Astrophysics, Pune as Vice–President, International Astronomical Union (IAU) for the term 2015– 2018.

Professor LS Shashidhara, Indian Institute of Science Education and Research, Pune as General Secretary of IUBS for the term 2016–2019.

Scientists Nominated For Various Positions of ICSU & Its Unions

Professor DM Banerjee, formerly Professor, Department of Geology, University of Delhi, Delhi for the position of Vice–President, International Union of Geological Sciences (IUGS) for the term 2016–2020.

Professor VP Dimri, Distinguished Scientist, CSIR–National Geophysical Research Institute, Hyderabad for the membership of International Union of Geodesy & Geophysics (IUGG) Capacity Building and Education Committee for the term 2015–2019.

Dr Anil Kumar, Scientist, Physical Chemistry Division, CSIR–National Chemical Laboratory,

Pune for the position of Ordinary Member of Executive Committee of Committee on Data for Science & Technology (CODATA) for the term 2016–2018**.**

Dr V Prakash, Distinguished Scientist of CSIR & Honorary Director, Research Innovation and Development, Jagadguru Sri Shivarathreeswara University, Mysore for the position of President Elect of International Union of Food Science & Technology (IUFoST) for the period 2018–2020.

Dr Sivaramakrishnan Rajan, Director, National Centre for Antarctic and Ocean Research (NCAOR), Goa for the membership of Ad–hoc Panel for the Joint review of the Scientific Committee on Antarctic Research (SCAR) and Scientific Committee on Oceanic Research (SCOR).

Dr Anita A Rampal, Department of Education, University of Delhi for the membership of the Executive Committee of the International Commission on Mathematical Instruction (ICMI) which is commission of the International Mathematical Union (IMU).

Professor RB Singh, Department of Geography, Delhi School of Economics, Delhi University for the membership of ICSU Scientific Committee for 'Health and Wellbeing in the Changing Urban Environment: a Systems Analysis Approach' for the term 2016–2018 and re–nominated for the position of Vice–President, International Geographical Union (IGU) for the term 2016–2020.

ICSU Subscription

INSA pays subscription of ICSU and its affiliated Unions every year on the basis of the invoices received from the respective union. In 2015, a total of Rs. 2.06 crores was paid towards subscriptions to ICSU and its affiliated unions.

ICSU–sponsored General Assemblies/ Congresses/Conferences held during 2015:

A total of 16 scientists were supported by INSA for attending various ICSU sponsored conferences abroad during 2015–16 (Numbers of scientists supported for each conference are noted in parentheses).

- 26th IUGG General Assembly was held during June 22 – July 2, 2015 at Prague, Czech Republic (4).
- 19th INQUA 2015 Congress was held during July 27 – August 2, 2015 at Nagoya, Japan (3).
- 29th IAU General Assembly was held during August 3–14, 2015 at Honolulu, Hawaii, USA (2).
- 48th General Assembly and 45th World Chemistry Congress of International Union of Pure & Applied Chemistry (IUPAC) was held during August 6–14, 2015 at Busan, Korea (5).
- IGU Regional Conference was held during August 17–21, 2015 at Moscow, Russia.
- 23rd IUBMB Congress was held during August 24–28, 2015 at Brazil (1).
- 32nd IUBS General Assembly was held during December 14–16, 2015 at Berlin, Germany (1).

Financial support by INSA to ICSU Sponsored Seminar/ Symposia/ Conference/ Workshop organized in India

- An International Conference on *Bacillus anthracis*, *Bacillus cereus* and *Bacillus thuringienis (BACILLUS ACT 2015)* was organized by National Committee for International Union of Biochemistry and Molecular Biology (IUBMB) during October 27–31, 2015. Professor Rakesh Bhatnagar, School of Biotechnology, JNU, New Delhi was the convener (Report enclosed in ***Annexure–V***).
- The 13th Conference of the Asian Crystallographic Association (AsCA) was held at Science City, Kolkata during December 5–8, 2015 with Professor Pinakpani Chakrabarti, Department of Biochemistry and Bioinformatics Centre, Bose Institute, Kolkata being the convener (Report enclosed in ***Annexure–VI***).
- A meeting of the Executive Committee of Scientific Committee on Oceanic Research

(SCOR) was held at CSIR–National Institute of Oceanography, Goa during December 6–9, 2015, with Dr M Dileep Kumar, Chemical Oceanography Division, CSIR–NIO, Goa, being the Vonvener (Report enclosed in ***Annexure–VII***).

- The 9th International Geographical Union (IGU) Conference on *Land Use Change, Climate Extremes and Disaster Risk Reduction* was held at Paintal Memorial Golden Jubilee Auditorium, VP Chest Institute, University of Delhi, Delhi during March 18–20, 2016. Dr Suraj Mal, Shaheed Bhagat Singh College, University of Delhi, Delhi was the Convener (Report enclosed in ***Annexure–VIII***).

Meetings Organized by the ICSU National Committees

- The Annual meeting of the ICSU National Committee was held on July 28, 2015 at INSA premises.
- An International workshop on *Big and Open Data: Evolving Data Science Standards & Citation Attribution Practices*, was jointly organized by INSA, Indian Institute of Public Administration, Committee on Data for Science & Technology (CODATA) International and other funding agencies during November 5–6, 2015 at INSA premises (Report enclosed in ***Annexure–IX***).
- A meeting of the National Committee of the Committee on Data for Science & Technology (CODATA) was held on February 4, 2016 in the Academy premises.
- A Meeting of the Executive Committee of the International Geographical Union (IGU) was held on March 17, 2016 at INSA premises. This was attended by 10 IGU Office–bearers, including Professor Tom Beer, Ex IUGG (International Union of Geodesy and Geophysics) President (Report enclosed in ***Annexure–X***).

Support to Non–ICSU Programmes

In addition to providing support to scientists for ICSU conferences, the Academy also provides support to scientists for attending conferences sponsored by agencies other than the ICSU and its affiliated bodies. Scientists above 35 years of age are eligible for the Non–ICSU support from INSA.

Scientists invited to deliver plenary lecture or to preside a session or to present a paper, and who are provided partial travel and/or maintenance allowance during their stay abroad by some agencies, are given preference. In case of their selection, INSA provides financial support ranging between Rs. 20,000/– to Rs. 40,000/–.

During 2015–16, 37 scientists were supported by INSA under the Non–ICSU Programme.

Establishment of South Asia Regional Office of Future Earth at Devecha Center for Climate Change (DCCC), Indian Institute of Science, Bengaluru

International Council for Scientific Union (ICSU) initiated a new, 10–year international research initiative, named "Future Earth" from 2015. Future Earth (FE) is a merger of IGBP (International Geosphere–Biosphere Programme), WCRP (World Climate Research Programme), IHDP (International Human Dimensions Programme) and DIVERSITAS. The goal of Future Earth is to develop the knowledge required for societies worldwide to face challenges posed by global environmental change and to identify and implement solutions and opportunities for a transition to global sustainability. It has five global hubs which will function as a single entity, and are located in Canada, France, Japan, Sweden and United States. This will be complemented by various regional offices spread across the globe.

Dignitaries on dais during the inaugural function of the international workshop

As approved by INSA, the South Asia Regional Office of Future Earth has been established at Divecha Centre for Climate Change (DCCC), IISc, Bengaluru which would cover the region including SAARC countries and some of the Indian Ocean island countries. The main focus of the regional office is to promote scientific cooperation between India and neighbouring countries in Future Earth related activities. Professor Satheesh, FNA, Former Chairman of IGBP–WCRP National Committee has been designated as Executive Director, South Asia Regional Office of Future Earth.

Centre for International Co–operation in Science (CICS)

The Centre is mandated to promote S & T related activities for the mutual benefit of scientists of developing countries. The Centre functions under the auspices of the Indian National Science Academy (INSA) with administrative grant obtained from the Department of Science & Technology, Government of India.

The Centre has a major focus for S & T training of scientists from developing countries in Asia, Africa, Latin America and Arab regions. The other programmes include Travel Fellowship to Indian scientists to participate in international conferences, workshops outside India, and to support Training programme for Women Scientists of India on 'Intellectual Property Rights' and Science Motivational Programmes for school students.

INSA JRD–TATA Fellowship for Scientists and Technologists from Developing Countries

INSA instituted the INSA–JRD TATA Fellowship in honour of the late JRD Tata, a great visionary, philanthropist and a leading industrialist. The INSA JRD–TATA Fellowship is coordinated by CICS since 2006. The objective of this Fellowship is to extend facilities of advanced scientific infrastructure and expertise of India to scientists and researchers from developing countries. This fellowship has been established from an endowment received from Sir Dorabji Tata Trust and is awarded to researchers below 45 years of age holding permanent position in their respective countries. The duration of fellowship is for a maximum period of three months.

During the year 2015–16, 14 researchers from countries like Bangladesh (1), Cameroon (2), China (2), Egypt (1), Indonesia (1), Nepal (1) and Nigeria (3), South Africa (1), Uzbekistan (1) and Zimbabwe (1) were awarded INSA JRD–TATA Fellowship and six candidates successfully completed the training programme.

JNCASR–CICS Fellowship for Developing Country Scientists

This fellowship programme was jointly instituted by the Jawaharlal Nehru Centre for Advanced Scientific Research (JNCASR), Bengaluru and the Centre for International Co–operation in Science (CICS), Chennai in 2009, to encourage mobility of scientists from developing countries. The fellowship covers short–term research, training or participatory research work in physical, chemical or biological sciences in reputed scientific institutions in India including the JNCASR for researchers below 45 years of age holding permanent position, in their respective countries.

During 2015–16, two fellows from Nigeria completed their training programme.

DBT–TWAS Post–Graduate & Post–Doctoral Biotechnology Fellowships

DBT–TWAS FELLOWSHIP is jointly promoted by TWAS, the academy of sciences for the developing world, Italy and Department of Biotechnology (DBT), Ministry of Science & Technology, Government of India, New Delhi for scientists from developing countries other than India in newly emerging areas in Biotechnology at premier research institutions in India. CICS is coordinating this activity on behalf of DBT, since 2010.

This Post Graduate and Post–Doctoral Fellowships programme are intended for researchers from developing countries who wish to pursue research leading towards Ph.D/Post–Doctoral Fellowship in newly emerging areas of biotechnology for which facilities are available in premier research laboratories/institutes in India. The Post–Graduate Fellowships is for a period up to 5 years for Full–Time fellowships (for those willing to register for a Ph.D in India), and for a period of 12–24 months for Sandwich Fellowship (for those already registered

for a Ph.D in their home country). Candidates below 35 years are eligible to apply. The Post–Doctoral Fellowships is for a period of 12–18 months for researchers below 45 years of age holding permanent position.

During the year 2015–16, nine researchers from Cameroon (2), Egypt (1), Nepal (2) and Nigeria (2) were awarded DBT–TWAS Post–Graduate Fellowship and two researchers from Egypt (1) and Nigeria (1) were awarded Post–Doctoral Fellowship.

India Science and Research Fellowship Program (ISRF)

India Science and Research Fellowship (ISRF) is to provide opportunity to scientists from developing countries of Afghanistan, Bangladesh, Bhutan, Maldives, Myanmar, Nepal and Sri Lanka to work in advanced research areas in all major disciplines of science and technology including engineering and medical sciences at premier research laboratories in India.

The fellowship is intended for researchers holding permanent positions in their countries and who are actively involved in research activities. They can visit India under the India Science and Research Fellowship (ISRF) Programme to pursue research in frontier/advanced areas of science including Engineering and Medical Sciences for a period of 3–6 months at premier research laboratories in India.

CICS is the co–ordinating agency for the India Science and Research Fellowship (ISRF) Program funded by the Department of Science & Technology, New Delhi.

The ISRF Fellowship was officially launched in December 2014. DST initially launched the program for Bangladesh and Sri Lanka with Bangladesh Academy of Sciences (BAS) and Ministry of Technology & Research, Sri Lanka as the partnering agencies.

During 2015–16, 27 researchers were awarded the fellowship and four researchers completed ISRF fellowship training programme.

INSA–CSIR–DAE/BRNS–CICS Travel Fellowship Programme (For Indian Scientists/Researchers affiliated to Indian Institutions)

CICS provides financial support towards partial travel/registration/per diem to scientists/researchers in various science disciplines and other related areas to attend international scientific conferences, seminars and workshops abroad. This scheme is jointly sponsored by the Indian National Science Academy (INSA)/ Council of Scientific and Industrial Research (CSIR)/ Department of Atomic Energy (DAE)/ Board of Research in Nuclear Sciences (BRNS) and CICS.

During the year 2015–16, 1791 applications were received, and 713 were awarded the fellowship.

Knowledge Involvement in Research Advancement through Nurturing–Intellectual Property Right (KIRAN–IPR) Programme

A scheme of Department of Science and Technology, Government of India for women 'Knowledge Involvement in Research Advancement through Nurturing – Intellectual Property Right (KIRAN–IPR) Programme (erstwhile known as WOS–C Scheme)' is being implemented by Patent Facilitating Centre, Technology Information Forecasting and Assessment Council (TIFAC), New Delhi for training of women scientists on IP matters. CICS is the nodal agency for the southern region. This program has provided opportunity for women, who are not able to pursue science as a career, to seek self–employment.

Candidates with M.Sc/Ph.D in physical sciences, chemical sciences, life sciences or B.E/B. Tech, or M.E/M.Tech or M.B.B.S/MS/MD/MVSc or B.Pharm/M.Pharm with good academic record are eligible to apply. Candidates are selected through a written test followed by an interview. Selected candidates are provided scholarship stipulated by TIFAC based on their qualification.

Selected candidates from all regions are offered common orientation programme at TIFAC, New Delhi during the first 4–5 weeks, followed by 11–months on–the job training facilitated by four centres (TIFAC, New Delhi; CICS, Chennai; URDIP, Pune and IIT, Kharagpur).

For eighth batch of the KIRAN–IPR programme, Patent Facilitating Centre (PFC) received 715 applications for its Chennai centre for the academic year 2015–16. Out of 715 candidates, 28 candidates were selected for the IP training.

INSA International Collaboration and Exchange Programme

Since its inception, the Academy has fostered scientific relationships with prominent science academies and organizations of the world to develop and promote internationalization of science. These relationships cover exchange of information/ publications and visits, organization of joint symposia/seminars and collaborative research projects with the Science Academies/ Organizations in 50 countries in Europe, Asia, North America, South America and Latin America.

The Inter Academy Exchange Committee at its Meeting held on October 15, 2015 selected 58 Indian scientists to visit abroad during 2016 under the various Bilateral Exchange Programmes of the Academy. In addition, the Committee after going through the nominations received for INSA Chairs selected one distinguished senior scientist named after Professor PC Ray and one middle level outstanding scientist named after Dr BP Pal.

During the year 2015–16, 88 Indian scientists visited abroad and 75 overseas scientists visited India under the various exchange/ International programmes.

New Initiatives

Professor Krishan Lal, Immediate Past President INSA was elected President AASSA during October 2014 for the term 2014–2016. As approved by INSA Council, AASSA Secretariat has been established at INSA premises. This is a temporary secretariat, funded by DST and will be co–terminus with the term of Professor Krishan Lal, as President AASSA.

INSA has become a member of the Science Council of Asia (SCA) during its 15th SCA Conference held in Siem Reap, Cambodia in May 2015.

Joint Bilateral Meeting/Workshop/ Symposium

IAP/IAC/IAMP Joint Meeting

The Joint Session of IAP Executive Committee, IAC Board and IAMP Executive Committee were held during September 28–30, 2015 in Academy premises. 51 delegates including Presidents of IAP/ IAC/IAMP member academies, representatives, delegations, observers and invited guests participated in this event. There were two joint sessions besides a meeting of the InterAcademy Partnership Board. (Report enclosed in ***Annexure–XI***).

A group picture of the delegates attending the joint meeting

Academia Sinica (Taiwan) and the University of Calcutta Workshop

A Joint Workshop was organized on October 7–8, 2015 at Centre for Research in Nanoscience and Nanotechnology, University of Calcutta, Salt Lake by Academia Sinica and University of Calcutta under the aegis of agreement signed between Academia Sinica and the Indian National Science Academy. Dr Sue–Lin Chao, Director of International Affairs Office, Academia Sinica was the coordinator from Taiwan and Professor Amitava Raychaudhuri, FNA and Professor Dhrubajyoti Chattopadhyay of the University of Calcutta were

Dignitaries on dais during the joint workshop at Kolkata

the coordinators from India. (Report enclosed in ***Annexure–XII***).

INSA–German National Academy of Sciences Leopoldina Symposium

The 6th INSA–German National Academy of Sciences Leopoldina (GNASL) joint symposium on *The Brain and the Eye* was organized at LV Prasad Eye Institute, Hyderabad during February 1–2, 2016. The symposium focused on all aspects of Neurosciences including biochemistry, molecular biology, basic research and psychology. Professor Brigitte Roeder, Hamburg University, Germany delivered the Leibniz Prize Lecture on *Sensitive Stages in Human Brain Development* on February 3, 2016. President, INSA and President, German National Academy of Sciences, Leopoldina attended the symposium. 10 scientists from Europe and 11 scientists from India participated in the symposium.

International Awards/Lectures/Medals

Jawaharlal Nehru Birth Centenary Medal Lecture

Professor Venkatraman Ramakrishnan, President, The Royal Society, London visited India during December 29, 2015–January 11, 2016 and delivered the Jawaharlal Nehru Birth Centenary Medal Lecture (2016) of INSA on *One hundred years of Visualizing Molecules* at IISER Mohali, Chandigarh on January 4, 2016.

Cooperation with International and Regional Organisations

Meetings organized by the InterAcademy Partnership (IAP) / InterAcademy Council (IAC)

- Dr Mahesh Kumar, Indian Institute of Technology Jodhpur was nominated to attend the workshop on *Realizing a Sustainable Energy Future: Roles and Tasks for the World's Academies* which was hosted by the Royal Netherlands Academy of Arts and Sciences, Netherlands on June 26, 2015 organized by InterAcademy Council (IAC).
- Dr Anindita Bhadra, Indian Institute of Science Education and Research, Kolkata as IAP Young Scientist attended IAP Young Scientists Side Event on *Scoping the future: views and ideas of young scientists to tackle global challenges* held on November 4, 2015 and the World Science Forum (WSF) held during November 4–7, 2015 at Budapest, Hungary. Dr Bhadra is the Chairperson of newly established Indian National Young Academy of Sciences (INYAS).
- Professor JP Mittal, Vice President and Dr Alok Moitra, Executive Director, INSA on the invitation of President, Academy of Science of South Africa (ASSAf), visited South Africa to participate in the IAP Conference on *Science Advice* and 8th General Assembly hosted by the Academy of Science of South Africa in Hermanus, South Africa during February 28–March 2, 2016 (Report enclosed in ***Annexure–XIII***).
- Dr S Ayyappan, former DG–ICAR, has been nominated by the Academy as an expert for the New IAP Project on *Agriculture and Food and Nutrition Security.*
- Professor RB Singh, Head, Department of Geography, Delhi School of Economics, University of Delhi has been nominated by the Academy as an expert for IAP International Committee to assist with implementation of the Sendai Framework on 'Disaster Risk Reduction'.

Group picture of the participants during the IAP Conference

- Professor SC Lakhotia, Vice–President, INSA and Professor Emeritus & DAE–Raja Ramanna Fellow, Banaras Hindu University, Varanasi has been nominated as the National Focal Point for IAP's Science Education/Science Literacy activities from India. Professor Lakhotia is also a member of Science Education Programme of the Academy.

TWAS/TWANSO Meeting and Conference

The Academy nominated 16 INSA Fellows to attend the 13th General Conference and 26th General Meeting of The World Academy of Sciences (TWAS) held at Vienna, Austria during November 18–21, 2015.

Participation of INSA in the Meetings of SCA/ IAMP/AASSA/STS/IASSF/ G Science

- The 15th SCA Conference on *Science and Technology for Culture* was organized by Institute of Technology of Cambodia in cooperation with the Ministry of Education, Youth and Sports of Cambodia, Ministry of Culture and Fine–Arts of Cambodia, and the Science Council of Japan. Professor Rajendra Prasad, Vice–President, INSA attended the conference in Siem Reap, Cambodia held during May 15–16, 2015 as an observer.

- Professor SC Lakhotia, Vice–President, INSA visited China to participate in the IAMP Symposium on *Exploring Traditional Medicine* held during September 23–24, 2015 in Beijing.

- Dr Arun Kumar Kallare Puttaraje Gowda, Head, Laboratory of Molecular Genetics, Centre for DNA Fingerprinting & Diagnostics, Hyderabad attended the 12th Annual Meeting of Science and Technology in Society (STS) forum as Future Leader held during October 4–6, 2015. He also attended a special event on *Dialogue between Nobel Laureates and Future Leaders* on October 3, 2015 in Kyoto, Japan.

- Professor Chitra Mandal, Acting Director, J.C. Bose National Fellow, Head, CSIR–Innovation Complex, Kolkata attended AASSA International Symposium on *Global Health Issues in Asia* during October 19–21, 2015 hosted by Korean Academy of Sciences and Technology in Daejeon, Korea.

- Professor R Gadagkar, President INSA, on the invitation of Korean Academy of Science & Technology (KAST), visited Korea to participate in 2015 Inter Academy Seoul Science Forum (IASSF) held during November 11–12, 2015.

- Dr Chandrima Shaha, Vice–President, INSA and Professor Subrata Sinha, National Brain Research Centre, Manesar attended, on the invitation of Professor Takashi Onishi, President, Science Council of Japan, the G–Science Academies Meetings held in Tokyo, Japan during February 17–19, 2016. During the meeting, the deliberations were focused on the following three issues:

  a. Understanding, Protecting and Developing Global Brain Resources

  b. Strengthening Disaster Resilience for Sustainable Development and

  c. Nurturing Future Scientists

The Joint Statements on the above three issues released by all the participating academies are enclosed as ***Annexure–XIV(a, b, c)***.

Visits of Distinguished Overseas Scientists to India

- Dr Vincent Caudrelier, City University London, Northampton Square, London, and recipient of Dr V Ramalingaswami Chair of INSA (2015–16) visited Saha Institute of Nuclear Physics, Kolkata; Jawaharlal Nehru University, New Delhi and Delhi University. During his visit he delivered lectures at JNU on July 29 and at Delhi University on July 30.
- Dr Saibal Roy, Tyndall National Institute, Cork, Ireland and recipient of Professor AS Paintal Chair of INSA (2015–16) visited Indian Association for the Cultivation of Science, Saha Institute of Nuclear Physics, SN Bose National Centre for Basic Sciences and CSIR–Central Glass & Ceramic Research Institute, Kolkata.
- Professor Neelima R Sinha, University of California, USA, and recipient of Dr BP Pal Chair of INSA (2015–16) visited Delhi University, Indian Institute of Science, Bengaluru and IISER Pune. During her visit, she delivered a lecture on *Heteroblasty and Heterophylly – What Happens When Two Programs Collide?* at Department of Botany, Delhi University on September 3, 2015.

Reports on INSA Chair Awardees are enclosed in ***Annexure–XV***.

➤ Professor Venkatraman Ramakrishnan, President, The Royal Society, London visited India during December 29, 2015 – January 11, 2016. On January 7, 2016 he delivered Rutherford Memorial Lecture of The Royal Society, London on *The use of Recent Advances in Electron Microscopy to Study Ribosome Structure* at JNU Convention Centre, New Delhi.

Professor Ramakrishnan also delivered a public lecture on *On nobody's word: evidence and modern science* at KK Birla Auditorium, FICCI, New Delhi on January 8, 2016. Later he visited Rashtrapati Bhawan to meet the Hon'able President of India. He was accompanied by the President and Vice–Presidents of INSA.

On January 10, 2016, Professor Ramakrishnan visited INSA and had discussions with President and other officers of INSA for further strengthening the scientific bilateral cooperation between INSA and the Royal Society London.

➤ A three member delegation of the German National Academy of Sciences Leopoldina, comprising of Professor Dr Jörg Hinrich Hacker, President; Dr Marina Koch–Krumrei, Head, International Relations Department and Dr Ruth Narmann, Deputy Head, International Relations Department, visited the Academy on February 4, 2016. They had a discussion meeting with Dr Chandrima Shaha, Vice–President, INSA; Professor Subrata Sinha, Director, National Brain Research Centre, Manesar; Professor NK Gupta, Indian Institute of Technology Delhi, Delhi and Dr Alok K Moitra, Executive Director, INSA about the future scientific activities under INSA–GNASL bilateral exchange programme on the following selected topics of mutual interest to both the Academies:

- Genome Editing
- Anti–Bacterial/Anti–Microbial Resistance/ Drug Resistance
- Climate Change in Relation to Agriculture, Health and Energy

Science Promotion

One of the basic mandate of the Indian National Science Academy is the promotion of science in India and harnessing scientific knowledge for the welfare of humankind. The Academy has evolved mechanisms over the years to identify and promote scientific endeavours and projects in various institutions round the country that hold promise and potential.

The Academy believes that the right support at the right time for fruitful scientific projects can help in achieving results with immense benefits for the country. INSA has supported several such endeavours in the past as part of its Science Promotion Programme. The Academy has also assisted in organizing seminars/ symposia/ conferences at national as well as international levels on contemporary issues of wide–ranging implications for the country, thus furthering the cause of Indian science.

During the year, the Academy used its own resources to support various schemes under the Science Promotion Programme. These include: (i) Platinum Jubilee Chair for Promotion and Service to Science, (ii) Research Professorships, (iii) INSA Senior Scientists, (iv) Honorary Scientists, (v) Young Scientists Research Projects, and (vi) Visiting Fellowships. In addition, the Academy also provided assistance for organizing National/International Seminars and Symposia.

INSA Platinum Jubilee Chair for Promotion and Service to Science

On the occasion of the Platinum Jubilee Year (2009–10), the Academy instituted a Chair to recognize sustained life time contribution of a scientist/ technologist to the promotion and service to science in India. The main objective of instituting the Chair is to recognize a scientist/technologist who has made sustained life time contributions to the promotion and service to Indian science. The awardee of the Chair may continue to work in an area of his/her choice in any R&D Centre/University/Institution in India. The Chair is tenable for five years.

Research Professorships

The Academy in 1984 instituted Research Professorships to recognize the pioneering contribution of Indian scientists to science and/ or technology. These prestigious Professorship are for a period of five years with the total number not exceeding five at any given time. The INSA Research Professor may continue to work in his/her own institution or in any other institution within India.

The following four scientists continued their research programme as INSA Research Professorship:

- **Srinivasa Ramanujan Research Professor–ship** – Professor HY Mohan Ram, FNA, Shriram

Institute for Industrial Research, Delhi (w.e.f. 2011).

- **Albert Einstein Centenary Research Professorship**–Professor M Vijayan, FNA, Molecular Biophysics Unit, Indian Institute of Science, Bengaluru (w.e.f. 2012).
- **INSA Golden Jubilee Research Professorship**–Professor Samir Bhattacharya, FNA, Centre of Advanced Studies in Zoology, School of Life Sciences, Visva Bharati, Santiniketan (w.e.f. 2015).
- **INSA CV Raman Research Professorship** –Professor N Mukunda, FNA, Indian Institute of Science, Bengaluru (w.e.f. 2015).

Support for Research to Senior Scientists and Honorary Scientists

The Academy has instituted a scheme for its Senior Scientists and Honorary Scientists to continue their high quality research in their specialized disciplines through recognized institutions/universities in India. Presently, 91 Fellows are holding position of Senior Scientists and 72 of Honorary Scientists under this programme.

The list of Senior Scientists and Honorary Scientists is given in ***Annexure–XVI***.

Support for Research to Young Scientist Medal Awardees

The Academy provides startup or interim research grant to INSA Young Scientist Medal Awardees based on their research proposals. 57 Young Scientist Awardees were being supported for their research programme and two were given interim fellowship.

The names of these Young Scientists are provided in ***Annexure–XVII***.

Support for International/National Seminars/ Symposia/Conferences

The Academy supported 67 Conferences/Seminars/ Symposia/Workshops, which were held in various parts of India.

The Conferences/ Seminars/ Symposia/Work–shops supported by the Academy are listed in ***Annexure–XVIII***.

Visiting Fellowship Scheme

In 1991, the Academy instituted the Visiting Fellowship Scheme with the aim to provide specialized training or to conduct advanced research in any Indian research institutes/laboratories other than one's own institution. Five scientists were offered the Visiting Fellowship under this programme for collaborative research, and to receive training for furtherance of their research capabilities within the country.

Highlights of research work carried out by INSA Research Professors/Senior Scientists, Honorary Scientists and Young Scientist Medal Awardees are mentioned in ***Annexure–XIX***.

History of Science

India has a long and proud scientific tradition. Science and technology have always been an integral part of Indian culture. India's earliest scientists are credited with remarkable scientific and technological discoveries in fields of Mathematics, Astronomy, Metallurgy and Medicine leading to several practical applications. The country also has a vast repository of traditional knowledge related to herbal medicines, nutrition, water harvesting etc. which along with the rich scientific tradition needs to be studied, analyzed and preserved for the generations to come.

The Academy, as a part of its History of Science programme, has been in the forefront of catalyzing and supporting programmes that seek to document, analyses and preserve India's rich scientific heritage. Such programmes have not only thrown light on scientific methodologies followed in India in the past but have also provided solutions to some intractable problems that the country faces today.

Collection of source material, its compilation, documentation, translation and critical evaluation is the major activity of the History of Science programme. The programme also involves writing of monographs, organization of discussion meetings and publication of the quarterly journal–the *Indian Journal of History of Science (IJHS).* The programme is managed and organized under the guidance of the Indian National Commission for History of Science through the Research Council.

A workshop cum project investigator meet along with the meeting of the Research Council and National Commission for History was held at Indian Institute of Chemical Technology, Hyderabad during October 8–10, 2015 to assess the progress of ongoing projects and consider the new proposals received for support. Commission recommended seven new projects and reviewed 19 ongoing projects on diverse topics like history of cannons, metals and

Professor D Balasubramanian, Chair, Research Council with INSA Fellows and other participants during the History of Science seminar and Project Investigators' meeting at Indian Institute of Chemical Technology, Hyderabad

metallurgy, mathematics and astronomy, ecology and forestry, art and architecture, science education and society, history, science and culture, critical study of manuscript based study from Sanskrit, Malayalam, Persian and other sources. Out of the 19 ongoing projects, nine projects were accomplished during the current financial year. The highlight of the work done under the projects is mentioned at ***Annexure–XX***.

A two day seminar entitled "The Indian Heritage: A Genomic View" was also organized along with the meeting of the Research Council and National Commission. During the seminar, papers on Iconic Flora and Fauna of Heritage Significance in India, Rice Genome its Origin & Domestication; Genome of the Holy basil (*Ocimum sanctum*), Diversity and Genome Sequence of Mango, Evolution of the Sacred Lotus, Evolutionary History of Asian Elephant and Tigers, Genetic Structure of Wild Populations of the Indian Rhinoceros and Peopling and Genomic Structure of Ethnic India, were presented by Indian and overseas scientists.

The division also publishes the *Indian Journal of History of Science* (quarterly) as part of the publication programme of the Academy. During 2015, *IJHS* completed its 50th year of uninterrupted publication. In the 50th Anniversary year, all the four issues of 50th Volume covering 675 pages were published. During the year, the journal started providing DOI numbers to all published papers and also obtained e–ISSN number for the journal (ISSN 2454–9991).

The reprinting of the out of print books in History of Science has also been taken up. During the year 2015, two books entitled '*Āryabhaṭīya* of Āryabhaṭa', critically edited with translation and notes by KS Shukla and KV Sarma and '*Āryabhaṭīya* of Āryabhaṭa' with commentary of Sūryadeva Yajvan edited by KV Sarma have been reprinted.

Science & Society

Under the Science & Society Programme, the Academy endeavours to address issues pertaining to science and technology that are of relevance to the society. Some of the initiatives are: Science Education Programme, study group for preparation of evidence–based well considered documents and topical seminars of societal relevance to initiate enthusiasm and positive discussion amongst the scientific community and influence science policy. Some of the recent activities of Science and Society division are noted below.

Public–Experts Interaction Event on Climate Change Issues

In the year 2014, a series of outreach events on climate change issues were organized by INSA with the support of US–NAS. Professor V Rajamani, School of Environmental Sciences, Jawaharlal Nehru University, New Delhi, was the coordinator of this programme. As the funds were not fully utilized, US–NAS agreed to extend this programme and to use the balance funds for related outreach activities. The first activity was organized in Anna University, Chennai during March 4–5, 2016.

National Science Day

The Academy had taken a decision in 2014 that, as far as possible, INSA should arrange lecture programmes in association with other educational/ research institutions in Delhi so that students/ faculty are benefitted.

Indian National Science Academy, in collaboration with The World Academy of Sciences–National Chapter, celebrated the National Science Day on February 29, 2016. Five public lectures were organized at University of Delhi (South Campus), JNU and IIT–D. Professor Anil Kumar Gupta of IIM–Ahmedabad and founder of Honey Bee Network delivered a lecture on *Is Autopoietic Model of Creativity and Innovation Self–limiting?* at DU and JNU. Professor Ashok Jhunjhunwala, Department of Electrical Engineering, Indian Institute of Technology Madras, Chennai delivered lecture on *How does India get 50% of its Electrical Power from Solar by 2030?* at JNU & IIT–D. Professor MS Raghunathan, Department of Mathematics, Indian Institute of Technology Bombay, Mumbai delivered a lecture on *Making Mathematics in India* at DU.

Indian National Young Academy of Sciences (INYAS)

The Indian National Science Academy established Indian National Young Academy of Sciences (INYAS). The first 20 members of INYAS were selected from the pool of INSA Young Scientist awardees, who were below 40 years of age. In the second batch, 13 members (some of them are our Young Scientist awardees) have been selected.

INYAS organized a scientific symposium at the Annual General Meeting of INSA hosted by IISER Mohali, in October 2015. The symposium was aimed to showcase the academic diversity and strength of the newly founded young academy.

INYAS conducted the first Science Camp at Choksi Hall, Indian Institute of Science, Bengaluru during December 2–3, 2015. The second camp was also held at Jawahar Navodaya Vidyalaya, Bengaluru Urban (JNV) on December 4, 2015. This camp invited 50 students from JNV from 9th to 11th standards who were given lectures on: i) At the interface of Physics and Chemistry on nanomaterials and ii) At the interface of Chemistry and Biology on the functioning of Brain and related diseases. Various experiments in physics, chemistry and biology, relating to everyday activities, were demonstrated.

The first General Body Meeting of INYAS was held on February 27, 2016 at INSA. Members discussed future activities and plans to develop the INYAS website and other programmes.

Brain–storming session on 'Spreading Quality Teaching'

A Brain–storming session on 'Spreading Quality Teaching' was organized in INSA premises on March 29, 2016 by Professor SC Lakhotia and Professor LS Shashidhara, Vice–Presidents, INSA. The main objective of this session was to create network among teachers for achieving quality science education in the country. The three science Academies already have programmes for improving teaching quality. The idea of this brain storming session is to expand the horizon, so that teachers and students across the Indian colleges/universities can have the benefit of quality science teaching methods.

During the meeting, members identified contact persons among participants who will collate protocols for different lab exercises that are doable at colleges with basic facilities. Professor Lakhotia suggested to plan workshops for training and to take advantage of the existing inter–academy programmes for funding such workshops.

Lectures by INSA Fellows to Young Students and Teachers of Schools and Colleges in the Remote /Rural Areas

The Academy organizes a scheme under which lecture–cum–interaction meetings were organized by Fellows at different schools/colleges in semi–rural and rural areas. Recently, the Academy has received suggestions from INSA Young Scientists and INSA Teacher Awardees to involve them in this programme. This has been enthusiastically accepted by the Academy. It has been decided to include the interested INSA Young Scientists and INSA Teacher Awardees from the year 2016 in this programme.

During the year, a total of 59 popular lectures were delivered to young students and teachers of schools and colleges in the remote/rural areas.

The list of lectures delivered is mentioned in ***Annexure–XXI.***

Partial assistance by INSA for participation in International Conferences abroad sponsored by agencies other than ICSU and its listed bodies

Partial assistance is provided by INSA for participation in International Conferences abroad sponsored by agencies other than ICSU and its listed bodies (called Non–ICSU Conferences). This initiative was suspended for some time due to shortage of funds which however, has been resumed from October 2015. Since then, 37 scientists have been supported to attend International Conferences abroad.

Inter Academy Panel on 'Ethics in Science'

The Academy established an Inter Academy Panel on 'Ethics in Science'. The panel is expected to develop guidelines for ethical conduct of science, which will be adopted by all the Academies and other academic and research institutions across the country. Any complaint received by the Academies on ethical issues will be referred to this panel. The first meeting of this committee was held on September 18, 2015 at IASc, Bengaluru.

ACTIVITIES UNDER LOCAL CHAPTERS

Nurturing science and promoting excellence in the country is one of the objectives of the Academy. Towards this end, INSA has established Local Chapters in different regions of the country. These Local Chapters have been established at places where five or more Fellows reside. The primary aim of these chapters is popularizing science among the school and college going students and masses in

general, strengthening existing scientific activities, and promoting interaction amongst the local scientific community, local academies and learned bodies and the Indian National Science Academy.

Presently there are 17 local chapters in different regions of the country. Some of the local chapters have shown interest to collaborate with local scientific bodies for inculcating interest in scientific issues. The Local Chapters have been charged with the responsibility of organizing INSA award lectures. Besides lectures, chapters are also engaged in other activities of holding meeting of Fellows of the chapter to discuss problems of the respective regions. The local chapters of the Academy also organize their own outreach programmes aimed at Capacity Building initiatives in Science Education which are coordinated by INSA's Science Education Panel (Convener: Professor SC Lakhotia). Activities of some of the local chapters are described below:

Allahabad Local Chapter: (Convener–Professor BK Agrawal, FNA, Department of Physics, Allahabad University, Allahabad).

The following lectures were delivered under Allahabad Local Chapter:

1. *Decoding Cyanobacterial Survival under Arsenic Stress through Proteomic, Genomic and Bioinformatics Approaches* by Professor LC Rai on August 22, 2015 at Botany Department, Allahabad University.
2. *OPTICS* by Professor BK Agrawal on October 18, 2015 at Vivekanand College, Allahabad.

Science Day was celebrated with a popular lecture on *Graphene* by Professor BK Agrawal and also Extempore speeches and posters by students on February 28, 2016 at Physics Department of Allahabad University.

Chandigarh Local Chapter: (Convener–Professor RC Mahajan, FNA, Department of Parasitology, Post Graduate Institute of Medical Education and Research, Chandigarh).

The following activities took place under Chandigarh Local Chapter:

1. Professor (Mrs) Sudesh Khunduja, Department of Mathematics, llSER Mohali delivered **VV Narlikar Memorial Award Lecture of INSA (2014)** on November 18, 2015 in the Lecture Hall Complex of IISER, Mohali. The title of the talk was *Inducible Polynomials*. Professor N Sathyamurthy, Director, IISER Mohali presided.
2. Professor V Ramakrishnan, Nobel Laureate and President Royal Society London delivered the **Jawaharlal Nehru Birth Centenary Medal Lecture of INSA** on January 4, 2016 at IISER Mohali. The title of the talk was *One hundred years of observing molecules*. Professor N Sathyamurthy, Director, IISER Mohali presided.

Chennai Local Chapter: (Convener–Professor BS Murty, FNA, Department of Metallurgical and Materials Engineering, Indian Institute of Technology, Madras)

The following lectures were delivered at IIT, Madras under Chennai Local Chaper:

1. *String Theory* by Professor J Maharana on November 17, 2015.
2. *Linking Agriculture with Nutrition and Health* by Professor MS Swaminathan on February 10, 2016.

Delhi Local Chapter: (Convener–Professor Satish Kumar Gupta, FNA, National Institute of Immunology, New Delhi)

The following lectures were organized by Delhi Local Chapter:

1. **Indian National Science Academy–National Institute of Immunology Joint Invited Lecture** by Professor G Padmanaban, at NII auditorium on March 21, 2016. The topic of the oration was *Curcumin – the wonder drug in waiting*.

Professor G Padmanaban delivering lecture at NII

2. **Professor Vishwa Nath Memorial Lecture (2015)** of INSA was delivered by Professor Subrata Sinha on March 19, 2016 in the South Campus of University of Delhi. The topic of the oration was *Molecular markers and tumour behavior of glioma: tumours of the supporting cells of the brain*.

Professor Subrata Sinha receiving the citation after the award lecture

3. **Professor Krishna Sahai Bilgrami Memorial Medal Lecture (2015)** of INSA was delivered by Professor Yadvinder Singh at Centre for Environment Science and Climate Resilient Agriculture (CESCRA), Indian Agricultural Research Institute (IARI), New Delhi on October 28, 2015. The topic of the oration was *Managing crop residues for nutrient cycling, improving crop productivity and reducing air pollution*.

Professor Yadvinder Singh receiving the citation after the medal lecture

Kanpur Local Chapter: (Convener–Professor Debashish Chowdhury, FNA, Department of Physics, Indian Institute of Technology, Kanpur)

The following activities took place under Kanpur Local Chapter:

1. Public Lecture (jointly with Department of Physics, IIT Kanpur) on *Einstein's Centennial Gift: Gravitational Waves Discovered* by – Professor Sanjeev V Dhurandhar, IUCAA, Pune on March 30, 2016.

2. A series of lectures by newly selected members of Indian National Young Academy of Science (INYAS) on March 12, 2016.

   a. Dr Krishanu Biswas, Department of Materials Science and Engineering, IIT Kanpur, on *Science and Technology of Free Standing Metallic Nanoparticles*.

   b. Dr Tarun Gupta, Department of Civil Engineering, IIT Kanpur, on *Lab to Market PM1 Sampler Story*.

   c. Dr Pratik Sen, Department of Chemistry, IIT Kanpur, on *Molecular Dancing under Light*.

3. Professor Yogesh Joshi, INSA YS Awardee and Professor of Chemical Engineering, IIT Kanpur was felicitated on his selection for ***Shanti Swarup Bhatnagar Prize in Engineering Sciences (2015).*** This was jointly organized with Indian National Academy of Engineering (Kanpur Local Chapter), and Department of Chemical Engineering, IIT Kanpur.

4. Professor Manindra Agrawal, FNA and Professor of Computer Science, and Dean of Faculty Affairs, IIT Kanpur, was felicitated on May 4, 2015 on his election to the National Academy of Sciences, USA, as a foreign associate. This was jointly organized by Indian National Academy of Engineering (Kanpur Local Chapter, Department of Computer Science and Engineering, IIT Kanpur, and Alumni Association, IIT Kanpur).

Kolkata Local Chapter: (Convener – Professor Hemanta K Majumder, FNA, Scientist G, Director Grade Scientist, Indian Institute of Chemical Biology, Kolkata).

Following lectures were organized:

1. Professor Syamal Roy, FNA, Scientist–G, CSIR–Indian Institute of Chemical Biology, Kolkata delivered lecture on *Ethics in Science* at Scottish Collegiate School, Kolkata on May 11, 2015.
2. Professor Chanchal K Das Gupta, FNA, Jadavpur University, Kolkata delivered lecture on *Rationale to look at the Biological World* at Ramananda Centenary College, Laulara, Purulia on August 7, 2015.
3. Dr Hemanta K Majumder, FNA, CSIR–Indian Institute of Chemical Biology, Kolkata delivered lecture on *Epoch making discovery in Biology* at Ramananda Centenary College, Laulara, Purulia on August 7, 2015.
4. Shri Sandip Kumar Sen, Beleghata Santisangha Vidyaayatan delivered lecture on *Vision to Earth* at Ramananda Centenary College, Laulara, Purulia on August 7, 2015.
5. Professor Bruce P Lanphear, Faculty of Health Sciences, Simon Fraser University, Canada delivered lecture on *Nutrition and Child Health* at CSIR–Indian Institute of Chemical Biology, Kolkata on September 8, 2015.
6. Professor Siddartha Roy, FNA, Bose Institute, Kolkata, delivered **Professor Viswa Nath Memorial Lecture of INSA (2009)** on *Defining the Pathway of Transcription Initiation* at Calcutta University, Department of Biotechnology, Kolkata on November 6, 2015.
7. Professor Amitabha Chattopadhyay, FNA, Scientist–H, Centre for Cellular and Molecular Biology (CCMB), Hyderabad delivered **Professor GN Ramachandran 60th Birthday Commemoration Medal Lecture of INSA (2015)** on *Lessons from GPCR–Cholesterol Crosstalk: Implications for Health and Disease* at Calcutta University, Department of Biotechnology, Kolkata on November 6, 2015.
8. Professor Pijush K Das, FNA, NASI Senior Scientist Platinum Jubilee Fellow, CSIR–Indian Institute of Chemical Biology, Kolkata delivered lecture on *Targeted Drug delivery: Majic Bullet Approach* at Surah Kanya Vidyalaya., Govt. Sponsored Girls High School on National Science day on February 28, 2016.

Award Lectures Delivered under Different Local Chapters

Several award lectures were organized under different Local Chapters. A list of all such lectures is given in ***Annexure–XXII***.

SCIENCE EDUCATION PROGRAMME

The Academy, in August 2006 established the Science Education Panel to initiate and oversee the Science Education Programmes undertaken for School and College students. The panel is currently chaired by Professor SC Lakhotia, FNA. The panel, jointly, in association with Indian Academy of Sciences, Bengaluru and the National Academy of Sciences of India, Allahabad sponsored a variety of activities that are aimed at strengthening of Higher Education in Science and encouraging the young students to take science as a career. These are:

1. ***Summer Research Fellowships for Students and Teachers:*** Under this programme, specific proposals are invited from students and teachers for the work they propose to undertake during the two month long Fellowship from May–July 2015.

   During the year 2015–16, a total of 24516 applications were received from students and teachers out of which 1321 students and 136 teachers availed the fellowship. A detailed table presenting the figures of the Summer Research Fellowship (May–July 2015) is given in ***Annexure–XXIII***.

2. ***A 2–week All India Refresher Courses for Teachers:*** This course is aimed at capacity building of teaching community. The primary focus is to enhance the quality of science education at undergraduate and graduate levels. Refresher Courses are thus, primarily aimed at helping teachers to add value to their teaching.

   During 2015–16, 19 refresher courses were held in various parts of the country. A list of these refresher courses is given in ***Annexure–XXIV***.

3. ***Lecture/Workshops for Students and Teachers:*** Short–duration Lecture Workshops is an important segment of the activities under the Science Education Panel. These two–three days programme is intended for the benefit of students and teachers at the undergraduate, graduate and research levels.

   During 2015–16, 65 Workshops were held on topics of current interest throughout the country. A list of these Lectures/Workshops is given in ***Annexure–XXV***.

Interactive Meeting of Summer Research Fellows and their Mentors

An interactive session of Science Academies' Summer Research Fellows and their mentors was organized at the INSA premises on June 22, 2015. The meeting was chaired by Professor R Gadagkar, President INSA along with Professor Dipankar Chatterji, FNA, Molecular Biophysics Unit, Indian Institute of Science, Bengaluru. Professor Chatterji, delivered a lecture on *Chance and Necessity: Nurturing the Young Talent*. A large number of summer research fellows, working in Delhi/New Delhi, and their mentors interacted with the panel after the lecture. The meeting was intended to solicit responses of the summer fellows and their mentors about the programme who are the prime users. All the participants appreciated usefulness of this major inter academy programme. Fellows and mentors, while applauding the programme initiated by the three Academies viz., INSA, IASc and NASI, also discussed some problems faced by them during the period of research.

Interactive session of Summer Research Fellows and their mentors

Informatics

The Informatics Centre (IC) of the Academy provides services to the secretariat and the Fellowship. It encompasses Library and the information resource centre, providing scholarly information and Computer facility for facilitating a whole range of IT–related services for the Academy and the Fellows of the Academy.

Besides constant efforts for improving and widening the information services steps are also taken to keep in tune with the changing needs of the information seekers. The IC is suitably equipped with modern facilities.

The records of the library are available in electronic format and several indigenous databases have been created, which are accessible to users. The information resource centre focuses on History of Science, Philosophy of Science, Science Planning, Policy Studies, Science Education and Teaching, Science and Society, Works of Eminent Scientists, Nobel Lectures, Reports of National /International Institutions and agencies, etc.

The Library has over 17681 Barcoded books and receives 350 titles of journals covering a wide range of subjects, out of which around 300 journals are received through exchange. To build an electronic resource collection, several databases have been procured on CDs/Online to facilitate electronic access to scientific literatures. eGranthalaya NIC software is installed for managing Library activities. Through NKRC consortium 8 international online publications (Emerald, IEEE, JCCC, Oxford University Press, Royal Society of Chemistry, Taylor and Francis, Web of Science, Wiley) are accessible within the INSA premises, which include more than 10000 online journals.

INSA Archives

Archive Unit of the Academy was established during the Platinum Jubilee Celebrations (2009–10) to document and preserve all available information about INSA Fellows. The Fellowship records such as their biodata, photographs, list of publications, nomination form, obligation form including reprints of 1737 Indian, 190 Foreign and four Pravasi Fellows have been documented and kept in specially designed boxes. All INSA publications brought out since inception have been archived. The Unit also serves as digital repository of important photographs of historical importance indicating landmark events of the Academy. The Academy has scientific bi–lateral exchange programmes with the other overseas science Academics and international scientific bodies such as ICSU, TWAS, IAP, IAC, AASSA, ASC, STS Forums etc. Copies of the agreement/memorandum of understanding with overseas national science academies are documented and kept in archive unit. All the above documents are retrieved through WINISIS software, developed by UNESCO.

Informatics Centre

Academy has two websites, www.insa.nic.in, www.insaindia.res.in: The former focuses on the three Online open Access Journals published by

INSA. These are *Proceedings of Indian National Science Academy, Indian Journal of Pure and Applied Mathematics* and *Indian Journal of History of Science*. Journal site has been hosted at NIC server with unique online eISSN numbers. Journal site is now indexed by SCOPUS, Google Scholar, Google analytics. 2014 onwards unique DOI numbers are being generated for each published articles for better visibility of the journals.

The www.insaindia.res.in site is focused on Academy activities.

INSA–DST INSPIRE online interviews are conducted through Video Conference Equipment with NIC software 'VidyoDesktop' and the National Knowledge Network (NKN) high speed internet.

Publications

Publication is one of the prime activities of the Academy to serve as a means of disseminating scientific information to the scientific community and the public at large. The Academy considers dissemination of such information integral to the progress of the country and essential since this not only updates scientists with the latest scientific developments but also helps the public in taking informed decisions. The Academy brings out important and varied publications like the Year Book, Biographical Memoirs, Status reports of national relevance, Study reports, specialized scientific reports and science journals. Three journals, covering Physical & Biological Sciences, Mathematical Sciences and History of Science, are published regularly.

Proceedings of the Indian National Science Academy is an interdisciplinary journal devoted to publication of original research papers, review articles, commentaries, lateral thinking/opinion, emerging techniques, award lectures and book reviews in all areas of sciences and engineering/ technology, except Pure and Applied Mathematics for which the Academy publishes a separate journal. Five issues of the journal have been published between March 2015 to March 2016 (inclusive of a Special Section: Ultrafast Science published in March 2015 and a Thematic issue: Science based technologies for Sustainable and Adequate Energy for India, published in September 2015). All the issues were published timely as scheduled. These issues included 43 Review Articles, 14 Research Papers, six Book Reviews, four Meeting Reports, four Letters to Editor, two Academy Sponsored Reports, two Correspondences, two Medal Lectures, one each of Commentary, Opinion, Public Lecture, Emerging Techniques and an Obituary. Beginning with the January 2014 issue, all articles carry a DOI number. The INSA News, which was a separate quarterly publication of the Academy, has been merged with *Proceedings of the Indian National Science Academy* as a section entitled Academy News. All articles are freely and fully accessible at the Academy website (http://insa.nic.in).

During the period, the ***Indian Journal of Pure and Applied Mathematics***, a bimonthly journal, published five issues of Vol. 46 for the year 2015 and one issue of Vol. 47 for the year 2016. There has been a steady increase in its subscription. The journal received 1421 papers from 61 countries, including Australia, Bangladesh, Canada, Egypt, Germany, India, Japan, Korea, Malaysia, Namibia, Oman, Pakistan, Qatar, Romania, Serbia, Thailand, United Kingdom, Vietnam and Yemen, during the past one year. These papers covered all areas of Mathematics, including Algebra, Analysis, Difference and Differential Equations, Discrete Mathematics, Geometry, Linear Algebra, Number Theory, Optimization Theory and Statistics.

The periodicity of *IJPAM* has been changed from 2016 to make it a quarterly with issues published in March, June, September and December each year. The co–publishing agreement with Springer (India) Pvt. Ltd for *IJPAM* has been renewed for a period of five years starting from January 01, 2016.

The Indian Journal of History of Science completed its 50th year of uninterrupted publication in 2015. In the 50th Anniversary year thirty eight research articles, five book reviews, four project reports, seminar, conference reports and news from areas of history of science were published. All the four issues were published on time. All papers published in *IJHS* carry DOI numbers and the journal now also has e–ISSN number (ISSN 2454–9991).

The Academy also periodically publishes ***Biographical Memoirs of Deceased Fellows of the Academy***. The Memoirs are written by their close associates, colleagues or friends of the deceased fellows highlighting their lives and scientific achievements. Academy has so far published 41 volumes of these *Memoirs*, covering 562 of the Academy's Fellows. All these have been digitized using the OCR technique and are available as searchable pdf files on Academy's website for ready reference.

The ***Annual Report*** and the ***Year Book*** are other important publications of the Academy. Apart from their printed versions, these are also available at the Academy website, www.insaindia.res.in. Back issues of the *Proceedings of the Indian National Science Academy* (Physical Sciences: Part A), (Biological Sciences: Part B), *Indian Journal of Pure and Applied Mathematics* (IJPAM) and *Indian Journal of History of Science* (IJHS) are also available online at http://insa.nic.in.

Implementation of Official Language Policy

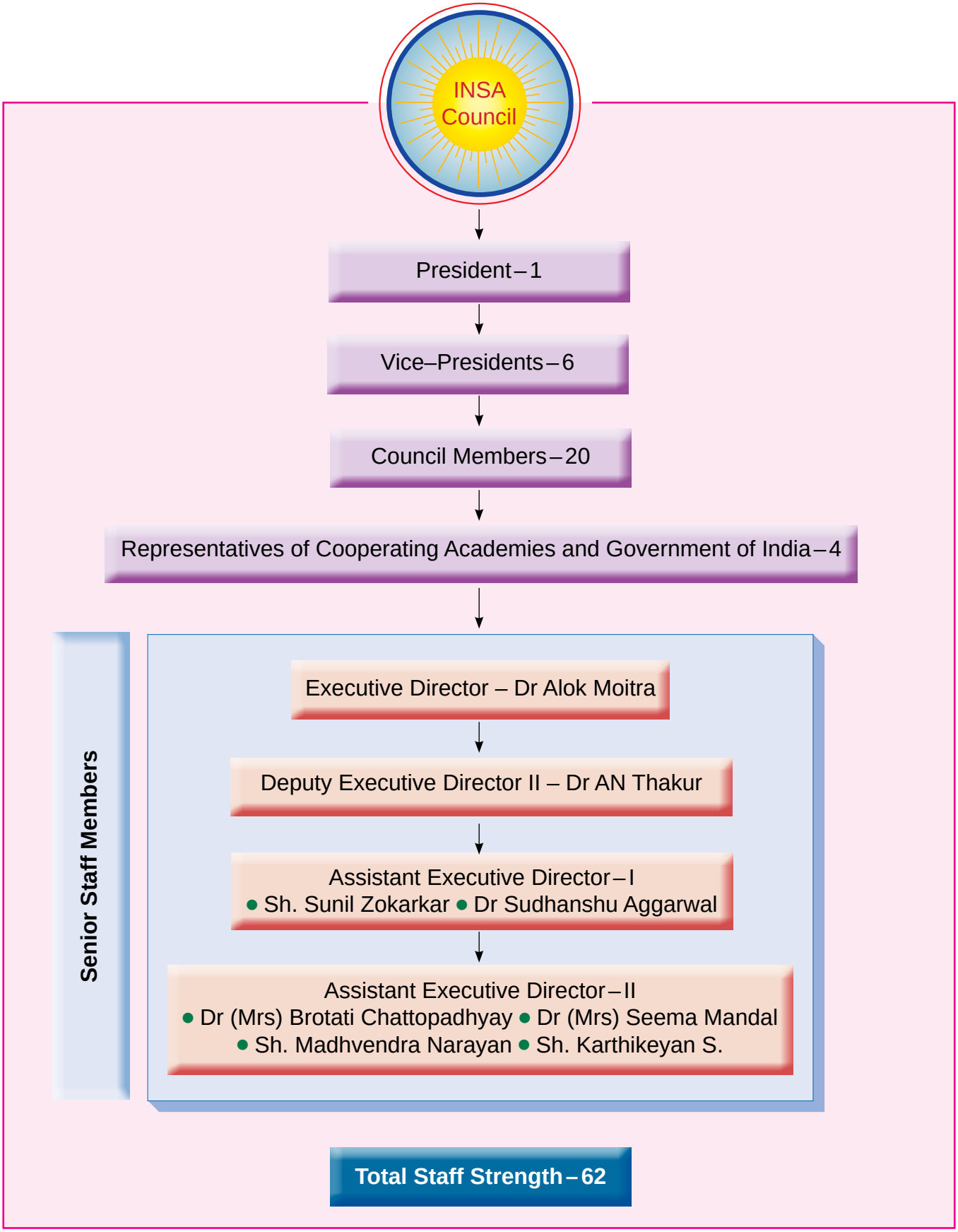
The Hindi Fortnight was observed in the Academy during September 1–14, 2015 to promote use of the Official Language. During this period, various programmes in Hindi language such as lectures, *sulekh,* dictation, Hindi essay, Hindi typing, quiz and word translation competitions were organized. Short documentaries in Hindi on Scientific topics were also screened. Staff members of the Academy participated in these programmes with great enthusiasm. An exhibition of Hindi books was also organized. Prize Distribution Ceremony was held in the Academy on September 14, 2014. The prizes were distributed to the winners in various categories of competitions organized during the fortnight celebrations. The Chief Guest of this occasion was Sh. Ram Sakal Singh, Assistant Director (T&S), Hindi Teaching Scheme, Department of Official Language, Ministry of Home Affairs, New Delhi. He also delivered a lecture on '*Sarkārī kāmkāj me saral Hindi kā prayog'*.

Status of Reservation Policy for SC/ST/ OBC/PWD

Guidelines for reservation of SC/ST/OBC/PWD are observed.

(From Left) Sh. Jagdish Kumar, Sh. Ram Sakal Singh, Assistant Director (T&S), Hindi Teaching Scheme, Department of Official Language, Ministry of Home Affairs and Sh. Madhvendra Narayan during closing ceremony of 'Hindi Pakhwara' on September 14, 2015.

Organizational Structure



JAIN PRAMOD JAIN & CO.
CHARTERED ACCOUNTANTS

Phones: 41401901, 26943877
E–mail: jainpjco@gmail.com
*New D*elhi– 110076

Auditors' Report

We have audited the annexed Balance Sheet of the Indian National Science Academy as at 31st March, 2016 and also the relevant Income & Expenditure Account of the Academy for the year ended on that date with the help of the books of the accounts & vouchers relating thereto.

It is the policy of the Academy to prepare its financial statements on the cash–receipts and disbursements basis. On this basis revenue and the related assets are recognised when received rather than when earned, and expenses are recognised when obligation is incurred.

Fixed Assets register is being updated. Interest earned Rs. 100.78 lacs out of Corpus fund has been included in the fund instead of the Income and Expenditure. No depreciation has been provided on the fixed assets and books as total capital expenditure claimed u/s 11 of Income Tax Act. Capital Grants & Non–recurring capital expenditure accounted for in the Balance Sheet and consequently Rs. 13,68,38,074/– has been transferred from respective funds to the Income and Expenditure A/c as on 01.04.2015. Stock of the publication has not been included in the Balance Sheet. Interest earned on fixed deposit is accounted for on maturity, renewal or encashment.

Subject to the foregoing the impact of the same on profit is unascertained, the Balance Sheet & Income & Expenditure Accounts give a true and fair view of the assets and liabilities arising from cash transactions of Indian National Science Academy as at 31.03.2016 and of the revenue collected and expenses paid during the year accounted on cash receipts and disbursements basis as described in Note I (a).

For JAIN PRAMOD JAIN & CO.,
Chartered Accountants
(FRN–016746N)

JAIN PRAMOD JAIN & CO. Chartered Accountants

(P.K. JAIN)
Partner
Membership No.10479

Place : New Delhi
Date : 01.09.2016

INDIAN NATIONAL SCIENCE ACADEMY

BALANCE SHEET AS ON 31.03.2016

	Schedule	(Amount in Rs.) Current Year	Previous Year
Corpus / Capital Fund and Liabilities			
Corpus/Capital/ Government Fund	1	45,10,74,127.00	41,46,52,201.26
Unspent Balance of Government Grant	2	10,84,602.00	48,99,699.64
Earmarked / Endowment Funds	3	5,45,93,549.00	5,21,02,832.01
Unspent Balances of other Various Schemes	4	92,32,213.00	2,98,25,111.00
Current Liabilities and Provisions	5	77,57,467.00	1,08,81,602.90
Employees Provident Fund	6	4,95,22,075.00	4,29,86,726.62
TOTAL		57,32,64,033.00	55,53,48,173.43
Assets			
Overspent Balances of other Various Schemes	4 (A)	27,24,215.00	32,70,393.49
G.P.F. Advance (Staff)	7	21,19,135.00	21,60,741.00
Fixed Assets (Including in Progress)	8	29,23,98,928.00	29,23,98,928.48
Investments with Banks	9	22,19,01,449.00	20,26,01,449.00
Current Assets, Loans, Advances, Etc.	10	5,41,20,306.00	5,49,16,661.46
TOTAL		57,32,64,033.00	55,53,48,173.43

As per our report of even date at schedule 20

FOR JAIN PRAMOD JAIN & CO.,
Chartered Accountants
(FRN NO. 016746N)

Sd/-
(P.K. JAIN)
Partner
M.No.10479

1 SEP 2016

FOR INDIAN NATIONAL SCIENCE ACADEMY

Sd/-
(A.K. MOITRA)
Executive Director

FOR INDIAN NATIONAL SCIENCE ACADEMY

Sd/-
(SUNIL ZOKARKAR)
Deputy Executive Director (F & A)

INDIAN NATIONAL SCIENCE ACADEMY

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.2016

Particulars	Schedule	(Amount in Rs.) Current Year	Previous Year
Income			
Income from Sales / Services	11	19,20,320.00	31,25,626.56
Grants/Subsidies : Plan, Non–Plan & ICSU Subs.	12	23,63,36,843.00	19,37,38,000.00
Fee & Subscription	13	4,500.00	19,400.00
Income from Royalty, Publications etc.	14	28,62,014.00	35,16,613.96
Interest Earned	15	1,33,375.00	1,04,54,664.00
TOTAL (A)		24,12,57,052.00	21,08,54,304.52
Expenditure			
Establishment Expenses	16	8,09,39,046.00	7,68,36,659.00
Other Administrative Expenses etc.	17	2,33,08,497.00	2,68,56,423.00
Expenditure on Grants, Subsidies, etc.	18	7,88,99,535.00	3,99,25,581.00
Capital Expenditure (incl Golden Jubilee blg.)		0.00	2,08,79,103.00
TA/DA	19	56,89,466.00	1,04,09,359.00
Publications	19	51,01,736.00	34,29,596.00
Subscriptions to ICSU bodies	19	2,07,34,071.00	1,94,47,318.43
International Scientific delegations/ Exchange Programme	19	87,41,773.00	91,60,011.00
Seminars/symposia/Popularisation of Science activities	19	64,98,952.00	42,02,045.00
Other Expenditure	19	1,13,76,443.00	6,52,525.63
Transferred to Unspent Balance (Schedule 2)		0.00	–9,44,316.54
TOTAL (B)		24,12,89,519.00	21,08,54,304.52
Deficit transferred to Income & Expenditure A/c (Schedule 1)		–32,467.00	
Significant Accounting Policies	20		

As per our report of even date at schedule 20

FOR JAIN PRAMOD JAIN & CO.,
Chartered Accountants
(FRN NO. 016746N)

Sd/-
(P.K. JAIN)
Partner
M.No.10479

1 SEP 2016

JAIN PRAMOD JAIN & CO. Chartered Accountants

FOR INDIAN NATIONAL SCIENCE ACADEMY

Sd/-
(A.K. MOITRA)
Executive Director

FOR INDIAN NATIONAL SCIENCE ACADEMY

Sd/-
(SUNIL ZOKARKAR)
Deputy Executive Director (F & A)

SCHEDULE – 1

CORPUS/GOVERNMENT FUND – SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Funds Account				
(As per last Balance Sheet)	1,19,28,076.09			1,19,28,076.09
Less : rounded off	0.09			
	1,19,28,076.00			
Less: Transferred to Income & Expenditure	1,19,28,076.00			
		0.00		
Capital Fund				
Unspent Balance of last year	41,37,396.00			
Add: Grant in aid during the year	1,37,99,000.00			
	1,79,36,396.00			
Less: Expenditure during the year	31,71,736.00			
(As per annexure X)				
		1,47,64,660.00		
Golden Jubilee Fund				
(As per last Balance Sheet)		50,00,000.00		50,00,000.00
CORPUS FUND				
(As per last Balance Sheet)	11,69,88,435.70		11,67,28,591.60	
Add: Amt transferred from INSA Plan General A/c	98,18,883.00		0.00	
Add: Interest during the year	1,00,78,321.00		1,00,78,727.10	
	13,68,85,639.70		12,68,07,318.70	
Less : rounded off	0.70		–	
Less: Interest Transferred to INSA Plan–General A/c	–		98,18,883.00	
		13,68,85,639.00		11,69,88,435.70
Non–Recurring Expenditure Fund				
(As per last Balance Sheet)	4,96,58,785.37		3,66,46,909.37	
Add: during the year	0.00		1,30,11,876.00	
	4,96,58,785.37		4,96,58,785.37	
Less : rounded off	0.37		–	
	4,96,58,785.00			4,96,58,785.37
Less: Transferred to Income & Expenditure	4,96,58,785.00			
		0.00		
Building Fund Account				
1 **Golden Jubilee Building Fund (main building)**				
(As per last Balance Sheet)	15,76,18,221.45		15,72,27,117.45	
Less : rounded off	0.45		–	
Add : during the year	–		3,91,104.00	
		15,76,18,221.00		15,76,18,221.45
Balance c/f		31,42,68,520.00		34,11,93,518.61

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Balance b/f		31,42,68,520.00		34,11,93,518.61
2 **Renovation of INSA**				
Convention Centre (Administrative Block)				
(As per last Balance Sheet)	4,29,16,914.73		3,66,34,080.73	
Add: rounded off	0.27		62,82,834.00	
	4,29,16,915.00			4,29,16,914.73
Less: Transferred to Income & Expenditure	4,29,16,915.00			
		0.00		
3 **Renovation of INSA**				
Information Centre(Archive Dept.)				
(As per last Balance Sheet)	1,42,47,693.92		1,41,83,869.92	
Add: rounded off	0.08		63,824.00	
	1,42,47,694.00			1,42,47,693.92
Less: Transferred to Income & Expenditure	1,42,47,694.00			
		0.00		
Computers				
(As per last Balance Sheet)	1,62,94,074.00		1,51,78,200.00	
Additions during the year	0.00		11,15,874.00	
	1,62,94,074.00			1,62,94,074.00
Less: Transferred to Income & Expenditure	1,62,94,074.00			
		0.00		
4 **Income & Expenditure A/c**				
Amount transferred from funds (Annexure XI)	13,68,38,074.00			
Less: Deficit for this year as per A/c attached	32,467.00			
		13,68,05,607.00		
TOTAL		45,10,74,127.00		41,46,52,201.26

SCHEDULE – 2
UNSPENT BALANCE (GOVERNMENT GRANT)

SCHEDULE OF UNSPENT BALANCE FORMING PART OF BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs)	Previous Year Amount (Rs)
Unspent Balance of fund at year end	10,84,602.00	48,99,699.64
TOTAL	10,84,602.00	48,99,699.64

SCHEDULE – 3
EARMARKED / ENDOWMENT FUNDS

SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Fellowship Fund				
(As per last Balance Sheet)	7,51,755.60		6,51,755.60	
Add: Rounded off	0.40			
Addition during the year (Annexure–VII)	87,500.00		1,00,000.00	
		8,39,256.00		7,51,755.60
General Fund				
(As per last Balance Sheet)	1,69,42,521.59		1,55,21,485.59	
Add : Interest during the year	16,20,193.41		15,21,736.00	
	1,85,62,715.00		1,70,43,221.59	
Less: Expenditure	22,296.00		1,00,700.00	
		185,40,419.00		169,42,521.59
Endowment Fund				
1) Chandra Kala Hora Memorial Medal Fund				
(As per last Balance Sheet)	15,51,030.11		14,77,013.11	
Add: Interest during the year	1,11,918.00		1,11,918.00	
	16,62,948.11		15,88,931.11	
Less : rounded off	0.11		37,901.00	
		16,62,948.00		15,51,030.11
2) Dr. B.C. Guha Memorial Lecture Fund				
(As per last Balance Sheet)	9,24,233.95		8,53,775.95	
Add : Interest during the year	70,458.05		70,458.00	
		9,94,692.00		9,24,233.95
3) Dr. S.S. Bhatnagar Memorial Fund				
(As per last Balance Sheet)	45,697.93		43,927.93	
Add : Interest during the year	1,769.07		1,770.00	
		47,467.00		45,697.93
Balance c/f		2,20,84,782.00		2,02,15,239.18

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Balance b/f		220,84,782.00		202,15,239.18
4) Silver Jubilee Commemoration Fund				
(As per last Balance Sheet)	22,968.96		22,240.96	
Add: Interest during the year	796.04		728.00	
		23,765.00		22,968.96
5) Shri Dhanwantri Prize Medal Fund				
(As per last Balance Sheet)	96,841.80		93,966.80	
Add: Interest during the year	5,750.20		2,875.00	
		1,02,592.00		96,841.80
6) Dr. B.N. Chopra Lecture Fund				
(As per last Balance Sheet)	5,009.46		30,597.46	
Add: Interest during the year	2,211.00		1,106.00	
	7,220.46		31,703.46	
Less: rounded off	0.46		26,694.00	
		7,220.00		5,009.46
7) Prof. L.S.S. Kumar Memorial Award Fund				
(As per last Balance Sheet)	1,69,767.50		1,56,454.50	
Add: Interest during the year	10,438.00		13,313.00	
	1,80,205.50		1,69,767.50	
Less: rounded off	0.50		–	
		1,80,205.00		1,69,767.50
8) Shri A.K. Bose Memorial Award Fund				
(As per last Balance Sheet)	30,813.05		29,071.05	
Add: Interest during the year	1,713.00		1,742.00	
	32,526.05		30,813.05	
Less: Expenditure	0.05		–	
		32,526.00		30,813.05
9) Dr. S.B. Saxena Memorial Award Fund				
(As per last Balance Sheet)	1,63,375.80		1,55,413.80	
Add: Interest during the year	7,962.20		7,962.00	
	1,71,338.00		1,63,375.80	
Less: Expenditure	25,000.00		–	
		1,46,338.00		1,63,375.80
Balance c/f		225,77,428.00		207,04,015.75

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Balance b/f		2,25,77,428.00		2,07,04,015.00
10) Prof. M.R.N. Prasad Memorial Lecture Award Fund				
(As per last Balance Sheet)	50,911.80		44,099.80	
Add: Interest during the year	6,811.20		6,812.00	
		57,723.00		50,911.80
11) Dr. Jagdish Shankar Memorial Fund				
(As per last Balance Sheet)	99,984.00		1,17,642.00	
Add: Interest during the year	7,342.00		7,342.00	
	1,07,326.00		1,24,984.00	
Less: Expenditure	–		25,000.00	
		1,07,326.00		99,984.00
12) Prof. G.N. Ramachandran 60 th Birthday Commemoration Medal Fund				
(As per last Balance Sheet)	3,16,931.00		3,22,835.00	
Add: Interest during the year	19,094.00		19,096.00	
	3,36,025.00		3,41,931.00	
Less: Expenditure	43,998.00		25,000.00	
		2,92,027.00		3,16,931.00
13) Prof. T.R. Sheshadri 70 th Birthday Commemortion Medal Fund				
(As per last Balance Sheet)	–8,260.04		–9,724.04	
Add: Interest during the year	1,591.00		1,464.00	
	(6,669.04)		–8,260.04	
Less: rounded off	0.04		–	
		–6,669.00		–8,260.04
14) Vishwa Karma Medal Fund				
(As per last Balance Sheet)	4,18,850.33		3,89,058.33	
Add: Interest during the year	30,384.00		29,792.00	
	4,49,234.33		4,18,850.33	
Less: Expenditure	25,506.33		–	
		4,23,728.00		4,18,850.33
15) Prof. K. Rangadhama Rao Medal Fund				
(As per last Balance Sheet)	–59,800.25		–60,710.25	
Add: Interest during the year	910.00		910.00	
	–58,890.25		–59,800.25	
Less: rounded off	0.25		–	
		–58,890.00		–59,800.25
Balance c/f		2,33,92,673.00		2,15,22,632.59

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Balance b/f		2,33,92,673.00		2,15,22,632.59
16) Dr. H. Swarup Memorial Lecture Fund				
(As per last Balance Sheet)	5,67,074.50		5,46,608.50	
Add: Interest during the year	45,467.00		47,105.00	
	6,12,541.50		5,93,713.50	
Less: rounded off	0.50		26,639.00	
		6,12,541.00		5,67,074.50
17) Dr. G.P. Chatterjee Memorial Fund				
(As per last Balance Sheet)	8,910.99		6,698.99	
Add: Interest during the year	2,211.01		2,212.00	
		11,122.00		8,910.99
18) Prof. T.S. Sadasivan Lecture Award Fund				
(As per last Balance Sheet)	41,938.80		38,842.80	
Add: Interest during the year	3,096.20		3,096.00	
		45,035.00		41,938.80
19) Prof. B.D. Tilak Lecture Award Fund				
(As per last Balance Sheet)	5,33,319.55		5,34,319.55	
Add: Interest during the year	42,148.45		42,148.00	
	5,75,468.00		5,76,467.55	
Less: Expenditure	–		43,148.00	
		5,75,468.00		5,33,319.55
20) Prof. R.K. Asundi Memorial Lecture Award Fund				
(As per last Balance Sheet)	12,359.75		10,531.75	
Add: Interest during the year	1,988.25		1,828.00	
		14,348.00		12,359.75
21) Dr. Panchnan Maheshwari Memorial Lecture Fund				
(As per last Balance Sheet)	22,004.00		18,466.00	
Add: Interest during the year	3,538.00		3,538.00	
		25,542.00		22,004.00
Balance c/f		2,46,76,729.00		2,27,08,240.18

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Balance b/f		2,46,76,729.00		2,27,08,240.18
22) Dr. Vainu Bappu Memorial Award Fund				
(As per last Balance Sheet)	11,19,161.00		11,21,165.00	
Add: Interest during the year	92,645.00		74,441.00	
	12,11,806.00		11,95,606.00	
Less: Expenditure	–		76,445.00	
		12,11,806.00		11,19,161.00
23) Dr. T.S. Tirumurti Memorial Lecture Fund				
(As per last Balance Sheet)	–7,043.00		–8,459.00	
Add: Interest during the year	1,416.00		1,416.00	
		–5,627.00		–7,043.00
24) Dr. Nitya Anand Endowment Lecture Fund				
(As per last Balance Sheet)	3,86,814.28		3,54,662.28	
Add: Interest during the year	32,152.00		32,152.00	
	4,18,966.28		3,86,814.28	
Less: Expenditure	45,117.28		–	
		3,73,849.00		3,86,814.28
25) INSA Prize for Material Science Fund				
(As per last Balance Sheet)	48,400.90		43,978.90	
Add: Interest during the year	4,423.10		4,422.00	
		52,824.00		48,400.90
26) Prof. Brahm Prakash Memorial Award fund				
(As per last Balance Sheet)	2,63,067.40		2,72,433.40	
Add: Interest during the year	15,633.00		15,634.00	
	2,78,700.40		2,88,067.40	
Less: Expenditure	0.40		25,000.00	
		2,78,700.00		2,63,067.40
27) Prof.S.Swaminathan 60th Birthday Commemoration Medal Fund				
(As per last Balance Sheet)	3,17,107.73		2,91,007.73	
Add: Interest during the year	26,100.27		26,100.00	
		3,43,208.00		3,17,107.73
Balance c/f		2,69,31,489.00		2,48,35,748.49

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Balance b/f		2,69,31,489.00		2,48,35,748.49
28) Prof. Shambhu Nath De Memorial Lecture Award Fund				
(As per last Balance Sheet)	1,77,356.75		1,68,858.75	
Add: Interest during the year	8,912.25		8,498.00	
		1,86,269.00		1,77,356.75
29) Prof. Vishnu Vasudeva Narlikar Memorial Lecture Award Fund.				
(As per last Balance Sheet)	3,91,316.25		3,92,589.25	
Add: Interest during the year	27,860.00		27,128.00	
	4,19,176.25		4,19,717.25	
Less: Expenditure	25,000.25		28,401.00	
		3,94,176.00		3,91,316.25
30) Dr. K. Naha Memorial Fund				
(As per last Balance Sheet)	9,36,539.50		8,66,835.50	
Add: Interest during the year	69,705.00		69,704.00	
	10,06,244.50		9,36,539.50	
Less: Rounded off	0.50		–	
		10,06,244.00		9,36,539.50
31) Prof. K.P. Bhargava Memorial Fund				
(As per last Balance Sheet)	2,99,456.00		2,98,666.00	
Add: Interest during the year	25,790.00		25,790.00	
	3,25,246.00		3,24,456.00	
Less: Expenditure	–		25,000.00	
		3,25,246.00		2,99,456.00
32) Prof. Vishwa Nath Memorial Fund				
(As per last Balance Sheet)	1,95,969.13		1,85,845.13	
Add: Interest during the year	10,761.00		10,124.00	
	2,06,730.13		1,95,969.13	
Less: Expenditure	50,000.13		–	
		1,56,730.00		1,95,969.13
33) Prof. Sadhan Basu Memorial Lecture Award Fund				
(As per last Balance Sheet)	3,67,405.00		3,64,377.00	
Add: Interest during the year	28,027.00		28,028.00	
	3,95,432.00		3,92,405.00	
Less: Expenditure	–		25,000.00	
		3,95,432.00		3,67,405.00
Balance c/f		2,93,95,586.00		2,72,03,791.12

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Balance b/f		2,93,95,586.00		2,72,03,791.12
34) Dr. Biren Roy Memorial Fund				
(As per last Balance Sheet)	5,89,230.25		5,46,512.25	
Add: Interest during the year	43,198.00		42,718.00	
	6,32,428.25		5,89,230.25	
Less: rounded off	0.25		–	
		6,32,428.00		5,89,230.25
35) Dr. Y. Subba Rao Memorial Lecture Fund				
(As per last Balance Sheet)	4,14,372.50		3,83,092.50	
Add: Interest during the year	30,515.00		31,280.00	
	4,44,887.50		4,14,372.50	
Less: rounded off	0.50		–	
		4,44,887.00		4,14,372.50
36) Dr. K.S. Bilgrami Memorial Fund				
(As per last Balance Sheet)	6,47,360.00		6,14,161.00	
Add: Interest during the year	46,324.00		33,199.00	
	6,93,684.00		6,47,360.00	
Less: Expenditure	28,341.00		–	
		6,65,343.00		6,47,360.00
37) Dr. D. Ranganathan Memorial Lecture Fund				
(As per last Balance Sheet)	13,36,244.50		12,59,892.50	
Add: Interest during the year	1,01,352.50		1,01,352.00	
	14,37,597.00		13,61,244.50	
Less: rounded off	–		25,000.00	
		14,37,597.00		13,36,244.50
38) Dr. A.C. Jain Endowment Fund				
(As per last Balance Sheet)	10,67,219.50		9,87,863.50	
Add : Interest during the year	79,358.00		79,356.00	
	11,46,577.50		10,67,219.50	
Add: rounded off	0.50		–	
		11,46,578.00		10,67,219.50
39) Prof. M.R. Das Memorial Fund				
(As per last Balance Sheet)	4,43,514.00		4,37,464.00	
Add : Interest during the year	32,195.00		31,050.00	
	4,75,709.00		4,68,514.00	
Less: Expenditure	–		25,000.00	
		4,75,709.00		4,43,514.00
Balance c/f		3,41,98,128.00		3,17,01,731.87

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Balance b/f		3,41,98,128.00		3,17,01,731.87
40) INSA – SJRD TATA FUND				
(As per last Balance Sheet)	1,21,92,882.87		1,28,19,589.87	
Add: Interest during the year	1,73,925.13		1,73,293.00	
	1,23,66,808.00		1,29,92,882.87	
Less : Expenditure	8,00,000.00		8,00,000.00	
		1,15,66,808.00		1,21,92,882.87
41) IUPAB–Prof.G.N. Ramachandran lecture fund				
(As per last Balance Sheet)	51,24,539.00		47,31,673.00	
Add: Interest during the year	3,77,866.00		3,92,866.00	
		55,02,405.00		51,24,539.00
42) IGBP Fund				
(As per last Balance Sheet)	19,96,013.27		18,50,334.27	
Add: Interest during the year	1,51,518.00		1,45,679.00	
	21,47,531.27		19,96,013.27	
Less : rounded off	0.27		–	
		21,47,531.00		19,96,013.27
43) Professor B.S. Trivedi Mem. Medal Fund				
(As per last Balance Sheet)	10,87,665.00		10,45,506.00	
Add: Interest during the year	91,012.00		71,097.00	
	11,78,677.00		11,16,603.00	
Less : Expenditure	–		28,938.00	
		11,78,677.00		10,87,665.00
TOTAL		5,45,93,549.00		5,21,02,832.01

SCHEDULE – 4
UNSPENT BALANCE OF INSA OTHER VARIOUS SCHEMES NOBEL LAUREATES AND INDO-AUSTRALIA VISITS FUND

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
INDO Australia visit programme	0.00	2,05,92,898.00
Visit of Nobel Laureates	92,32,213.00	92,32,213.00
TOTAL	92,32,213.00	2,98,25,111.00

SCHEDULE– 4(A)
OVERSPENT / UNSPENT BALANCES OF INSA OTHER VARIOUS SCHEMES

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
Climate Change Workshop	6,78,260.00	9,05,059.00
CODATA Conference	3,56,539.00	44,088.18
TWAS-India Chapter	1,03,369.00	1,63,306.00
IUCr. Seminar (RCB)	–	2,55,733.00
IUCr. Conference	2,16,635.00	0.00
DST PAC Meetings (Refer Annexure-V-A)	2,22,896.00	4,743.00
INSPIRE Meetings (Overspent)	(–)43,01,914.00	(–)46,37,158
Indo-US Workshop	0.00	(-)6164.67
TOTAL	Rs.(–) 27,24,215.00	Rs.(–) 32,70,393.49

SCHEDULE – 5
CURRENT LIABILITIES AND PROVISIONS

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
Security Deposit	1,08,399.00	1,08,399.00
Security Deposit (Contractor)	24,56,786.00	69,06,296.00
Bills Payable	51,92,282.00	15,24,377.00
Advance Fund	–	23,42,530.90
TOTAL	77,57,467.00	1,08,81,602.90

SCHEDULE – 6
EMPLOYEES PROVIDENT FUND

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Employees General Provident Fund				
(As per last Balance Sheet)	428,25,176.00		409,25,268.00	
Add: Subscription	76,84,500.00		74,81,100.00	
Add: Interest (@ 8.7% per annum)	37,81,163.00		34,23,423.00	
	542,90,839.00		518,29,791.00	
Less : Final Withdrawal	49,48,433.00		90,04,615.00	
		493,42,406.00		428,25,176.00
Excess Interest earned on investments				
(As per last Balance Sheet)	1,61,550.62		1,48,599.95	
Add: Rounded off	0.38		0.00	
Add: during the year	18,118.00		12,950.67	
		1,79,669.00		1,61,550.62
TOTAL		495,22,075.00		429,86,726.62

SCHEDULE – 7
G.P.F. ADVANCE TO STAFF

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
(VIII) Advance - Employees Provident Fund (Refer Annexure-VIII)		
Opening Balance	21,60,741.00	30,14,331.00
Add : Advances paid during the year	16,37,559.00	12,99,682.00
	37,98,300.00	43,14,013.00
Less: Recovery	16,79,165.00	21,53,272.00
TOTAL	21,19,135.00	21,60,741.00

SCHEDULE– 8
FIXED ASSETS

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
(A) **Land and Building**				
1) Building (Main – old) (as per last B/S)	9,35,690.06			9,35,690.06
Less: rounded off	0.06	9,35,690.00		
2) Golden Jubilee Building				
(As per last Balance Sheet) (main Bldg.)	15,73,69,721.45		15,69,78,617.45	
Less: rounded off	0.45		0.00	
Add : Exp during the year	–		3,91,104.00	
		15,73,69,721.00		15,73,69,721.45
3) RenovationofAdministrative Block				
(As per last Balance Sheet)	4,29,16,914.73		3,66,34,080.73	
Add: rounded off	0.27		0.00	
Add : During the year Auditorium	–		51,95,054.00	
Admn. Block, Transit house & Garden	–		10,87,780.00	
		4,29,16,915.00		4,29,16,914.73
4) Renovation of Library Buildings				
(As per last Balance Sheet)	1,42,47,693.92		1,41,83,869.92	
Add: rounded off	0.08		0.00	
Add: During the year Transit House (Library)	–		63,824.00	
		1,42,47,694.00		1,42,47,693.92
5) Office Equipment, Furniture & Fixture				
(As per last Balance Sheet)	4,11,37,934.32		4,09,01,525.32	
Less: rounded off	0.32		0.00	
	4,11,37,934.00		4,09,01,525.32	
Add :during the year - Furniture	–		2,36,409.00	
		4,11,37,934.00		4,11,37,934.32
6) Plant & Machinery				
(As per last Balance Sheet)	1,27,75,467.00			1,27,75,467.00
		1,27,75,467.00		
7) Computer				
(As per last Balance Sheet)	1,62,94,074.00		1,51,78,200.00	
Add : Exp during the year	–		11,15,874.00	
		1,62,94,074.00		1,62,94,074.00
8) Library Books				
(As per last Balance Sheet)		67,21,433.00		67,21,433.00
TOTAL		29,23,98,928.00		29,23,98,928.48

SCHEDULE – 9
INVESTMENTS WITH BANKS

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
Employee Provident Fund (F.D.)	4,65,50,000.00	3,90,50,000.00
General Fund (F.D.)	1,62,30,000.00	1,62,30,000.00
Earmarked/Endowment Fund (F.D.)	1,72,17,000.00	1,72,17,000.00
Golden Jubilee Building (F.D.)	50,00,000.00	50,00,000.00
Corpus Fund (F.D.)	12,40,54,449.00	11,15,54,449.00
SJRD Tata Fund (F.D.)	1,14,50,000.00	1,21,50,000.00
IGBP (F.D.)	14,00,000.00	14,00,000.00
TOTAL	22,19,01,449.00	20,26,01,449.00

SCHEDULE – 10
CURRENT ASSETS, LOANS & ADVANCES ETC.

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
PART – A – CASH AND BANK BALANCES		
Imprest Canteen	15,000.00	10,000.00
Postage Advance	1,79,797.00	1,80,719.00
Bank balance in Current Accounts	2,87,11,428.00	3,87,22,779.87
Bank Balance in Savings Banks with SBI	2,30,09,305.00	1,30,23,976.12
Savings Bank with Syndicate Bank	3,56,539.00	44,088.18
	5,22,72,069.00	5,19,81,563.17
PART–B– ADVANCES TO STAFF		
Conveyance Advance	52,100.00	59,900.00
Computer Advance	1,08,750.00	98,250.00
Festival Advance	37,350.00	42,750.00
House Building Advance	29,970.00	44,790.00
LTC Advance	–	70,000.00
Local Chapter & Popularisation of Science	9,08,676.00	12,25,952.29
Advance Design	–	2,00,000.00
Advance Sectt. Asstt & other	57,842.00	38,000.00
CODATA Advance	–	5,62,888.00
	11,94,688.00	23,42,530.29
PART – C – ADVANCE– Security Deposits	3,87,113.00	3,82,787.00
PART – D – BILLS RECOVERABLE		
T.D.S. Recoverable	2,66,436.00	2,08,909.00
Indo Australian Programme	–	872.00
	2,66,436.00	2,09,781.00
GRAND TOTAL (A+B+C+D)	5,41,20,306.00	5,49,16,661.46

SCHEDULE – 11

SCHEDULE FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
INCOME FROM SALES / SERVICES		
Guest/ Committee Rooms/ Conference hall charges and Canteen Food Charges	11,99,838.00	24,58,445.56
Receipts against DST PAC Meetings (Admn.& Other Services)	7,04,606.00	6,50,768.00
House Rent Recovered	15,876.00	16,413.00
TOTAL	19,20,320.00	Rs. 31,25,626.56

SCHEDULE – 12

SCHEDULE FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.2016

Particulars		Current Year Amount (Rs.)	Previous Year Amount (Rs.)
GRANTS / SUBSIDIES (from Department of Science and Technology)			
Non – Plan		50,00,000.00	62,78,000.00
ICSU Subscription		2,01,30,000.00	2,00,00,000.00
Plan – General		13,00,00,000.00	7,14,08,000.00
Plan – Salary	8,12,01,000.00		7,63,77,000.00
Add: Unspent Balance of last year	5,843.00		
		8,12,06,843.00	
Plan – Capital		–	1,96,75,000.00
TOTAL		23,63,36,843.00	19,37,38,000.00

SCHEDULE – 13

SCHEDULE FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
Fee & Subscription		
IUPAC Membership Subs. Fee	4,500.00	19,400.00
TOTAL	4,500.00	19,400.00

SCHEDULE – 14

SCHEDULE FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
Income From Royalty & Reciepts From Publications Etc.		
(1) Income from Royalty	7,37,853.00	7,50,004.96
(2) Income from Sale of Publications	14,61,406.00	14,89,437.00
(3) Refund – Publications (Report Writing)	–	4,00,000.00
(4) Documentation & Publication	–	236.00
(5) Tender fee	15,500.00	8,500.00
(6) Misc. receipts :–		
CODATA	–	3,00,000.00
Plan	–	1,17,717.00
Non–Plan – Forfeited Security Deposits Rs. 5,45,184.00		–
– Sale of scrap goods Rs. 92,763.00		4,35,000.00
– Misc. Rs. 9,160.00	6,47,107.00	15,601.00
RTI	148.00	118.00
	6,47,255.00	8,68,436.00
TOTAL	28,62,014.00	35,16,613.96

SCHEDULE – 15

SCHEDULE FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.2016

Particulars	Current Year Amount (Rs.)	Previous Year Amount (Rs.)
INTEREST EARNED		
1) Interest on Security of Library mem. & Printers Investment	5,750.00	5,750.00
2) Interest on Loans / Advances (HBA, Computer & Conveyance)	1,27,625.00	1,37,224.00
3) Interest on G. J. Building Investment (GJB)	–	4,92,807.00
4) Transfer from Corpus Fund to meet deficit	–	98,18,883.00
TOTAL	Rs. 1,33,375.00	Rs. 1,04,54,664.00

SCHEDULE – 16

SCHEDULE FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.2016

ESTABLISHMENT EXPENSES

Particulars		Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
a)	Staff Salaries :		5,10,36,932.00		4,67,59,718.00
b)	Pensionary Benefits				
1)	Pension	2,08,99,179.00		1,95,87,128.00	
2)	Leave Salary Encashment	14,84,205.00		12,29,095.00	
3)	Gratuity	27,45,238.00		25,91,517.00	
4)	Misc Superannuation exp	42,037.00		0.00	
			2,51,70,659.00		2,34,07,740.00
c)	Other Benefits				
1)	L.T.C	4,33,104.00		14,40,988.00	
2)	Medical .	32,18,290.00		40,27,565.00	
3)	Tution Fee	3,82,092.00		3,19,139.00	
4)	Bonus	89,737.00		1,05,395.00	
5)	Leave Encashment (Staff)	94,017.00		2,78,627.00	
6)	Newspapers	74,927.00		57,750.00	
7)	Other Facilities (Tel.)	4,39,288.00		4,39,737.00	
			47,31,455.00		66,69,201.00
TOTAL			8,09,39,046.00		7,68,36,659.00

SCHEDULE – 17

SCHEDULE FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.16

OTHER ADMINISTRATIVE EXPENSES

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
A) NON–PLAN (Contingencies)				
Telephone Expenses		2,64,094.00		3,23,385.00
Postage		2,19,743.00		10,53,605.00
Printing & Stationery	1,92,409.00		2,08,129.00	
Documentation & Publication	2,10,651.00		2,44,053.00	
		4,03,060.00		4,52,182.00
Advertisement Charges		2,97,114.00		1,29,319.00
Photographs Charges		10,500.00		24,465.00
Repairs and Maintenance		69,53,582.00		65,56,883.00
Ground Rent	5,625.00		5,625.00	
Meeting Expenses	3,32,214.00		6,93,657.00	
Audit Fee	30,780.00		28,090.00	
Bank Charges	14,916.00		9,796.96	
Misc. Expenses	12,877.00		30,514.00	
Legal Fee	5,91,250.00		2,68,500.00	
Hindi Promotion Expenses	30,010.00		57,393.00	
Electricity & Water Charges	6,05,129.00		0.00	
		16,22,801.00		10,93,575.96
Total – A		97,70,894.00		96,33,414.96
B) PLAN (Contingencies)				
Water & Electricity Charges	73,75,644.00		1,27,34,905.00	
Subscription to IIC	1,70,145.00		0.00	
Bank Charges	–		3,244.04	
Maintenance of AC System	29,71,594.00		24,22,968.00	
Maintenance of Electrical Operation	27,19,014.00		15,79,669.00	
Maintenance of Computer System	3,01,206.00		4,80,722.00	
Felicitation Function	–		1,500.00	
		1,35,37,603.00		1,72,23,008.04
Total – B		1,35,37,603.00		1,72,23,008.04
Grand Total – A+B		2,33,08,497.00		2,68,56,423.00

SCHEDULE – 18

SCHEDULE FORMING PART OF INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDING 31.03.2016

EXPENDITURE ON GRANTS , SUBSIDIES ETC.

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
Grants to Institution				
Science Promotion Scheme (Projects)		4,02,12,999.00		1,81,74,696.00
(Refer Annexure – I)				
History of Sciences Projects				
(Refer Annexure – II)	45,66,255.00			52,21,121.00
Young Historian (Cash Awards) (Annexure–VI)	50,000.00			
		46,16,255.00		
Young Scientists Project				
Research Projects (Refer Annexure – III)	2,38,31,952.00		1,02,36,806.00	
Cash Awards (Refer Annexure VI)	7,25,000.00		7,50,000.00	
Cash Awards (H/S)	–		25,000.00	
		245,56,952.00		110,11,806.00
Teachers Awards				
Cash Prizes (Refer Annexure V–B)	6,00,000.00		4,50,000.00	
Books Grant	1,07,902.00		79,958.00	
		7,07,902.00		5,29,958.00
INSA Chair for Overseas Scientists		8,05,427.00		2,88,000.00
CICS, Chennai		80,00,000.00		47,00,000.00
TOTAL		7,88,99,535.00		3,99,25,581.00

SCHEDULE – 19

SCHEDULES FORMING PART OF INCOME & EXPENDITURE FOR THE YEAR ENDING 31.03.2016

Particulars	Current Year Amount (Rs.)		Previous Year Amount (Rs.)	
I) TRAVELLING		56,89,466.00		1,04,09,359.00
II) PUBLICATIONS		51,01,736.00		34,29,596.00
III) Subscription to ICSU Bodies		2,07,34,071.00		1,94,47,318.43
IV) International Scientific Delegations/				
Exchange Programmes				
ICSU	18,69,023.00		21,38,332.00	
Non – ICSU	15,66,536.00		25,35,909.00	
Inter – Academy	53,06,214.00		44,85,770.00	
		87,41,773.00		91,60,011.00
V) Seminars /Symposia /Conferences/Workshops Popularisation of Science Activities		64,98,952.00		42,02,045.00
VI) Other Expenditure				
Subscription for Journals & Library exp	15,37,762.00	44,356.00		
IUPAC Membership Subscription	5,117.00	18,271.20		
Deficit of Plan General (Previous year)	98,18,883.00	0.00		
Science Policies Cell	–	5,36,348.00		
INSA Teacher Award	–	35,325.00		
Medals	14,681.00	1,13,76,443.00	18,225.43	6,52,525.63
TOTAL		5,81,42,441.00		4,73,00,855.06

SCHEDULE – 20

SIGNIFICANT ACCOUNTING POLICY AND NOTES TO ACCOUNTS FOR THE YEAR ENDING 31ST MARCH 2016

1. Significant accounting policies
   a) The books of accounts have been maintained on cash basis.
   b) In view of claim of Capital expenditure as application to charitable purposes under Section 11 of Income Tax Act, no depreciation has been charged on Fixed Assets and Books. Fixed assets are stated at historical cost and no revaluation of Fixed Assets has been done.
   c) Long term investments are stated at cost of investments. Interest earned on fixed deposit is being accounted for on maturity, renewal or encashment.
   d) Gratuity and other retirement benefits are accounted on cash basis.
   e) Funds / Grants include interest of respective fixed deposits / investments and related Expenses are also deducted.
   f) Government grants have been accounted for on Cash basis. Fixed assets acquired out of Government grant are shown at purchase value (cost of Assets).
   g) Grants from Government relating to Fixed Assets are credited to specific funds and Fixed Assets acquired out of such grants are shown at cost.
   h) Provident Fund is managed and administered by the Academy as per the guidelines of Govt. of India.

2. Capital Grants and non recurring capital expenditure which was hitherto accounted for in Income and Expenditure account by credit to respective capital funds has now been accounted for in the Balance Sheet. Consequently various capital funds of earlier years aggregating to Rs. 13,68,38,074/- has been transferred from respective funds as on 01.04.15 to the Income & Expenditure account in the Balance Sheet.

3. Interest earned Rs. 1,00,78,321/- out of corpus fund investements has been included in Schedule 1 of Corpus Fund A/c.

4. Stock of Publications of the Academy as on 31st March 2016 has not been included in the Balance Sheet, whereas, the same is the property of the Academy.

5. Fixed Assets Register is being updated.

6. Grants-in-aids released to various institutions under various schemes are subject to their audit / utilization certificate.

7. Surplus earned Interest of Rs. 18,118/- (difference of interest earned on investments with banks and interest paid to GPF Subscribers) has been credited to Employee General Provident Fund account in schedule 6 which is to be utilized in case of deficit in future.

FOR JAIN PRAMOD JAIN & CO., Chartered Accountants	FOR INDIAN NATIONAL SCIENCE ACADEMY	FOR INDIAN NATIONAL SCIENCE ACADEMY
Sd/- (P.K. JAIN) Partner M.No.10479 1 SEP 2016	Sd/- (A.K. MOITRA) Executive Director	Sd/- (SUNIL ZOKARKAR) Deputy Executive Director (F & A)

JAIN PRAMOD JAIN & CO. Chartered Accountants

Annexures

ANNEXURE-I

MINI-SYMPOSIUM ON 'TO CELEBRATE INTERNATIONAL YEAR OF LIGHT 2015'

(Summaries of the Lectures delivered during AGM)

Development of Light Based Technologies: Indian Perspective

Dr BN Jagtap
Bhabha Atomic Research Centre, Mumbai

International Year of Light (IYL-2015) is a celebration of optical technologies, which have been instrumental in providing solutions to the global challenges in energy, education, agriculture, communications and health. In this context, it is prudent to discuss various efforts targeted towards the development of optical technologies in the India. This talk attempts to provide a bird's eye view of these efforts in the domains of communication, ultra-purification, precision measurements, nano-photonics and health, with a particular reference to the work carried out in the Department of Atomic Energy. The lessons learnt from these efforts and a possible way forward will also be discussed.

Light Reveals Biomolecular Dynamics

Dr G Krishnamoorthy, FNA
Anna University, Chennai

The complexity of biological world arises from the myriad of chemical structures and their associated dynamics. The wealth of structural information available in biology has led to the realization that a complete understanding of biological processes requires information on dynamics of the complex molecular systems apart from the knowledge on their high resolution structure. Despite this realization the level of information on dynamics is very scattered and highly insufficient.

A variety of physical techniques are being applied to bring out dynamic information on complex systems. Of these, optical fluorescence-based methods have a unique advantage due to their ultra-high sensitivity and selectivity. Furthermore, they cover a wide temporal range of femtosecond to seconds. In our laboratory we have been using various time-domain fluorescence techniques for addressing issues related to dynamics of proteins, protein-DNA complexes, biomembranes and single living cells. Subsequent to obtaining information on dynamics we then look for correlations between dynamics and biological function on these molecular systems. Such correlations, when established on firm grounds, bring out remarkable aspects of mechanistic details.

The following two examples from our recent work will be described in detail for amplifying the above statements: (i) Time-evolution of structural change during folded-unfolded transition was used to bring out the continuous (barrier-less) nature of protein folding/unfolding; and (ii) Site-specific fluorescence dynamics was used in revealing the mechanism of action of a temperature-sensitive RNA switch.

Fundamental Processes Probed by Light

Professor Anunay Samanta, FNA
University of Hyderabad, Hyderabad

Light plays a key role in our daily life and light-based technologies are the future to meet our need for energy, communication, health, education, etc. Photochemists employ light as a source of energy for initiating chemical transformation. They also use light from a variety of sources ranging from conventional lamps to high intensity short-pulse lasers to study chemistry at its very basic level. In our laboratory, we use light not for any chemical transformations, but for studying fundamental processes at molecular level where light plays a key role as an initiator or a probe. Specifically, we study the short-lived species, which vary from excited states of molecular systems to intermediates of chemical reactions, by monitoring their spectral and temporal behaviour. We also study

the dynamics of ultrafast processes such as solvation, rotational diffusion, excited state electron and proton transfer reaction, conformational dynamics and various radiative and nonradiative deactivation processes for a better understanding of these processes and to obtain insight into the nature of microenvironments of different complex media/assemblies of interest. In this talk, some of our recent work will be highlighted.

Luminescent Metal Nanoclusters: Versatile Probes For Multidisciplinary Applications

Dr Saptarshi Mukherjee
Indian Institute of Science Education and Research, Bhopal

Metal nanoclusters (NCs) are known to possess unusual size-dependent optical properties. Two silver NCs namely, Ag_9:HSA NCs (blue emission) and Ag_{14}:HSA NCs (red emission) were synthesized using a circulatory protein, Human Serum Albumin (HSA) as a template. These NCs are inter-convertible via simple redox chemistry, whereby, almost all of their photo-physical properties are retained. These luminescent Ag NCs were found to be efficient metal ion sensors. Upon trypsin digestion, Ag:HSA NCs exhibited quenching in PL intensity. Surprisingly, we could observe the gradual evolution of a new red emission band characterized by an enhanced photoluminescence properties in contrast to the parent blue emitting Ag:HSA NCs which was ascribed to the formation of a 28 atom "meta AgTp" NCs. We have also synthesized stable Cu NCs having intense blue emission and high photo-stability. These PL NCs were illustrated as efficient probes for Förster Resonance Energy Transfer (FRET) with a compatible fluorophore (Coumarin 153). These non-toxic CuNCs were also synthesized using Glutathione as a template and besides sensing Fe^{3+} ions, these CuNCs can serve as potential nuclear membrane markers.

Single Molecule Spectroscopy of a Single Live Cell

Professor Kankan Bhattacharyya, FNA
Indian Association for the Cultivation of Science, Kolkata

The 2014 Nobel Prize in Chemistry has been awarded for the development of Single Molecule Spectroscopy. In this talk, we will discuss some recent application of this technique to the study of a single live cell. In a confocal microscope, the size of the focused spot (~200 nm = 0.2μ) is one-hundredth of the dimension of a cell. Thus one can probe different regions/organelles in a cell. Utilizing this, we will describe several new phenomena inside a live cell. We have detected the substantial differences between a cancer cell and a normal cell. The gold nano-clusters preferentially enter or stain a cancer cell compared to a non-malignant cell. This has been utilized in selective killing of cancer cells without causing any damage of the non-cancer cells. The red-ox processes (thiol-disulfide interconversion) lead to intermittent structural oscillations leading to fluctuations in fluorescence intensity in a single live cell. Such oscillations are absent for a cancer cell. The number of lipid droplets are much higher in a cancer cell.

Molecular Framework of Light Perception and Signalling in Plants

Professor JP Khurana, FNA
University of Delhi South Campus, New Delhi

Light plays a pivotal role in regulating plant development all through their life cycle, starting from the onset of seed germination, cessation of stem growth, cotyledon expansion and leaf development, phototropism, stomatal movement and transition to flowering. Plants have developed an intricate network of light signaling components, which interact with almost all the important metabolic pathways. The light signaling cascade is quite hierarchical with photoreceptors like phytochromes and cryptochromes placed up in the ladder and are involved in sensing the light signals. It is followed by early signaling factors like HFR1 and central integrators like COP1 (a component of E3 ligase). Further downstream are effectors like HY5, a bZIP transcription factor, which regulates the expression of a rather large number of downstream genes that eventually regulate diverse plant responses. Although the red/far-red sensing phytochromes are unique to plants among the eukaryotes, but the blue/UV-A sensing cryptochromes are present also in Drosophila, mouse and humans and play a major role in regulating biological clocks.

In the past nearly 15 years, major focus in our laboratory has been on the functional characterization of cryptochromes from Brassica (Cry1 and Cry2) and rice (Cry2) and an orthologue of Arabidopsis Hy5 from rice. The transcript levels of Brassica and rice CRY2 gene are not affected by light but it encodes a protein that is rapidly degraded on exposure to blue light, whereas CRY1 protein from Brassica is light stable. The Brassica CRY1 when over-expressed in its native species caused dwarfism and, conversely, its knockdown stimulated stem elongation. In contrast, the over-expression of CRY2 gene from both rice and Brassica caused hyper-photomorphogenesis, including early flowering, in transgenics. The Hy5 orthologue in rice, which is expected to work downstream to cryptochromes, when over-expressed both in rice and Arabidopsis caused strong reduction in plant height. How light sensed by cryptochromes is able to reduce plant height by modulating the expression of genes associated with gibberellin (GA) metabolism is another question we are addressing now. We have some clue that at least three transcription factor, including Hy5, bind to the promoter of GA2ox gene that codes for an enzyme involved in GA catabolism, that can cause degradation of bioactive GA, thus causing reduction in plant height.

These data provide evidence that sensory

photoreceptors like Cry1 and Cry2 and the downstream effectors like Hy5 can be used as potential tools to control flowering time and plant height, the two traits that are crucial for enhancing plant productivity.

ANNEXURE-II

MINI-SYMPOSIUM ON 'RESEARCH AT IISER BHOPAL: QUEST FOR SOME NEW FRONTIERS'

(Summaries of the Lectures delivered during AGM)

Ambient Fine Particles over an Ecologically Sensitive Zone in Bhopal–Characterization, Temporal Variability, And Sources

Dr Ramya Sunder Raman
Indian Institute of Science Education and Research, Bhopal

Scientific and public concern over fine particulate matter (PM) induced climate and health effects has resulted in the inclusion of $PM_{2.5}$ (PM ≤ 2.5 µm, $PM_{2.5}$) in the National Ambient Air Quality Standards (NAAQS) in 2009.

In response to the revised NAAQS and a general need to better understand the nature of fine particles over locations in India, a monitoring station was set-up at an ecologically sensitive zone in Bhopal, Van Vihar National Park (VVNP), to measure $PM_{2.5}$ and apportion its sources. $PM_{2.5}$ mass, its chemical constituents, optical properties, and meteorological parameters over VVNP were measured for two years, between January 2012 and December 2013.

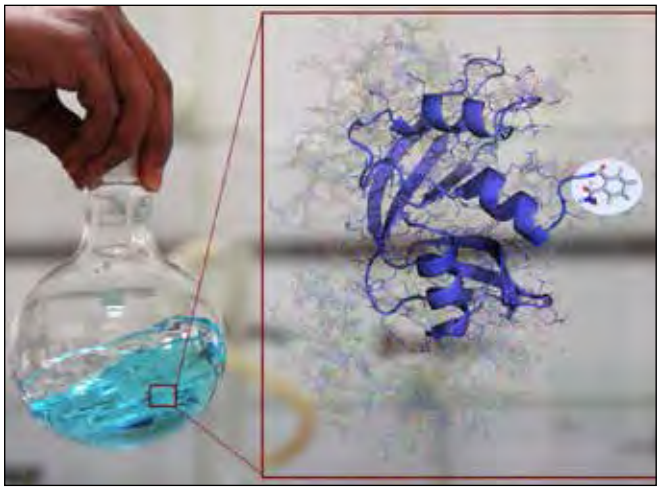
This talk will focus on the results obtained from this study, including the temporal variability in fine PM mass, its chemical and optical properties and the potential sources of the aerosol. Study outcomes will be placed in the context of assessing and managing fine PM mass concentrations and aerosol induced visibility degradation over protected environments.

Reactivity and Selectivity in Chemical Modification of Un-Engineered Proteins

Dr Vishal Rai
Indian Institute of Science Education and Research, Bhopal

The surface of protein offers a rich landscape of functional groups. Chemical tools for site-specific labeling of these functionalities are desired for their myriad applications in understanding biological interactions, ligand discovery, disease diagnosis, and biophysical investigations. Typically, these diagnostic tools can be accessed by the derivatization of nucleophilic side chains in the case of un-engineered proteins.

Our research group is investing efforts to develop chemo- and site-selective chemical methodologies for labeling of proteins. Here, the first step involves the development of transformations that would be efficient in controlled reaction conditions such as aqueous buffer,



neutral pH and room temperature. The critical challenge relates to the identification of principles that would allow us to generate reactivity biases at specific sites of the protein. Our ongoing efforts in this direction will be discussed in the presentation.

Primitivity in the Mapping Class Group

Dr Kashyap Rajeevsarathy
Indian Institute of Science Education and Research, Bhopal

The *mapping class group* of a closed orientable surface is the defined by the group of isotopy classes of its homeomorphism group. As solving the primitivity problem is fundamental to any group, we try to analyse this problem from the perspective of the mapping class group.

We will state various results that have been derived in this direction, and some crucial steps that still remain before we can obtain a complete solution to the problem.

Yeast Sen1 is Essential for Maintenance of Cellular Redox Homeostasis and Life Span

Dr Raghuvir Singh Tomar
Indian Institute of Science Education and Research, Bhopal

Diseases can occur due to the accumulation of cellular oxidative stress, misfolded/aggregated proteins, dysfunctional organelles, damaged DNA and epigenetic alterations in chromatin structure. However, cells

have evolved a variety of mechanisms to protect from these deleterious changes; expression of enzymes that remove reactive oxygen species, chaperone proteins to fold misfolded proteins, autophagy to recycle damaged organelles, and DNA repair. Defect in these mechanisms due to genetic as well abnormal epigenetic alterations can lead to diseases such as cancer and neurological disorders. Mutations in the human *SETX* gene, which encodes an orthologue of yeast Sen1, called Senataxinprotein have been correlated with the progressive neurodegenerative disorders; ataxia with oculomotor apraxia type 2 (AOA2) and amyotrophic lateral sclerosis type 4 (ALS4). However, the underlying mechanism is not clear. Given the strong similarity between yeast Sen1 with human Senataxin proteins, we utilized Sen1 mutant strains of yeast to study role of Sen1 in cellular homeostasis mechanisms and life span. Upon N-terminal truncation of Sen1, we observed drastic decrease in mitochondrial DNA copy number, increase in cellular ROS level and decrease in chronological life span. Altogether our results with yeast Sen1 are expected to provide clues for the progressive neurological disorders that occur due to mutations in the human Senataxin.

The Mitochondrial Regulator: Molecular Origin of Structure, Function and Regulation in Human Vdac-2

Dr Radhakrishnan Mahalakshmi
Indian Institute of Science Education and Research, Bhopal

Every cell requires energy to survive. This energy is generatedas ATP by the mitochondria present within each cell. Voltage-dependent anion channels (VDACs) are pore-forming proteins in the mitochondrial outer membrane that ensure efficient supply of ATP and other metabolites from mitochondria to the various parts of the cell. In addition to achieving bidirectional metabolite transport, VDACs regulate cellular enantiostasis and are responsible for mitochondria-mediated apoptosis. Human VDAC-2, one of the three VDAC isoforms, is anti-apoptotic, and differs from its pro-apoptotic analogs by a mere 25% variance in primary sequence. This difference allows hVDAC-2 to perform unique auxiliary functions including the binding and regulation of apoptotic Bcl-2 family proteins, calcium homeostasis, steroidogenesis as well as gametogenesis. For hVDAC-2 to function, it is imperative that optimal stability and structure be preserved, despite a continually fluctuating cellular environment, and insults from toxins.

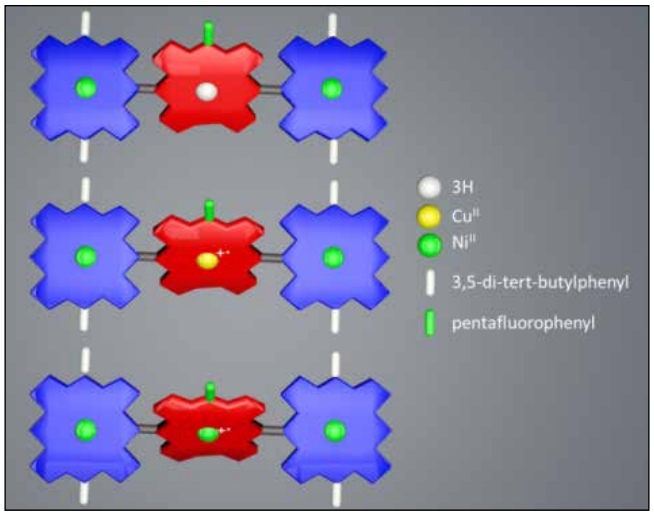
Identifying the origin and molecular basis of the unique functionality in hVDAC-2 and factors stabilizing the 19-stranded barrel structure has remained a challenge for decades. We employ a heuristic approach involving biophysical, biochemical, and electrophysiological experiments, coupled with *in silico* and *in vivo* complementation studies to decipher the multifaceted role of hVDAC-2. Towards this end, we have obtained exciting results on the regulatory role of the hVDAC-2 N-helix, and the interface cysteines unique to this protein. Our findings reveal that the N-helix regulates channel voltage sensing, drives the correct folding and establishes a thermodynamically stabilized barrel. We further observe that interface cysteines contribute differentially to protein-lipid interaction, scaffold stabilization, and modification by reactive oxygen species. Finally, our studies reveal the functional requirement of a 19-stranded barrel structure in hVDAC-2.

Our findings have led to the identification of biophysical properties and structural elements of hVDAC-2 that modulate barrel function and regulation. We find that hVDAC-2 is vital in containing reactive oxygen species build-up in the mitochondrial intermembrane space. Further studies in this direction will allow us to deduce how hVDAC-2 decides the fate of the cell.

A Multichromophoric Platform for Stabilizing Metal Ions in Different Oxidation States

Dr Jeyaraman Sankar
Indian Institute of Science Education and Research, Bhopal

Research on developing multichromophoric platforms for stabilizing metal ions is different oxidation states is gaining momentum due to their wide applications expected in various areas like catalysis, magnetism and opto-electronic materials. Till date porphyrins have been used for stabilizing multiple metal ions as multichromophoric arrays but incorporation of different metals in their variety of oxidation states was not possible in such arrays due to the inherent dianionic nature of the ligand. Recently, we have succeeded in the synthesis and characterization of porphyrin–corrole–porphyrin (Por-Cor-Por) hybrids directly linked at the meso–meso positions for the first time. The stability and solubility of the trimer are carefully balanced by adding electron-withdrawing substituents to the corrole ring and sterically bulky groups on the porphyrins. The new hybrids are capable of stabilizing more than one metal ion in a single molecular scaffold. The versatility of the triad has been demonstrated by successfully stabilizing homo- (Ni) and heterotrinuclear (Ni-Cu-Ni) coordination motifs. The solid-state structure of the NiPor-CuCor-PorNi hybrid was revealed by single-crystal X-ray diffraction studies. The NiII porphyrins are significantly ruffled and tilted by 83° from the plane of corrole. The robustness of the synthesized hybrids was reflected in the electrochemical investigations and the redox behaviour of the hybrids show that the oxidation processes are mostly corrole-centred. In particular it is worth noting that the Por-Cor-Por hybrid can further be manipulated due to the presence of substituent-free meso-positions on both the terminals. Thus we strongly believe that the molecular platform developed by us will be highly flexible and the highlights of the work will be discussed in detail in this talk.



Publications:

1. Murugavel M, Reddy RV Ramana, Dey D and Sankar J, *Chem. Eur. J.*, **21** (2015) 14280-14286 (Hot Article).
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Autonomous Motion of Deformable Objects

Dr Snigdha Thakur
Indian Institute of Science Education and Research, Bhopal

Self-propelled motion involving conversion of chemical energy to mechanical energy internally is widespread in nature. Examples include biological motors which play essential roles in the transport and synthesis biochemicals in the cytoplasm and in cell motility [1, 2]. In addition to these biochemical motors, synthetic molecular motors have been designed that use chemical, light, or other energy sources to perform directed motion. Model for one such class of synthetic motors, where the motion does not rely on the conformational change will be discussed [3]. This class of motors includes electrochemically synthesized striped bimetallic nanorods and synthetic catalytic molecules tethered to inactive particles. We also probe the collective behaviour of such motors.

The chemo-mechanical propulsion is not limited to particle-like elements, rather there are many instances where such conversion occurs on filaments [4]. The dynamics of such active semi-flexible filament will be discussed. We show that the filament exhibits three distinct type of motion, namely, translational, snaking and rotation: as the rigidity of the filament decreases. Further, the autonomous propulsion of a chemically powered vesicle will be discussed.

Publications:

1. Vale RD and Milligan RA, *Science*, **288** (2000) 88.
2. FJ Nedelec et al., *Nature*, **389** (1997) 305.
3. WF Paxton et al., *J. Am. Chem. Soc.*, **126** (2004) 13424.
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Low-Energy Charge Dynamics Across Metal-Insulator Transition in Rare-Earth Nickelates as Probed by Terahertz Spectroscopy

Dr Dhanvir Singh Rana
Indian Institute of Science Education and Research, Bhopal

Recent advances in terahertz (THz) science and technology - encompassing various spectroscopic and imaging techniques – have enriched all disciplines of fundamental and applied sciences. In this talk, I will present our recent results of the applications of THz time-domain spectroscopy in complex oxides[1,2], more specifically in rare-earth nickelates ($RNiO_3$, R=Nd, Pr and Sm) which exhibit metal-insulator transition. We present first evidence of the charge-density-waves (CDW) resonances in a prototypical $NdNiO_3$ system employing terahertz time-domain spectroscopy along selective crystal axes.[3]A finite peak structure at 5meV in the terahertz conductivity displays all the characteristics of a charge-density-wave condensate. Contrasting charge-dynamics of collective CDW mode and Drude conductivity emerging, respectively, from orthorhombic and cubic crystal symmetries disentangle charge-ordering from the insulating state in $NdNiO_3$and establish a novel structure-property cause-effect relationship. In $PrNiO_3$, the manifestation of a giant dielectric constant in the metallic state and a unique scaling of the dielectric constant and THz conductivity across the insulator-metal transition are rare attributes of the complex oxides.[3] These studies suggest that THz technology is indispensible to unravel a range of rich physical phenomena in complex systems.

Publications:

1. Parul Pandey *et al*, *Appl. Phys. Letts.*, **100** (2012) 62408.
2. Rakesh Rana *et al*, *Phys. Rev. B*, **87** (2013) 224221; *J Phys.: Condens. Matter*, **25** (2013) 106004.
3. Rakesh Rana *et al* (Communicated); EV Phanindra *et al* (In progress)

INSA AWARD LECTURES

(Summaries of the Lectures delivered during AGM)

INSA Medal for Promotion & Service to Science Lecture (2014)

Evolving Approach of Biology to Ayurveda

Professor MVS Valiathan, FNA
Manipal University, Manipal

The East-West encounter which led to British rule cast its mantle on all aspects of human endeavor in India. This was especially true for medicine because the Europeans who came to India were suddenly confronted by unfamiliar diseases of the tropics such as malaria, dysentery, cholera and plague. From Garcia Da Orta in the 16th century in Goa and Van Rheed in the 17th in Kerala to Roxburgh in Kolkata in the 19th, Europeans approached the medical practices of natives through the study of India's medicinal plants. The taxonomic approach to India's traditional medicine attracted serious attention in Europe and 70% of drugs of plant origin in BP were of Indian in origin in 19th century. This phase was followed in the 20th century by the pharmacologic approach of Professor RN Chopra who became the "Father of Indian Pharmacology". The advent and rapid growth of natural products chemistry came next during the 20th century. Today's vibrant herbal drug industry in India owes its progress to the preceding efforts of generations of natural products chemists.

It is no surprise that modern biology provided the latest instrument to study traditional medicine in India toward the end of the 20th century because double helix had been discovered and hardly any serious research in biomedicine could be done without tracking events at the molecular level during illness and treatment. "A Science Initiative in Ayurveda" was launched in 2006 with the support of the PSA, Government of India to promote research in modern science based on cues from Ayurveda. The initial round of five projects involved the participation of scientific institutions and Ayurvedic centers across India, which gave new insights into ancient concepts such as Prakriti or constitutional types of individuals, and procedures like Panchakarma. The progress in these studies, resulting publications, and the expanding scale of collaboration between scientific and Ayurvedic institutions resulted in the creation of a Task Force in Ayurvedic Biology under the SERB. Four studies which were completed and published on Prakriti, Rasāyana, Rasasindur and Panchakarma will be outlined to illustrate the kind of effort required for advancing research in Ayurvedic Biology.

The Aryabhata Medal Lecture (2015)

Exotic Organisms and Novel Biology: World Of Parasites

Professor Alok Bhattacharya, FNA
Jawaharlal Nehru University, New Delhi

Our current knowledge of biology comes from extensive study of a handful of organisms, generally known as model organisms. Some of these are laboratory mouse (mammal), *Arabidopsis* (plant), *Drosophila* (insect), *Caenorhabditis elegans* (nematode), *Saccharomyces* (yeast, a unicellular eukaryote) and *E. coli* (bacteria). There are overwhelming reasons to continue studying these organisms, chief being availability of research material and established methods that help to initiate and pursue research withless delay. However, research should not be limited to just a handful of model organisms as biological systems are not identical, and similar processes are carried out in different organisms utilizing different pathways. This is essentially due to optimization of cellular and physiological processes when organisms adapt themselves to survive in unique ecological niches. Parasitic organisms provide great opportunities for discovering new biological processes and mechanisms as these organisms have coevolved with their specific hosts. Since most parasites are important pathogens (plant or animal) understanding their biology can also be rewarding with respect to development of new therapeutics. Protozoan parasites constitute a highly divergent group of organisms that display interesting biology besides continuing to be a major health burden in countries like India. In this talk I will provide examples of new biology that have been pieced together from different parasites and will give some examples from work done in our laboratory on *Entamoeba histolytica*, the causative agent of amoebiasis.

Dr Nitya Anand Endowment Lecture (2015)

Epigenetic Regulation of Chromatin Dynamics and Gene Expression: Implications in Differentiation, Disease and Therapeutics

Professor TK Kundu, FNA
Jawaharlal Nehru Centre for Advanced Scientific Research, Bengaluru

The dynamic nature of the eukaryotic genome, which is organized into a nucleoprotein structure called chromatin is regulated by epigenetic modifications of DNA and associated proteins, which in turn control the underlying

gene function. Chromatin organization is also closely linked to the function of chromatin associated nonhistone proteins. Our laboratory has discovered that the highly abundant human transcriptional coactivator PC4, is a chromatin organizer, and helps in maintenance of epigenetic state of the genome and thereby the global regulation of gene expression and cell cycle. Our recent observations suggest that PC4 is an important factor in breast cancer progression. From the angle of development, we have found that PC4 is absolutely critical for life, as its absence leads to embryonic lethality in mouse. The conditional PC4 brain knockout mice show specific defects in spatial memory, while their viability, fertility and motricity are normal. Gene expression analysis of the dorsal hippocampus of the knockout mice, which was performed to explain these specific defects, revealed dysregulated expression of several neural function-associated genes. This could be a unique role for a chromatin-associated protein in memory extinction.

However, the altered function of any epigenetic modification also causally affects the physiological homeostasis in different pathophysiological conditions such as cancer, neurodegenerative disorders, diabetes, asthma, COPD etc. Among the different epigenetic enzymes we focus on three important classes: lysine acetyltransferases, arginine methyltransferases and Aurora Kinases in the context of cancer and neurodegenerative diseases. Our laboratory has discovered several small molecule modulators of these enzymes, which may serve as lead scaffolds to design new generation therapeutics. By using a novel histone acetyltransferase activator molecule, we find that p300/CBP mediated acetylation of histones is an important inducing factor for robust neurogenesis; which presumably contributes to long-term spatial memory. Besides, as potential therapeutic agents, these molecules may also be highly useful to elucidate the epigenetic regulation of differentiation pathways; as we have elucidated the role of histone H3R17 asymmetric dimethylation in astroglial differentiation by employing a specific inhibitor of PRMT4/CARM1. Furthermore, by employing our newly discovered Aurora Kinase inhibitor, Felodipine (an antihypertensive drug) we found how surface enhanced Raman spectroscopy, could be used as a novel drug discovery tool.

ANNEXURE-IV

SPECIAL LECTURES

(Summaries of the Lectures delivered during AGM)

Making Sense of Science, An Indian Science Journalists' Perspective

Mr Pallava Bagla
Editor, Science, New Delhi Television

When science meets the public, how can the gap be bridged? Why is it that Indian science finds it hard to make it to headlines? Can scientists and science journalists be friends? How can the twain meet, journalists work on sharp deadlines while scientists the visionary thinkers prefer longer lead times. Journalists may seem to be in a hurry but no communicator ever wants to make wanton mistakes. What is the best time to reach out to journalists and what is the essential tool kit for effective outreach. Today most funding agencies want science communication to be part of all research projects. Can scientists leverage the social media to their advantage for effective outreach?

Long Non-Coding RNA's Play Fundamental Roles in Cell Regulation

Professor SC Lakhotia, FNA
BHU, Varanasi

It is well known that DNA carries the genetic information in most organisms and that this information is utilized to produce the various proteins that function either as enzymes to catalyze the different reaction in cells or as structural proteins. Since the total DNA content (C-value) in genome of any eukaryote is much more than required for the various proteins known to exist in the organism, the "C-value paradox" has been a perplexing issue for many decades. As a corollary to the "central dogma of molecular biology", Crick and others suggested in 1980s that bulk of the genomic DNA in eukaryotes is "junk" or "selfish", in spite of indirect evidences existing in 1960s and 1970s that bulk of the nuclear DNA in many higher organisms is actually transcribed. The concept of "junk" or "selfish" DNA was widely and quickly accepted. Consequently, the parts of genomes that did not code for protein or were not involved in facilitating protein synthesis, remained largely ignored. However, an increasing number of studies during the past 10-15 years have confirmed that bulk of the nuclear DNA is indeed transcribed and that the non-coding transcripts actually provide a very complex multi-layered regulatory network essential for generating and maintaining the self-organized state of living organisms. With the evolutionary increase in biological complexity, the regulatory network has also evolved to greater complexities and commensurate with this the so-called

"non-coding" transcripts have also diversified. In this talk, Professor Lakhotia summarized the various classes of short and long non-coding RNAs known in eukaryotes and explained the mechanisms of actions of some long non-coding RNAs like the Xist and roX that ensure dosage compensation of the X-chromosomal genes in males and females through changes in chromatin organization of the X-chromosome in mammals and *Drosophila*, respectively. He further described in detail the functions of the long non-coding RNA *hsrω* gene of *Drosophila*, which his lab has been studying for nearly 45 years. This gene is now known to produce at least 7 non-coding transcripts (ranging in size from 12. to 21kb) through alternative transcription start and termination sites and variable splicing of the single intron. His lab had shown that the 13-21 kb long nuclear transcripts of this gene that contain >5kb of tandem repeat sequences are present in the nucleoplasm as "omega speckles". These act as nucleoplasmic stores of a variety of heterogeneous RNA-binding proteins (hnRNPs) and a few other proteins and thus regulate their availability for transcription and RNA processing. He proposed that such long non-coding RNAs, through their interaction with a diverse arrays of proteins, may act as hubs in cellular networks. A variety of cell stresses that disrupt the normal nuclear transcription and RNA processing lead to a rapid accumulation of the various omega speckle associated proteins almost exclusively at the *hsrω* gene locus. Using live cell imaging his lab has recently shown that when the cell is stressed, the omega speckles rapidly disappear and the associated proteins move to the *hsrω* gene locus in a diffuse form with assistance of some of the nuclear matrix associated proteins. As cells recover from the stressful condition, the accumulated proteins and the hsrω transcripts rapidly emerge out of their caged state at the *hsrω* gene locus as fully formed omega speckles. Several different chromatin remodeling proteins like the ISWI etc were shown to be essential for the biogenesis of omega speckles during recovery from stress as well as under normal cell conditions. He emphasized that in view of the increasing evidence and realization of the enormous importance of the non-coding component of human and other genomes in maintaining normal homeostasis and because of their critical involvement in many human disorders, it is necessary that the diversity and functions of the non-coding transcripts in different organisms be proactively studied.

PUBLIC LECTURE

(Summary of the Lecture delivered during AGM)

Rock Paintings in Central India

Professor GL Badam (Retd)
Deccan College, Pune

Of the many things that our ancestors left behind for us nothing is more exciting than their signatures on rock, what is generally known as Rock Art. Broadly speaking, it includes all sorts of artistic expressions like paintings, (pictographs), engravings (petroglyphs), cup marks etc. drawn on the bare surface of rocks, boulders, ceilings, caves and sometimes on the horizontal surfaces too. With the antiquity of rock art ranging from the Palaeolithic to Historical period, it constitutes the earliest documentation of man, indicating his artistic expressions, inner thoughts and beliefs.

Rock Art is a global phenomenon found almost everywhere in the world and its diversity, temporal and spatial distribution is much above the level of any work of fine art known so far. The study of rock art provides rich and realistic insights into the cultural history of man which was hitherto known by stone implements, skeletal remains and fossils of various types. It is not generally easy to identify and interpret these evidences as it involves the thought process of Early Man which is difficult to judge. Some scholars consider the thought process of Early Man a subject for the future. This is what really makes the study of rock art challenging.

India is one of the countries along with S. Africa and Australia, to have great diversity and density in rock art. The Central Indian region, in particular, is most prolific in rock art and has been studied from a multidisciplinary point of view. These include sites in Madhya Pradesh (Bhimbetka, Adamgarh, Mandsaur, Pachmarhi, etc.); Chhattisgarh (Raigarh, Kanker, Bastar etc.); and some adjoining regions of Uttar Pradesh and Orissa. Drs. VS Wakankar, CW Anderson and GR Hunter were amongst the first to bring to light richness of rock art in and around Bhimbetka (1973), Raigarh (1918) and Pachmarhi (1934) respectively. During the last few decades several rock art sites have been excavated, various Indian and foreign scholars are busy working on these sites and a great deal of information is now available in the form of publications.

During the last one and a half decades the author has been involved in the study of multidisciplinary approaches to Rock Art research in Central India as part of projects initiated by the Rashtriya Manav Sangrahalaya, Bhopal, Govt. of Chhattisgarh, Raipur and the Indira Gandhi National Centre for the Arts, New Delhi. Studies on available dating techniques (relative and absolute), chronological implications of faunal remains depicted in rock art, the first appearance datum (FAD) of an allochthonous fauna, the last appearance datum (LAD) of an autochthonous fauna, taphonomic implications, ecological models, geological and geographical background with respect to site formation process, landscape archaeology and other aspects have made the area of rock art research more comprehensive. Many habitation sites have been discovered recently which may date to Middle- Upper Palaeolithic period and the

study of these could throw a flood of light on the life ways of Early Man in various regions of Central India.

It is well known that artists express their thought process in any activity including during the course of paintings and engravings, thus indirectly trying to depict the lifestyle of the people. This aspect of cognitive archaeology (understanding the nature of human mind) is one of the greatest challenges faced by science. Some evolutionary psychologists are of the opinion that the way we think, remains largely conditioned by the lifestyle of our prehistoric hunter- gatherer ancestors. In fact the last decade has seen radical advancements in the way we approach and understand the prehistory and evolution of human mind. Naturally, trying to reconstruct past ways of thinking, as they emerge and take shape in the different cultural manifestations of our species, has been a great challenge for archaeology.

Neuroarchaeology and archaeology of mind are the new areas which will have a strong bearing on the rock art research in future. During the earlier periods when people were living in shelters they made numerous social based figures indicating the association of rock art with social and natural sciences. Animals are the most frequently drawn figures and humans come next. Then there are symbols, designs and other kinds of expressions which help in reflecting their social fabric, religious beliefs and lifestyles. Such studies of the multidisciplinary nature would give a comprehensive account of rock art research in India.

Examples of the rich and varied rock art sites, particularly in Central India, have been presented in this communication. Steps taken towards restoration and conservation of the sites by various agencies need to be re-inforced so as to help preserve this rich heritage of India.

ANNEXURE-V

The "7th International Conference on *Bacillus anthracis*, *Bacillus cereus* and *Bacillus thuringiensis*–Bacillus ACT 2015" was organized successfully by the School of Biotechnology, Jawaharlal Nehru University, New Delhi from 27th–31st October 2015. It is a biannual conference which brings together scientists performing basic and translational research related to the *Bacillus anthracis, Bacillus cereus* and *Bacillus thuringiensis* group species. This conference provides a distinct and important platform for scientists and researchers working in different areas of molecular biology, cell biology, genomics, transcriptomics, proteomics, metabolomics, immunology, pathogenesis, vaccinology, epidemiology, ecology and diagnostics of these three important species of the genus Bacillus, and accelerates translational research by discussions and presentations. It has become a crucial meeting for scientists working in the area to present their work to a wide international audience and foster collaborations. The basic objective of the meeting is to bring together academicians and experts from different parts of the country and abroad to exchange knowledge and ideas. Novel research done in the last two years is presented and discussed amongst participants, which not only helps in augmenting the future research but also contributes to troubleshooting and developments in the field. Collaborations between scientists as a result of exchange of ideas at the meeting is expected which will enhance research and infrastructure.

The last three conferences of the Bacillus ACT have taken place at various places in the USA, Canada and Europe, and witnessed cutting edge science in the field. Traditionally, the conference has taken place alternatively in the USA and the Europe. This was the first time that the Bacillus ACT meeting was held at a place other than these two, and brought to New Delhi, India. In 2009, the meeting was held in Santa Fe, New Mexico, USA; the 2011 conference was held in Bruges, Belgium and the 2013 Bacillus ACT was held in British Columbia, Canada. This year, the "7th international conference on *Bacillus anthracis*, *B. cereus* and *B. thuringiensis*- Bacillus ACT 2015" was held in New Delhi, India. Around 150 participants representing 20 countries gathered to discuss over 120 oral and poster presentations. A majority (80 percent) of the participants were from abroad signifying the reach and impact of the conference. The meeting saw participation from delegates

from the USA, the Europe, Canada, Japan, Korea, Brazil, Kazakhstan and Bangladesh. At the same time, over 40 Indian participants from across the length and breadth of the country attended the meeting. The delegates who participated in the conference were from the ranks of senior faculty, medical professionals and industry experts to students who had freshly joined for PhD. The conference saw a huge participation by young scientists from different countries. The keynote address was given by Dr. Arthur M. Friedlander, a noted expert in the field of anthrax infection, pathogenesis and vaccine development. The agenda of the meeting covered a wide range of very interesting topics with a total of six sessions- Epidemiology/Ecology/ Bacterial Decontamination, Bacterial Physiology & Gene Regulation, Cell Wall & Spore Structure/Bacillomics, Host Pathogen Interactions, Vaccines, Therapeutics & Diagnostics and Bacterial Toxins. Each session had a number of stimulating oral talks and poster presentations. The oral talks and poster presentations were selected from the submitted abstracts, on a competitive merit basis, by an abstract reviewing committee comprising of Indian and international experts, who also served as the Chairs for different sessions. A total of seven awards were presented for the poster presentation category which was also decided by a poster reviewing committee. The valedictory talk for the conference was delivered by the acclaimed Indian scientist, Prof. P. Ananda Kumar. The meeting also initiated many fruitful future collaborations between Indian and international scientists, giving Indian research infrastructure a boost and international exposure. The meeting also saw a string of generous sponsors including INSA.

A pre-conference workshop on "Biorisk Management for *Bacillus anthracis*" was held on 26th October 2015, jointly sponsored by the American Society for Microbiology (ASM) and the Society for Biosafety-India (SBS). The workshop was fully funded by the ASM and saw participation of around 80 delegates, mostly Indians from clinical and research background. The workshop focused on safe and secure diagnostics and response to outbreaks, as well as approaches to reduce the threat of bioterrorism. A combination of international and Indian experts moderated the interactive workshop. Best practices for sample collection and transport, referral systems, rapid and conventional diagnostics, outbreak-site and laboratory-based decontamination and waste management, institutional policies to prevent accidental exposure and the potential for intentional misuse were discussed in the workshop. Case studies from the management of the 2001 anthrax outbreaks in the US and recent biosafety incidents were also taken up in the workshop. A demonstration of biosafety practices and personal protective equipment used in biosafety laboratory facilities was given to the participants.

The conference was also unique in a way that it incorporated a social programme also in its agenda, in addition to its elaborate scientific programme. A tour of the city of Delhi and a trip to the Taj Mahal for the participants was also arranged. The valedictory session of the conference took place in Agra after the trip to Taj Mahal. This was highly appreciated by the delegates, particularly the foreign participants, and brought a fresh feeling to the meeting, in addition to leaving a long lasting impression.

ANNEXURE-VI

REPORT ON ASIAN CRYSTALLOGRAPHIC ASSOCIATION (AsCA) 2015

The 13th Conference of the Asian Crystallographic Association was held at Science City, Kolkata during December 5-8, 2015. The only other time the meeting was held in India was in 2001 (November 18-21) at Bangalore. Since then the meeting has increased in scope and level of international participation. The meeting had about 400 participants, with the break-up among different countries being: Australia 36; Bangladesh 19; Brazil 1; China 10; France 2; Germany 4; Hong Kong 2; India 192; Ireland 1; Italy 1; Japan 46; Korea 12; Netherlands 1; New Zealand 3; Nigeria 1; Saudi Arabia 2; Singapore 12; Sri Lanka 2; Switzerland 2; Taiwan 9; Thailand 2; UAE 1; UK 13; USA 13; Uzbekistan 2; Vietnam 2.

The meeting covered all aspects of crystallography and the latest developments in techniques and softwares. The scientific session consisted of 4 plenary talks, 5 keynote addresses, and 102 oral presentations distributed in 18 microsymposia (MS1-18), two software sessions (CS1-2) and one General Interest session (GIS) on pharmaceuticals. There were about 180 poster presentations. A special AsCA Rising Star Session was conducted on the last day, where the six best abstracts submitted by young participants (PhD or early post-docs), as selected by a panel of judges, made a 15-minute oral presentation of their work. This gave an opportunity to the promising young scientists to present their work and provide a boost to their scientific career. Besides, there were three IUCr Poster Prizes, three ASCA 2015 Poster Awards and one RCSB PDB Award.

A number of companies sponsored the meeting, and exhibited their machines in their booths. In fact, Bruker made a world-wide launch of their product, D8 Venture at the meeting. This is for the first time that a product has been launched at an AsCA meeting, and definitely first time for India being used as a launching pad.

INSA contributed 2 lakhs rupees towards the meeting. The grant was used to partially support a number of young participants from India and from the neighbouring Bangladesh, thereby fostering cooperation between SAARC countries. The final finances are yet to be worked out. If there is some shortfall, the organizers may have to get back to INSA for a rescuing act.

The participants, especially those from outside India, generally went back satisfied with the scientific content and the hospitality offered. It may be mentioned that the International Union of Crystallography (IUCr) would hold its General Assembly in Hyderabad during August 2017. This meeting has been a positive advertisement for the Hyderabad meeting, and the participants are likely to visit India again in 2017. One issue, however, has been with us for a long time and has also been a nuisance at the meeting. This pertains to the clearance that the Chinese participants have to receive from the Ministry of Home Affairs prior to the issue of visa. The clearance is never issued on time and as a result of which many Chinese participants lost interest in attending the meeting and cancelled their trip at the last moment. This issue needs to be taken up by INSA at the highest level so that the Chinese participants are considered as par with the other international delegates, or at least their clearance should be promptly issued. This is very important considering that the General Assembly of IUCr would be held in two years time in Hyderabad, and INSA should provide all the support to the organizer of the Conference (Professor Gautam R. Desiraju).

The details of the scientific program, the list of participants, etc. are available at the conference website (www.Asca2015.org). The conference also had a Facebook account (Asca2015), which has been liked by many visitors to the site. This is the first time that many young researchers in India have been exposed to a meeting of international standard. The meeting would thus have made a positive impact on Indian science and scientific establishment.

ANNEXURE-VII

A BRIEF REPORT ON THE SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH (SCOR)-EXECUTIVE COMMITTEE MEETING AT CSIR-NIO DURING DECEMBER 6-9, 2015

The INSA-SCOR National Committee has invited the Scientific Committee on Oceanic Research to have its Annual Meeting in India. The SCOR accepted the invitation for its meeting in 2015. Consequently the SCOR Executive Committee meeting (as it names its Annual Meetings in odd numbered years) was held during 6 to 9 December 2015 at the CSIR-National Institute of Oceanography in Goa. The EC meeting was attended by 36 participants from India and abroad. Twenty five foreign participants represented 14 countries as SCOR-EC officials and Nominated Members of respective National Committees. Eleven Indians participated as officials of SCOR-EC Committee and National SCOR Committee, Members of SCOR Working Groups and registered participants.

The SCOR-EC meeting 2015 in Goa followed a highly successful International Symposium on "Dynamics of the Indian Ocean: Perspective and Retrospective" during 30 November–4 December 2015, organized by CSIR-NIO, Goa. The Symposium was a part of the Golden Jubilee celebrations of the establishment of CSIR-NIO in Goa and the culmination of the International Indian Ocean Expedition (1959-65). This Symposium was co-sponsored by Government of India, Scientific Committee on Oceanic Research (SCOR) and Intergovernmental Oceanographic Commission (IOC of UNESCO). The Symposium was attended by about 600 registered participants that comprised about 135 delegates from abroad. Particular attention has been paid to inviting students from the Indian Ocean Rim countries to facilitate collaborative research on Indian Ocean in future. Their participation is particularly important as the global community launched International Indian Ocean Expedition - Phase 2 (2016-2020) on the last day of the Symposium. The IIOE-2 is aimed to study the changes in Indian Ocean processes between early 1960s and now. The International Symposium preceding the SCOR-EC meeting 2015 in Goa is co-convened by Drs. M. Dileep Kumar and V. Purnachandra Rao (both are Members of the INSA-SCOR National Committee of 2015).

The SCOR-EC met in closed business session on 6 December 2015. On 7 December the meeting began with Dr SWA Naqvi, the Director of CSIR-NIO and Co-opted Member of the SCOR-EC, welcoming the participants in which he acknowledged the approval by INSA in inviting and supporting SCOR activities through this meeting. This was followed by Reports by the President, Professor Peter Burkill, and the Executive Director, Dr Edward Urban, of SCOR. On 7 December the meeting mainly focused on SCOR Capacity building activities, the Second International Indian Ocean Expedition (IIOE-2) and reviews of currently active Working Groups' activities. Capacity Building activities of SCOR were reviewed in terms of Capacity Building Committee's report, SCOR-Visiting Scholars, POGO-SCOR Visiting Fellowships for Oceanographic Observations and NSF

Travel Support for Developing Country Scientists. Also initiated were the presentations and discussions on 10 new Working Proposals received and reviewed by various National SCOR Committees. These new WG proposals were presented and the discussions led by an identified EC Member. Considerable amount of time was spent on evaluating these 10 new proposals to short-list only those to be funded by SCOR on 7 and 8 December.

On 8 December the Working Group evaluations were followed by reviewing and discussions on Large Scale Scientific Programs the SCOR is associated with: (a) Global Ecology and Oceanography of Harmful Algal Blooms Program (IOC-SCOR), (b) Integrated Marine Biogeochemistry and Ecosystem Research (SCOR-IGBP), (c) GEOTRACES (SCOR-NSF), (d) Surface Ocean—Lower Atmosphere Study (SCOR-NSF), (e) International Quiet Ocean Experiment (SCOR) and (f) the IIOE-2 (SCOR, Govt. of India and IOC).

On 8 and 9 December discussions were made on SCOR Infrastructural Activities with respect to (a) IOC/SCOR International Ocean Carbon Coordination Project, (b) SCAR/SCOR Southern Ocean Observing System, (c) IAPWS/SCOR/IAPSO Joint Committee on Seawater, (d) Global Harmful Algal Blooms and (e) Workshop on Seafloor Ecosystem Functions and their Role in Global Processes.

SCOR's relations with Intergovernmental organizations (a) IOC (b) GESAMP and (c) PICES, and with Non-governmental (ICSU) Organizations (a) IGBP (b) WCRP (c) SCAR and (d) Future Earth Initiative were evaluated on 9 December. Discussions were also held on the activities of the SCOR affiliated organizations and programs. Issues of SCOR in relation to Memberships, publications and Finances were presented and discussed.

The Annual SCOR Meeting 2016 in Sopot, Poland, has been announced. Potential location for its EC meeting in 2017 was discussed.

The SCOR-EC meeting ended by thanking the CSIR-NIO and INSA for support. The local Organizers also acknowledged INSA's support for this meeting.

ANNEXURE-VIII

9TH INDIA INTERNATIONAL GEOGRAPHICAL UNION (IGU) CONFERENCE, NEW DELHI

The Department of Geography, Shaheed Bhagat Singh College, University of Delhi, New Delhi organised the 9th India International Geographical Union (IGU) conference on 'Land Use Change, Climate Extremes and Disaster Risk Reduction' on March 18-20 March 2016. Four of the IGU Commissions – Commission on Biogeography and Biodiversity, Commission on Land Use and Land Cover Change, Commission on Hazards and Risk, Commission on Geopark–collaborated in this conference. A total of 35 oral presentation sessions and 2 poster sessions were organized. Besides, more than 40 international delegates (including IGU Executive members) from about 20 countries and more than 350 Indian delegates representing 27 states and UTs attended the conference. The conference had the representation of major science and research academies of India and abroad, including 1) International Geographical Union (IGU), 2) International Union of Geodesy and Geophysics (IUGG), 3) International Academic Partnership (IAP) - Global Network of Science Academies, 4) Commonwealth Scientific and Industrial Research Organization (CSIRO-Australia), 5) Chinese of Academy of Sciences, 6) Polish Academy of Sciences, 7) Russian Academy of Sciences, 8) National Geophysical Research Institute, Hyderabad, 9) Indian National Science Academy, 10) Defense Research and Development Organization and 11) Geological Survey of India etc.

The dignitaries for the inaugural session were Dr Krishan Lal, Co-Chair, International Academic Partnership (IAP) - Global Network of Science Academies and Ex-President, Indian National Science Academy (INSA) as Chief Guest; Dr Harsh Gupta, President, Geological Society of India and Ex-President, IUGG; Professor Vladimir Kolossov, President, IGU; Professor RB Singh, Vice-President, IGU as Guest of Honor and Professor Tom Beer, Ex IGU President as Keynote Speaker; Dr PK Khurana, Patron and Dr Suraj Mal, Convener. Dr Krishan Lal quoting the present climate change and impending problems due to it asked for an interdisciplinary platform to mitigate these problems. Dr Harsh Gupta in his address emphasized on role of geography in reducing the risk of disasters. Citing the examples of various earthquakes in past he asked geographers to contribute towards Disaster Risk Reduction for future sustainability. Professor Vladimir Kolossov talking about IYGU emphasized on bridging the gap in awareness between local actions and global effects, to encourage everyone to make daily decisions in light of global challenges and to contribute to bottom-up initiatives that connect individual, local action to global sustainability. Professor Tom Beer delivered the keynote address on the Impact of Extreme Weather Events on Food Security. Professor Beer examined the historical link between weather, food supplies, and food distribution; examine the Asian and international situation; summarise the response of the scientific community and point out the direction for future research.

Professor RB Singh and Professor Michael Meadows were two keynote speakers in the plenary session presided by Professor D. Soyez, Vice-President, IGU. Professor RB

Inaugural Session

Address by Dr Harsh Gupta

Cultural Programme

Valedictory Session

Singh, delivering his address on Urban Health and Wellbeing suggested the researchers to understand the relationship between urbanization, environmental degradation and health, and suggested that regression analysis under the systems approach is useful in identifying the major urban health challenges due to air pollution. He also focussed on various recent global initiatives like Sendai Framework of Disaster Risk Reduction, Sustainable Development Goals, UNFCC COP21, Future Earth, Habitat III and about the role geographers can perform to contribute to these initiatives.

Professor Michael Meadows in his key note addressed the Global Environments in the Anthropocene: Challenges for Future Earth. He emphasized on need to systematically incorporate a stronger physical geography perspective into global change science; the Anthropocene represents an appropriate platform from which to inject that perspective.

Out of the total 35 oral presentation sessions, six sessions were on Land Use Land Cover Change and Climate Change, Five sessions on Human Health and Wellbeing, Four sessions on Environmental Sustainability and Developmental Concerns, Three sessions each for Resource Conservation and Management, Extreme Environment Events, Environmental Change, Two presentation each on Disaster Risk Reduction, Ecological Modelling, Governance and Policies, Land use land cover change and Biodiversity, One session each on Himalayan Environment, Challenges and Strategies to Climate Resilient Livelihoods and Geoparks Potential in South Asia. The sessions on Land use land cover change encompassed the issues of Geo-Spatial Technologies in LULC, Climate Change and LULC in Arid Ecosystems, LULC in Urban areas and LULC and Biodiversity. The sessions on Human Health and Wellbeing had presentations on Health and Diseases, Geography of Gender and Marginalised, Environmental Quality, Urban Environment and Human Development. The sessions on Environmental Sustainability and Developmental Concerns encompassed issues on Water Issues and Hydropower Projects, Environmental Concerns and Urban Sustainability. The theme of Resource Conservation and Management had paper presentation on Natural Resource based Livelihood, Water Resource Management and Land based Resources. The broad topics for presentation in the sessions of Extreme Events were Landslides, Earthquake, Urban Environment Change and Rainfall and Floods. The sessions on Disaster Risk Reduction focussed on Analysis and Assessment of Disasters and Disaster Management. Geo-Spatial Modelling, Monitoring and Management were the major themes for the sessions of Ecological Modelling.

The valedictory session was graced by Dr MR Bhutiyani, Director, DTRL, DRDO as the Chief Guest, Professor Iain Hay, Vice-President IGU and Professor RB Singh, Vice-President, IGU as Guest of Honor and Presided by Professor Tom Beer. Dr Bhutiyani citing the examples

Professor RB Singh and Dr PK Khurana announcing Delhi Declaration, March 20, 2016

from Himalaya emphasized on promoting research on Climate Change and Himalayan Glaciers as the sustainability of low land depends on the sustainability of highlands. Professor Iain Hay emphasized on the need of geographical education as a solution to various global problems. As recommendations for policy makers from this international conference, IGU-SBSC 2016 Delhi Declaration was also announced.

Dr Suraj Mal, presented the vote of thanks. A post conference field visit was organised to the state of Uttarakhand (Haridwar-Dehradun-Mussorie- Dhanaulti-Tehri Dam-Rishikesh) during March 21-24, 2016. There were a total of 27 participants to the field trip, of which there were 10 foreign academicians, 10 Indian researchers and 7 undergraduate students.

DELHI DECLARATION

Resolved unanimously that 9th IGU three day Regional Conference on "Land Use Change, Climate Extremes and Disaster Risk Reduction" being organized by the Department of Geography, Shaheed Bhagat Singh College, University of Delhi, makes the following policy recommendations for the consideration of various stake holders.

1. Land use study is emerging interface of biophysical and human environment which requires careful geographical and geospatial inquiry.
2. Geo-spatial technology should be disseminated to deal with emergency situations particularly identification of safer areas special needs of vulnerable groups like children, old people, women and disabled.
3. Food and water availability is threatened by extreme climate and we need to take all possible steps to ensure food, water-energy security within the framework of sustainable of future earth.
4. Geospatial technology based environment education should be promoted to find appropriate local solutions to regional imbalances and diverse issues.
5. The return period, as a tool to forecast earthquake, has been effective at the medium and long term. Mock frills at various levels should be considered as an effective tool for disaster mitigation.
6. Human health and wellbeing should be continued to the focal point of research for sustainable future.
7. Geoheritage sites are neglected in India and other developing countries. This should be linked to the tourism development and community empowerment.
8. Earth science governance needs to be promoted among community stake holders though better information and amalgamation using spatial and temporal scales.
9. IGU India Foundation, an academic body was initiated in the Inaugural Function on 18th March 2016. This foundation will be responsible for planning, organization, execution and implementation of workshops and conferences as well as publications, as part of IGU India Series.

ANNEXURE-IX

INTERNATIONAL WORKSHOP ON BIG AND OPEN DATA – EVOLVING DATA SCIENCE STANDARDS & CITATION ATTRIBUTION PRACTICES

The current unprecedented explosion in the human capacity to acquire, store and manipulate data together with instant communication globally has transformed research from era of data scarcity to data deluge, where experts see it as a "second revolution of discovery". Simultaneously, the growth of electronic publishing of literature has created new challenges, such as the need for mechanisms for citing online references in ways that can assure discoverability and retrieval for many years into the future. This increase in online datasets presents related, yet more complex challenges for Big Data as well as Data Science. Undoubtedly, effective exploitation of "Big Data" basically depends on the international culture of "Open Data" involving data sharing, availability for reuse and re-purposing. Therefore, the challenges are to create the infrastructure, evolve methodologies, practices and most importantly policies that enable researchers in identifying patterns and processes that so far had been beyond the capacity to resolve, analyze, so as to predict behaviour of complex systems. In this regard, Data citation being one of the ways of giving attribution, its standards and good practices can form the basis for increased incentives, recognition and rewards for research data activities, that in many cases are currently lacking. Furthermore, the rapidly-expanding universe of online digital data holds the promise of allowing peer-examination and review of conclusions or analysis based on experimental or observational data, as well as the ability for subsequent users to make new and unforeseen uses and analyses of the same data – either in isolation, or in combination with other datasets. Accordingly, there is a need for strategy to be adapted to novel discoveries and approaches with the evolving needs of international research and the science community. Consequently, the crying need emerges for a framework of international agreements, practices or standards, national policies and practices for funding and incentivizing research.

The international Workshop on Data Citation was thus part of world initiative led by ICSU, CODATA-Data Citation Task Group. The issue concentrated on the important gap in research data infrastructure, the absence of broad availability and use of data citation protocols. The funding agencies for research have begun to require data management plans as part of their selection and approval processes. The initiatives are already underway in different countries. The key issues of S&T, institutional, financial, sustainability, legal, IPR, Data protocols, community norms and others, that need attention related to data citation, coordinate area activities, and promote common practices & standards of the research community globally, are being examined by the Data Citation TG of CODATA with representatives from other organizations. Through discussions on these aspects, eleven countries including India have been identified to hold workshops. The discussions and recommendations of the workshop are eventually going to be part of a synthesis paper that integrates the findings of respective needs and interests of the country/ region. The main objective in the next one year (2016) is to promote the implementation of the data citation principles in the research policy and funding communities throughout the world.

The two day workshop on "Big and Open Data– Evolving Data Science Standards & Citation Attribution Practices" drew around 300 eminent scientists, domain experts from learned societies, funding agencies, policy makers, researchers and research librarians from across the country and international organizations. The workshop was held at INSA, New Delhi on November 5-6, 2015. The aim of the workshop was to take a stock of what is being done in the data citation area, the existing culture of data sharing and citation practices along with the needs and interests of the respective disciplinary areas and domains. The workshop was structured in the form of theme based panel discussions that dealt with—Data Science, Technology, Research and Applications and developments in the Indian Context; Data Attribution & Citation Practices; Data – Management, Sharing and Services : Current & Future Roles of Data Stakeholders, that also included interoperability issues, cloud computing and IoT, etc., wherein, the experts and participants had detailed interactions. Dr Usha Mujoo Munshi set the ball rolling by spelling out the concept behind this international workshop and also wrapped up the key deliberations at the end of the Workshop.

Dr Chandrima Shaha, Director, National Institute of Immunology, emphasized the need for the country to take action regarding discipline-wise specific big data and citation attributions particularly in the large datasets of life sciences, biomedical data, genomic studies and the like. She set the context of the workshop by putting forward the need for formulation of a national level policy in India to standardized data citation practices, DOIs and persistent identifiers to data for the advancement of S&T and Big Data Science in the country. This step, in her opinion would make India emerge wiser on many issues related to Big Data.

Dr Krishan Lal, Workshop Chair and President, AASSA, apprised the august gathering about the need for data creation, use, reuse and repurposing of data for R&D globally and the role of CODATA in promoting such activities for the global good and also summed up the recommendations for framing policy guidelines. Dr

Tishyarakshit Chatterjee, Former Secretary, MoEF, GoI and Director, IIPA emphasised the importance especially in relation to the reliable data and mentioned about data monopoly attempts by multinationals and countries.

Dr Jan Brase, Co-Chair, CODATA-ICSTI Data Citation Task Group pointed out that data generator's effort is usually unnoticed and felt that one should be able to cite the data/dataset itself in a manner similar to citation of articles. He further explained that from Data Citation one can know about what research is going on in a country.

Dr TCA Anant, Secretary, MoSPI and Chief Statistician of India in his key-note address, stated that Government of India itself is both the largest user and producer of data in social science research, while stressing the need for integration of databases being generated by Government in administrative silos and data across these silos. He opined that though more openness is very much required but security & safeguards should always be kept in mind.

Dr R Chidambaram, Principal Scientific Advisor to GoI & Chairman, SAC-C while delivering the inaugural address referred to the Big Data as tomorrow's knowledge having a great potential to lead the world. Big Data and Open Data are not the same and Data related to National Security and data generated for profit cannot be made open. He opined that it would be worthwhile to hold a brainstorming session to see if these techniques can be used in governance.

Dr KR Murali Mohan, Advisor & Head, Big Data Initiative, DST, GoI specified the challenges of uncertainty of data management landscape, big data talent gap, data standards of uniformity, curation, processing-storage, security and privacy. He also informed the audience about the "National Data Sharing and Access Policy (NDSAP)" of GoI (2012) and efforts to motivate entrepreneurs to create analytics as service.

Professor Yadati Narahari, Chairman, Division of Electrical Sciences, IISc, Bengaluru stressed the need for theory, technology for transforming raw data into actionable knowledge and urged for data analytics needs to be integrated with big data ecosystem for India.

Professor Ajit Kembhavi, Director, IUCAA, Pune shared his own experience working with the astronomical data, its quality & distribution and explained the data driven initiatives in astrophysics and bioscience programmes for joint big data mining in collaboration using data management techniques. Dr Prahlada Rao BB, Executive Director, C-DAC, Bengaluru remarked that the Big Data analytics need to emphasize more on domain experts involved in solution development in each application domain.

Professor Alok Bhattacharya, School of Life Sciences, JNU mentioned about the experimental data available for which data analytics may be implemented. He suggested that at first, data should be available in specific format and then analysis can be thought of. Professor Santanu Chaudhury, Professor, Indian Institute of Technology, Delhi, mentioned that the citation, author analytics are used for quality assurance processes and benchmarking for the research work carried out in a specific domain. He emphasised the need for building ontological framework using citation network. Professor Suresh Misra, Chairman Centre for Consumer Studies, explained how the data collected can help in understanding the trends of complaints while detailing the challenges in maintaining massive data for years and recommended that the access to the consumer databases be offered for quality services. Professor Vinod K Sharma, Executive Vice-Chairman, Sikkim State Disaster Management Authority stressed the importance of reliable datasets for cyclone tracking, rainfall and earthquake prediction, etc., in minimizing loss of lives and economy, since historical data allows policymakers to take preventive measures in advance. Dr Durga Toshniwal, Indian Institute of Technology, Roorkee expressed that data privacy should be maintained and not disclosed for data mining. Dr Nafees Meah, Director, Research Councils, UK (RCUK) India, specified various methodologies and need to develop joint approaches for data collection for creating joint data hubs for different sectors, low cost approaches to data visualization, provide training in data sciences. Dr Neeta Verma DDG, NIC pointed out that NIC has developed data portal to share data under national sharing and accessibility policy and stressed the need for developing algorithms, getting real time data and quick analysis out of this data. She also specified the various historical / live datasets available on Data Portal of India and various visualization made out of these datasets. Dr S Ganesan, Raja Ramanna, Fellow of the DAE, while highlighting the challenging issues in Physics, multi-scale modeling, emphasized on the data science activities in nuclear data science tailored to the Indian Atomic Energy applications that are generically useful in other areas of sciences, in the Indian context. He pointed out the need of horizontally sharing the data science expertise across various disciplines. Dr Paul Meller, Strategic Lead for Data and Resources, Economic and Social Science Research Council (ESRC) UK, pointed out the challenges of open-science and open data that included cultural differences in approaches to data sharing and access, technological issues - size, type and variety of data while emphasizing that security concerns regarding policy to share data does not mean it can all be open. In response to these issues, he suggested harmonized, appropriate policies and procedures, incentives and rewards along with capacity building and training. Dr Jagdish Arora Director, INFLIBNET, discussed about the current status of ICSSR Data Repository-Policy Framework and shared the procedure to cite data from ICSSR Data Service. Col. Haridas M, from Centre for Land Warfare Studies (CLAWS) spoke on execution challenges of Big Data Applications for the defence and security forces by briefly describing about operational information system, logistics management system and

integrated MIS. Dr HK Kaul, Director, DELNET discussed about need for proper training in library science on big data and pointed out that PhD coursework data are not accessible to users resulting in research data losing its importance. Dr Debasisa Mohanty, Scientist, NII spoke on development of structural bioinformatics methods for analysis of protein interaction network as Nucleic Acids Research datasets are to be released for the public and the requirement of data scientists. Professor Roshan Lal Raina, VC, JK Lakshmipat University, Jaipur discussed about increasing credibility and effectiveness of data, and suggested provision of data for citing practices and addressed the problem of cost of citation data. Dr Harpreet Singh, Scientist, ICMR discussed about the medical data that can be collected from the hospitals, the sequencing format, research paper citation, data reliability and data standards. Dr Biplav Srivastava, Senior Researcher, IBM Master Inventor IBM Research, India opined that data must be integrated while pointing out the problems of analytics, linked data and the government data.

The deliberations, thus, focused primarily on effective use and sharing of Big Data which depend fundamentally upon the emerging international culture of 'Open Data' involving the availability for re-use and re-purposing. Observing the contemporary trends of rapid development and change in various fields, most of the speakers acknowledged that a strategy may be adopted towards data citation protocol, which researchers can adapt. The Question Time rounded off each of the panel discussions which provided participants the opportunity to question and explore how these methods might be used in their own contexts about flexibility, machine readability and meta-data issues along with the interoperability factors. Whilst there was a strong emphasis on sufficient flexibility of Data Citation methods to accommodate variant practices without compromising interoperability of data citation practices, this did not mean less emphasis at the national level. This message was re-iterated by domain experts throughout the two-day proceedings. In the concluding session, a detailed presentation on the deliberations which took place in the two-day workshop that clearly brought out how the presentations of speakers helped to spell out a set of six recommendations for further consideration.

The international workshop coordinated by Dr Usha Mujoo Munshi, IIPA, also witnessed wide coverage in the crowd sourced platform across the academia, research and policy communities.

ANNEXURE-X

INTERNATIONAL GEOGRAPHICAL UNION (IGU) EXECUTIVE COMMITTEE MEETING

IGU EC Meeting at INSA, New Delhi

IYGU Conference at IIPA, New Delhi

Indian National Science Academy, Delhi, India hosted IGU EC Meeting on March 17, 2016. The meeting was chaired by President Kolosov (Russia) who welcomed Secretary-General Mike Meadows (South Africa) and Vice Presidents Ron Abler (USA), Dieter Soyez (Germany), Jarkko Saarinen (Finland), Iain Hay (Australia), Yukio Himiyama (Japan), RB Singh (India) and Zhou Chenghu (China). Former Vice-President Bellezza (Italy) and Ma Xiaoyi (Beijing LOC) were invited to attend. Decisions have taken related to future EC Meeting Calendar, IGU Finance, IGU Commission and Task Force Reports 2012-16, IGU Strategy, IYGU, Young and Early Career Geographers Task Force, Sesquicentennial and Centennial Task Force, IGU Journals Project, IGU eNewsletter, OurSus Project, Geographer's Bio-bibliographic Studies, Africa Initiative, IGU Thematic Conferences. IGU Representatives on International Bodies and future IGU Congresses and Regional Conf. The 'Urbanisation: Health and Wellbeing' conference in Osmania University, Hyderabad, India, in March 2017 will have another opportunity to promote the 'thematic conference' concept and it was agreed to label this officially as an 'IGU Thematic Conference'.

ICSU/ISSC/CIPSH Joint IYGU Initiative South Asia Conference

Initiated jointly by International Council of Science (ICSU), International Social Science Council (ISSC), and International Council for Philosophy and Human Sciences (CIPSH), IYGU (2016) is actively supported by IGU. A South Asia Centre-CSR Foundation organised Conference in the evening of March 17 at IIPA, New Delhi and participated by Chair IUGG-IGU joint National Committee Dr Harsh Gupta, Ms. Anisa from UN Major Group of Children and Youth, IGU EC Members and about 200 participants from different parts of the world.

ANNEXURE-XI

IAP/IAC/IAMP JOINT MEETING

The Indian National Science Academy hosted the IAP/IAC/IAMP Joint Meetings during September 28-30, 2015 at its premises. During the inaugural session Professor R Gadagkar, President INSA, welcomed the participants. He gave a brief outline of the history of the academy. Professor M Hassan, IAP Co-Chair thanked INSA for the hospitality provided. He mentioned that the first historic meeting of academies of science was held at INSA in 1993 where participants looked at issuing a statement on population growth to be presented at the 1994 UN meeting on population in Cairo. IAP was formally established at INSA in 1995 with the sponsorship of the Royal Society, US NAS, and the Royal Swedish Academy of Sciences. 2015 is therefore the third time that IAP is hosted by INSA.

Professor R Dijkgraaf, IAC Co-Chair thanked the participants who had arrived from all over the world and he noted that it is becoming more natural to meet together to discuss a common future. The Partnership has made a lot of progress readying it for the launch in South Africa.

Legal status, fund raising, structure, modus operandi and strategic plan and implementation of Plans for Inter Academy Partnership were discussed on first day of the event.

Keynote address on the inaugural day was delivered by Dr Dinakar M Salunke, Vice-President INSA & Executive Director, Regional Centre for Biotechnology on *Bioclusters for translating biotechnology of societal needs: ongoing Indian experiments*.

On the second day reports from IAP, IAC and IAMP were discussed which was followed by the update on activities of IAP affiliated networks AASSA, EASAC, IANAS and NASAC. Key note address on September 29 was delivered by Dr R Chidambaram, Principal Scientific Adviser to the Government of India on *Science Advice to Governments: Role of PSAs office*.

IAP EC, IAMP EC and IAC Board Members were invited to vote on the establishment of the Inter Academy Partnership at the Joint Session - whereby it was unanimously agreed.

Closing Remarks were given by Professors R Dijkgraaf, IAC Co-Chair, Volker ter Meulen & M Hassan, IAP Co-Chairs, D Ganten, IAMP Co-Chair and George Griffin, IAMP Executive Committee member.

ANNEXURE-XII

REPORT ON JOINT WORKSHOP OF ACADEMIA SINICA (TAIWAN) AND THE UNIVERSITY OF CALCUTTA

Academia Sinica (Taiwan) expressed an interest to have a Joint Workshop with the University of Calcutta under an exchange agreement of Academia Sinica and the Indian National Science Academy. This was followed by meticulous planning over several months leading to a two-day Workshop which was organized on October 7-8, 2015 involving speakers from the University of Calcutta and from a delegation of scientists from Taiwan. The venue of this Workshop was the Centre for Research in Nanoscience and Nanotechnology, University of Calcutta, Salt Lake.

The Academia Sinica delegation was led by Dr Sue-Lin Chao, Director of International Affairs Office, Academia Sinica, and consisted of 12 scientists covering diverse areas of life sciences and physics. The organizers from the Indian side were Professor Amitava Raychaudhuri and Professor Dhrubajyoti Chattopadhyay, both of the University of Calcutta. The focus of the Workshop was on Life Sciences and Physics. Besides the speakers it was attended by a large number of faculty members, post-doctoral fellows, and Ph.D. students.

ANNEXURE-XIII

IAP CONFERENCE & GENERAL ASSEMBLY AT HERMANUS, SOUTH AFRICA

The InterAcademy Partnership (IAP), consisting of InterAcademy Panel, InterAcademy Council and InterAcademy Medical Panel, organized a conference on *Science Advice* (February 28 – March 1) which was followed by IAP General Assembly on March 2 at Hermanus, South Africa. These events were hosted by the Academy of Sciences of South Africa (ASSAf). Professor JP Mittal, Vice-President and Dr Alok Moitra, Executive Director represented INSA in these meetings.

The conference focused on:

- Science Advice to Governments – Modalities and Principles
- Science Advice in Times of Disasters/ Emergencies
- Science Advice in the International Arena with a Special Focus on Synthetic Biology
- Country Readiness for Science Advise, and
- Interplay between Science Advice, Politics and the Media

A large number of speakers presented their experiences with respective governments, the bureaucracy and the media. Professor RB Singh from Department of Geography, University of Delhi (Vice President, IGU) presented the Indian experience under the session *Science Advice in Times of Disasters / Emergencies*. He highlighted the lessons learned from Tsunami disaster and our preparedness during the subsequent cyclones in coastal area, especially in eastern and southern belt. The timely alerts and preventive measures saved enumerable human and animal lives and loss to property.

During the conference, there was a session on *Smart Villages: New Thinking for Off-grid Communities Worldwide* and release of the IAP report on *Women for Science: Inclusion and Participation in Academies of Science*.

During the General Assembly on March 2nd, there were customary presentations by the IAP affiliated networks: AASSA (Association of Academies and Societies of Sciences in Asia), EASAC (European Academies Science Advisory Council), IANAS (InterAmerican Network of Academies of Sciences), NASAC (Network of African Science Academies), IAC (Inter Academy Council) and IAMP (InterAcademy Medical Panel). The presentation on AASSA was made by Professor Krishan Lal. In addition, IAP Science Education Programme and IAP Strategic Plan were also discussed.

Besides these presentations and discussions, the IAP Co-Chairs and the new Executive Committee was also elected. Professor Krishan Lal, past President INSA was elected as a co-Chair for a three year term 2016-2018. This position is extendable for one more term. The Indian National Science Academy gave up the membership of the Executive Committee, having served it for two terms.

G-Science Academies Statement 2016:

Understanding, Protecting, and Developing Global Brain Resources

The human brain is civilization's most precious resource. Investment in brain science is, therefore, an investment in the future of society, and nations must cooperate to understand, protect, and foster optimal development of the brain. To cultivate global brain resources, the G-Science Academies propose four Objectives, to be pursued in parallel, where strategic support for neuroscience will benefit society. (1) Fundamental research with international collaboration; (2) Global programs for the diagnosis, prevention and treatment of brain disorders; (3) Theoretical modeling of the brain and the development of brain-based artificial intelligence (AI); and (4) Integration of neuroscience with the social and behavioral sciences to improve education and life management as components of a brain-aware society.

Understanding the brain and how its functions are expressed in behavior is a complex scientific endeavor rivaling the search for the origin of the universe. The path to treating brain disorders, developing brain-based AI, and promoting a brain-aware society cannot bypass the difficult challenge of fundamental research on brain structure and function. Basic brain science has made spectacular recent progress built upon advances in genomics and protein chemistry to identify genes and molecules, optical and transgenic tools to observe and manipulate neural circuits, and multimodal functional brain imaging to study human cognition. However, a remaining bottleneck is the lack of technologies to study the brain at a resolution sufficient to enable understanding of its complex neuronal network in animal models and humans. Such technologies, in association with computational tools, would enable a clearer view of brain functions to facilitate a deeper understanding of cognition and reveal the core mechanisms of brain disorders. To achieve this goal, systematic approaches are needed to complement and extend research in single laboratories. Large-scale brain science projects are being initiated in many countries along with other biomedical research initiatives (e.g. next-generation sequencing, prec ision medicine, and biobanking) to develop new technologies, perform brain network mapping and recording, and establish neuroinformatics platforms [1]. However, these projects require extensive international coordination of technology, personnel, and data to economize and accelerate scientific progress. A successful example of a multilateral global research organization is the Human Frontier Science Program (HFSP) founded by the initiative of Japan.

Brain disorders represent a global threat to individual well-being, economic productivity, and intellectual capital [2]. Owing to pervasive social stigmas and therefore a lack of data, however, the adverse impact of brain disorders is often hidden. These disorders can be classified into five groups: [A] Neurodevelopmental disorders (e.g. mental retardation, epilepsy, and autism spectrum disorders); [B] Mental illnesses in adolescence and adulthood (e.g. major depression, bipolar disorder, and schizophrenia); [C] Degenerative diseases (e.g. Alzheimer's and Parkinson's diseases); [D] Brain injuries (e.g. stroke, traumatic brain injury, brain infection, and brain tumors); and [E] Chronic conditions (e.g. stress, addiction, malnutrition, headache, and sleep disorders). Eight million deaths each year are attributable to brain disorders [3]. In the last 20 years, their incidence has increased 41% and accounts for 1 in 10 years of lost health [4]. Brain disorders account for 36% of disability-adjusted life years (DALYs) in high-income countries (HICs) and 29% in low- and middle-income countries (LMICs) [4]. In particular, dementia (including Alzheimer's disease) and depression are urgent public health issues with enormous economic and societal costs. In order to produce successful therapies, new economic approaches to drug development are needed, including the use of cellular and animal models with predictive validity, and trilateral cooperation of government, academia and industry. Brain illnesses overburden society: in LMICs there is insufficient access to infrastructure, resources and funding, while in HICs research and clinical stakeholders are often fragmented. Addressing this problem will require international programs and centers that tightly integrate medical research, diagnosis, treatment, rehabilitation, and caregiving to combat the global epidemic of brain disorders.

The brain is the most complex biological system in the known universe. For example, the human central nervous system can easily perform complex decision-making after minimal learning, a feat surpassing the capability of the most efficient computers. Theoretical studies are essential for understanding the computational principles of brain function and for creating quantitative mathematical models. A fundamental understanding of brain circuits and their functions in behavior will require an approach that incorporates theory, experimentation, and computation as peer methodologies. Success will depend on a multidisciplinary quantitative approach that includes mathematics, statistics, information science,

and computer science, as well as biological disciplines. An important component will be the acquisition and analysis of large data sets. The principles of open data, particularly as these apply to publicly funded research, should be recognized, in order to promote the widest possible sharing and analysis of data sets. Fundamental brain theories will also be essential for the development of applications in brain-based computing, AI, and information/communication technologies (ICT). While AI originated in computer science, recent advances in deep learning have been based on brain theory [5] and future AI will benefit from algorithms based on further brain research, which will also be useful for the design of brain-machine interfaces and brain activity-decoding machines. However, like other rapidly advancing technologies, AI raises concerns that need to be addressed by establishing a globally coordinated investigation of its social, ethical, and philosophical implications in the context of neuroscience and society.

Human culture is a dynamic concept that is created and renewed by diverse brain functions. Therefore, the role of neuroscience in the development of future society depends not only on studying the physical, biological, and computational basis of brain functions, but also on opening major research interfaces with the empirical social sciences. Collectively, these interactions will orient neuroscience toward a greater impact in the global society and economy. Integration of the neurobiological, behavioral and social sciences will also create paths for the use of brain-based information in human applications with everyday use. A key example of this potential interdisciplinary convergence is in the science of learning. Emerging knowledge on how the brain acquires new information from biological, cognitive, and computational approaches could greatly improve the design of evidence-based education programs for children and adults [6]. Such knowledge also could provide a scientific basis for regulation of those approaches along with those based on pseudo-scientific claims. Likewise, the integration of brain science and the behavioral and social sciences will enable better predictive models of human behavior that will be useful for individuals in areas as diverse as economic decision-making, risk assessment, and social interactions. Collectively, evidence-based understanding of brain functions will transform the theory and practice of life management for individuals and brain-informed policies for organizations with broad utility for developing a sustainable, innovative global society. The integration of brain, behavioral and social sciences will provide a path for the science-based development of global brain resources.

In accord, the G-Science Academies recommend four Objectives:

1. Support Fundamental Research on Brain Principles and Technologies

- Support fundamental brain research from the molecular and genomic landscape of brain cells to neural circuit development and functional mapping to brain networks and behavior.
- Prioritize the development of novel brain recording and imaging technologies for high-resolution and large-scale analyses of brain structure and function, especially for human studies.
- Facilitate the international collaboration of large-scale brain and biomedical projects in technology development, data management, researcher training/mobility, and coordinated funding.

2. Address Brain Disorders with Next-Generation Integrative Programs

- Recognize that brain disorders constitute a global health crisis and support basic and applied research on their causes, prevention, diagnosis, and therapy including rehabilitation.
- Advance new economic and scientific platforms to develop therapeutics using valid biological models including animals, and promote cooperation between academia and industry.
- Support partnerships between higher and lower-middle income countries to strengthen research and clinical capacity for the study and treatment of brain disorders, and enhance public education.

3. Promote Theoretical Neuroscience for Creating Brain-Based Applications

- Support multidisciplinary research using theoretical, computational, statistical, and data sciences and mathematics to reveal fundamental principles for developing a unified brain theory.
- Promote international cooperation for sharing neuroscience data to accelerate research and the development of brain-based artificial intelligence and neuro-technologies.
- Launch a global dialogue on neuroethics spanning scientific, policy, regulation, and governance spheres to address the safety and efficacy of brain-based technologies and applications.

4. Integrate Brain, Behavioral, and Social Sciences for Education and Life Management

- Support fundamental and translational research that integrates principles, technologies, methods, and theories of brain science with those in the empirical social sciences.
- Promote multidisciplinary research on the biological and cognitive foundations of human learning for the creation of scientific programs and tools for child and lifelong education.
- Launch research and international cooperation on the development of programs and guidelines for

brain-based life-management and social function for individuals and organizations.

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Science Council of Japan, Japan

Korean Academy of Science and Technology, Republic of Korea

Academy of Science of South Africa, South Africa

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National Academy of Sciences, United States of America

African Academy of Sciences

ANNEXURE-XIVb

G-Science Academies Statement 2016:

Strengthening Disaster Resilience is Essential to Sustainable Development

Present Status

In the decade between 2005 and 2014, more than 6,000 natural and technological disasters occurred around the world, which killed more than 0.8 million people, displaced millions more, and cost more than 1 trillion USD [1]. Losses due to disasters are increasing in both developed and developing countries. Human factors that increase exposure and vulnerability, such as poverty, rapid population growth, disorderly urbanization, corruption, conflict and changes in land use, poor infrastructure including non-engineered housing, together with effects of climate change on weather patterns with increased extreme events, aggravate the negative consequences of natural and technological hazards. Disasters derail sustainable development, particularly in developing countries. Consequently, the need to embed disaster risk reduction into sustainable development goals is paramount.

In the globalized 21st century, a disaster in one country creates disruptions in others: the 2011 Thailand floods cut off car component factories and adversely affected car production in Europe; the 2004 Indian Ocean tsunami inundating the beaches of Thailand and killing more than 5,000 people including tourists caused the largest numbers of deaths from a natural hazard in Sweden's history; the 2006 drought in Syria was one of several contributing conditions that led to the current humanitarian crisis; and the Great East Japan Earthquake in 2011 led to a tsunami, a nuclear facility malfunction, and economic effects worldwide. International events like these show the connection between disaster resilience and sustainable development.

Decision makers need better tools to understand impacts of these types of crises, cope with natural hazards, respond to technological breakdown, and apply lessons from past experiences to improve emergency preparedness and capacities to manage crises. Science can contribute by deepening the understanding of hazards and improve ability to anticipate future emergencies and quantify impacts. Innovative engineering can decrease impacts and provide critical information for planning, rapid response and recovery. Furthermore, cascading effects of disasters require better understanding of connections, and strong international cooperation; at present, international collaboration in disaster risk reduction is not sufficient.

Key Direction

In 2015, the international community agreed on three major accords: the Sendai Framework for Disaster Risk Reduction 2015-2030 (Sendai Framework), the Sustainable Development Goals (SDGs), and the Paris Agreement on Climate Change (Paris Agreement). These agreements collectively present an urgent need and opportunity for action in 2016 and beyond. There are important connections among these agreements. For example, the SDGs and Paris Agreement identify actions that can build resilience against both meteorological and geophysical hazards. Also, the Sendai Framework embeds disaster risk reduction as an indispensable part of sustainable development through four of its priorities:

Priority 1: understanding disaster risk

Priority 2: strengthening disaster risk governance to manage disaster risk

Priority 3: investing in disaster risk reduction for resilience

Priority 4: enhancing disaster preparedness for effective response and to "build back better" in recovery, rehabilitation, and reconstruction.

Increasing disaster resilience involves many stakeholders. To realize these priorities and to build resilient societies, we need to maximize the use of existing knowledge and create new types of science and technology that serve broad and collective societal needs. Building this new approach requires interdisciplinary research, collaboration, and cooperation among natural sciences; engineering; medical, social and political sciences; and the humanities. Transdisciplinary collaboration and excellent communication between scientists, practitioners, and policy-makers are essential.

With the increased scientific knowledge, innovation and technology, the scientific community can identify risks, evaluate system vulnerabilities, and become more ef fective in communicating the interconnected nature of disaster risk. Efforts are needed to strengthen national platforms for disaster risk reduction, and encourage or enable scientists and practitioners to work closely with relevant stakeholders in locally relevant contexts and language. Common, compatible, or even standardized disaster information resources and indices should be developed for easier exchange among different countries and regions. Integrated analysis of disaster data and information should be promoted to accelerate international cooperation and help countries identify the most impactful ways for bringing resources to a disaster, its risk reduction, or a response. These efforts will ensure interoperability among countries during multi-national responses, lead to better data on the costs of disasters, and greatly reduce losses through mitigation and resilience-building efforts.

Actions that Build Disaster Resilience and Sustainable Development

The following six actions are recommended for policymakers to increase resilience capacities applicable to a wide range of disasters, their cascading effects, and implications for foreign aid, assistance, or economic impacts.

1. Develop metrics and indicators for evaluating exposure, vulnerability and resilience. Metrics and indicators can be used to:
   - identify, visualize, and evaluate under-recognized disaster risks that hinder sustainable development by taking a holistic view of the changes in hazards, vulnerabilities and exposures arising from societal and environmental problems.
   - anticipate, prepare for, and reduce the consequent disaster risks effectively or in consistent ways
   - ascertain ways to evaluate level of risks.
   - make informed investment decisions and to understand value returns on investments
2. Advance scientific and technical knowledge and improve assessment of disaster risk, including building relevant data infrastructure that advances ability to anticipate future events with greater accuracy, developing disaster damage data archives, and expanding understanding of how disasters unfold across different regions and sectors.
3. Improve understanding of natural and human-made hazards, by developing new technologies and applying effective and innovative engineering for disaster prevention, by constantly raising political and public awareness and through effective emergency response and recovery – including mental and physical health management.
4. Strengthen inter- and trans-disciplinary collaborative efforts in cooperation through a major international research platform, such as Future Earth [2], providing the knowledge and support to accelerate our transformations to a sustainable world [2].
5. Engage the investor community. Investors, from both the private and public sectors, are important players in disaster risk reduction. It is important to find

ways to engage them more fully in disaster resilience decision making, as investments will drive the future of sustainable development.

6. Promote sharing information, initiate a forum to share best practices and lessons learned in disaster risk reduction and provide practical solutions to implement the Sendai Framework, focusing on community of practices with relevant stakeholders including the private sectors.

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Science Council of Japan, Japan

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Academy of Science of South Africa, South Africa

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National Academy of Sciences, United States of America

African Academy of Sciences

ANNEXURE-XIVc

G-Science Academies Statement 2016:

Nurturing Future Scientists

Science is a human endeavor driven by an innate desire to acquire an ever-deeper understanding of the workings of nature and to meet human needs. Throughout history, scientists have continuously increased our knowledge of the world, and their innovations and inventions have immensely improved the human condition. Present-day society relies heavily upon science-based discovery, technology, and policies – whether in information systems, energy management, or disease control. Thus, nurturing future generations of scientists is important for the development of society. How can nations best develop future generations of scientists? The major issues, outlined below, include improving education and career paths in science, encouraging social values in scientists to interact with society, and promoting a diverse workforce with opportunity for women, minorities, and scientists in developing countries. How these fundamental questions are addressed will have an enormous global impact on the future of science in and for society.

Connecting Scientists and Society

Promoting Science Education and Outreach

Science is an essential subject at all educational levels. Exposure to science at the pre-primary, primary and secondary levels is important for learning the values of evidence-based inquiry and for nurturing scientific thinking. This requires training of high-quality science teachers for all school levels and the design of attractive programs and innovative teaching methods. In higher education, students can learn to conduct research, explore specialized disciplines, and establish scientific integrity and professional principles to become responsible scientists in society. The study of science is beneficial for all students whether or not they continue on to scientific careers. Critical thinking and the scientific method should form the core of science curricula at all levels. Inquiry-Based Science Education requires active pedagogy where

students become "young researchers" investigating nature and society. Interdisciplinary approaches to education instill versatility, flexibility, and creativity important for research and other careers.

A key part of science education is learning the value and means of communicating science to the general public and policymakers. Education for Sustainable Development (ESD) [1] aims to provide benefits for society. In ESD, science education is a form of public outreach, improving scientific literacy and understanding of basic concepts related to human wellbeing (e.g. nutrition and public health), and increasing trust in science and scientists among citizens. This and similar efforts can promote the active involvement of non-scientists in scientific activities where appropriate and even accelerate open innovation. At the same time, science outreach experiences offer opportunities for scientists, particularly those in younger generations, to be conscious of "science in society" and learn to instill science as a way of life. A societal attitude favorable to science is also essential for stakeholders outside of the scientific community to be willing to contribute support for science.

Supporting Scientific Career Development

The future of science depends on education and support for younger scientists. However, in academia the prospects for their career development are challenging. The post-doctoral research (postdoc) stage is often a bottleneck for career advancement in developed countries due to insufficient principal investigator positions, while in developing countries such positions remain limited in general. Postdocs often are hired by senior research-grant awardees to work on specific projects on a short-term basis, resulting in significant risk for their career choices. With limited academic career opportunities, the pressure to "publish or perish" for all researchers can create an adverse environment for career development, leading to dropout, or even misconduct.

Specific training and career paths need to be developed for doctoral-level researchers in economic sectors outside of academia, including industry, commerce, service, education, media, government and non-government organizations. Given diverse career paths, scientists can contribute to sectors of knowledge-based economies that place a high value on critical thinking, evidence-based decision-making, and technological and conceptual innovation. To enable alternate career paths, universities can provide young scientists with opportunities for self-assessment, learning transferable skills, and engagement with other sectors of society.

The evaluation of research productivity based on publications constitutes a series of crucial checkpoints in the career development of young scientists. The widespread indiscriminate use of single metrics (e.g. number of peer-reviewed publications or a journal's impact factor) is inappropriate for evaluation of scientists. Instead, balanced rigorous reviews by scientific experts assessing scientific production are recommended. Assessment should be based on multi-faceted criteria and research evaluation guidelines such as DORA [2] as well as research-related activities such as societal involvement. This would ensure scientists' productivity, creativity, and ability to take scientific risks and pursue interdisciplinary and transdisciplinary research.

Scientists' Roles and Responsibilities in Society

While the primary mission of scientists is to develop and critically examine new knowledge, and pursue innovation and social progress, they also are expected to learn, perform, and take leadership positions in other important roles and responsibilities in and for society. First, scientists certify and systematize the acquired body of scientific knowledge and transmit it to the next generation. Second, scientists educate and mentor younger colleagues of successive generations and diverse backgrounds, to ensure the propagation of scientific values including critical inquiry and thinking, broad perspectives, and high ethical standards. Third, scientists get involved in outreach activities, communicate scientific developments to the general public, and engage citizens and young people who wish to improve their understanding of science [3]. The implementation of science and technology by policy makers also depends on a dialogue with stakeholders in society, so that scientists can know the concerns, perspectives, and priorities of society, and contribute to policy-making by offering evidence-based information related to policy choice. A critical aspect of these exchanges is that public stakeholders must be able to trust the validity of scientific results, whereas scientists bear the responsibility of meeting these expectations. The support for science and scientists in society is based on this trust/responsibility relationship, and the scientific community is responsible for training and enforcing appropriate ethical research standards.

Creating a Diverse Global Workforce

Inclusion of Women and Minorities in Science

The healthy development of science and research communities is impossible without the participation of scientists from diverse backgrounds. Although the proportion of women scientists and those from minority groups, in terms of ethnicity, physical disabilities and other groupings, varies among countries, they are rarely represented in fair proportion, especially at higher levels within organizations and in terms of equitable compensation. This under-representation is both a pervasive social injustice and a massive loss of potential contributions to science and society. Women are in some cases better represented among younger generations of scientists, but still face severe challenges in their later career development. Among these concerns is that the critical age

range for childbearing overlaps with the traditional period for career development from junior to senior positions. To mitigate this issue, parental duties can be handled by both men and women, and additional flexibility within the workplace can be promoted. The availability of child-care facilities is also important. A second problem is that more women researchers work in academia than in business enterprises [4] despite the increasing employment of scientists in business at a faster rate than academia in the global competition for building knowledge-based economies. Given this unfavorable situation, improvements in the working conditions for diverse researchers in both academia and industry is essential so that high-quality scientists can compete in a fair way for jobs regardless of gender or other backgrounds. Toward this goal, developing and exposing young scientists to successful peer role models for women and minorities is critical. Finally, training in cultural sensitivity is required in the scientific community along with policymaking that mitigates unconscious biases, ensures flexible timing in promotion decisions at all career stages, and protects work-life balance for all.

Supporting Scientists in Developing Countries

Science is a borderless activity and has long served as a role model for international cooperation. Many global issues remain, particularly with respect to capacity building and researcher mobility and training in developing countries, which can be adequately addressed only through effective collaboration between developed and developing countries. Bilateral and multilateral cooperative programs and partnerships between developing and developed countries, and their research universities and institutes, are strongly encouraged and can be better supported and incentivized by governments, to move from the directional depletion of human scientific resources called "brain drain" to the more equitable model of "brain connectivity and circulation". Such exchange-focused collaborations should aim at strengthening the capacity of institutions to reach a critical mass of researchers in developing countries. This should span all levels from pre-doctoral, doctoral, and post-doctoral training to independent research, to expand careers and opportunities. The formation of bilateral and multilateral programs for researcher exchange and new international institutes would enhance this pat tern of mobilization. International funding and awards would also encourage younger scientists to "circulate and connect" and support for programs that enable this are needed.

Ensuring Access to Scientific Information

All researchers worldwide should have access to the academic scientific literature and opportunity to publish their own research based on its quality irrespective of their financial means. Scientific societies, research organizations, publishers and governments should collectively strive to establish a sustainable economic model to mitigate the disparities in access to scientific information and to publication opportunities in different research environments. Various ideas have been proposed for the future of academic publication that go beyond the traditional model based on journal subscriptions levied by the publishing industry. This "Open Access" principle supports free access to scientific publications by all researchers and by the public. While the merits of open access policies are appreciated, concerns remain with quality control of the peer review and publication process that can be prone to malpractice (e.g. predatory publishing) and these must be resolved. An alternate business model involves public subsidy of journal subscription fees. For scientific publications to be sustainable and beneficial to scientists, a solution to cost sharing among journals publishers, journal subscribers, authors of journal articles, and the public sector must be viable and equitable.

Recommendations by the G-Science Academies Connecting Scientists and Society

(1) Science Education

The scientific community, policy makers and society can better promote science education and prepare future scientists, and all students, with inquiring minds, critical thinking, broad perspectives and ethical integrity.

(2) Career Development

Providing positive research environments and creating opportunities for doctoral students and post-docs to learn wider subjects and skills to pursue careers in broader sectors of industry, government and education is recommended.

(3) Scientists' Assessment

The use of single metrics for scientist evaluation, such as number of publications, citations, or journal impact factor should be replaced by those reflecting the quality and importance of the science and the diverse activities of scientists.

(4) Public Communication

Prioritizing public education and communication to the public and children on scientific developments, and engaging citizens to improve their understanding of science is needed.

(5) Resource for Policy

Evidence-based advice of scientists on issues in social choice and policymaking is critically important. Policymakers can seek scientists' input on these issues, and training scientists for such purposes is necessary.

Creating a Diverse Global Workforce

(6) Women and Minority Groups

Working conditions for scientists and practices that enable diverse representation and career prospects of women

and minorities in a discrimination-free environment are essential.

(7) Developing Scientific Capacity

Developed and developing countries can collaborate to strengthen global scientific capacity and mutual mobility at pre-doctoral, post-doctoral, and investigator stages.

(8) Access to Scientific Information

All scientists should have access to academic literatures and opportunities to publish their research results. Sustainable publication systems with appropriate cost-sharing should be developed.

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ANNEXURE-XV

INSA CHAIR AWARDEES

Professor AS Paintal Chair Award (2015-16)

Report by Professor Saibal Roy

Science Foundation Ireland Principal Investigator, Head of Micropower Systems and Nanomagnetics Micro-nano-systems Center, Tyndall National Institute, University College Cork, Ireland:

It was a great pleasure and honour for me to receive the coveted award of AS Paintal Chair Professor in engineering from the Indian National Science Academy (INSA) to visit some of the premier academic/research institutions in India during 2015-2016 and thereby forge potential academic/research collaborations between Tyndall National Institute in Ireland and some of the faculties of visited leading institutions in India in mutually beneficial research areas. Within this aforementioned program, I was hosted by Professor Dipankar Chakravorty, for the major portion of my visit and was invited to deliver AS Paintal Chair talk at IACS, Kolkata. During my stay in July/August 2015, besides delivering AS Paintal chair lecture at IACS, I have had extensive interactions with the various faculties of IACS. Among them, the interactions with Professor D Chakravorty, MLS Unit on some collaborative research on 'next generation nanostructured magnetic materials capable of operating at high frequency (MHz-GHz) particularly focussing on antennae applications' and the discussion with Professor SK Saha, Materials Science Department on 'possible measurements of some of the anomalous phenomena observed in nano graphene sheets, which could be further delineated by potential measurements of their relaxation behaviour at low temperature' at Tyndall National Institute in Ireland seem noteworthy.

Besides IACS, I visited as per the original plan, to other Kolkata based premier academic institutions such as SNBNCBS, CGCRI and SINP. Among these institutions,

the lab/facility visit and in depth interactions with Professor A Barman of SN Bose Institute on 'measurement of magnetization dynamics of thin nanostructured magnetic alloy films through time resolved magnetooptic kerr measurements (TRMOKE)' and Dr D Bhattacharyya of CGCRI on 'fabrication and characterization of thin film devices constituted of multi layers of nanostructured multiferroic composites' seem to forge fruitful near to long term research collaborations between premier Irish (Tyndall National Institute/UCC) and Indian Institutes. It is also been envisaged that we would submit joint research proposal/s to the forthcoming Ireland-India joint call administered by Science foundation Ireland (SFI), Ireland and Department of Science and Technology (DST), India.

With the above in context, I would consider my visit was not only quite successful, also beneficial to both Irish and Indian relevant scientific communities.

Dr BP Pal Chair Award (2015-16)

Report by Professor Neelima R Sinha

Department of Plant Biology, University of California, USA

The INSA Dr BP Pal Chair award facilitated my visit to several institutions in India where I interacted with students and faculty, learnt about research ongoing at these institutions, forged new collaborations (Drs Sandip Das, Geeta and I are analyzing data for a proposed publication) and initiated plans for future visits to run workshops and began plans for an international conference in conjunction with scientists at IISER Pune.

At Delhi University, I (along with a former Post-doc and now faculty at NIPGR, Dr Aashish Ranjan) taught a workshop on experimental design and data analysis considerations in large-scale genomics projects. The workshop was primarily for students, but many faculty attended, and this workshop led to several one-on-one discussions with students and faculty on specifics of their own projects. While at DU, I was also happy to interact with many female graduate students and give them advice and feedback on their specific concerns as they pursue a career in Biological sciences. At IISc, Bangalore I presented two research talks, including one on high throughput field phenotyping that generated much interest and exchange of ideas). I interacted with numerous faculty and students and discussed with Dr Usha Vijayraghavan the possibility of teaching a short course. We will explore specifics and funding sources in the near future. I also visited the NCBS campus in Bangalore and met with faculty and students there. The final part of my formal visit schedule was a trip to IISER, Pune. There I was asked to give a lecture for undergraduate and graduate students and presented a talk titled "Biology in the 21st Century". Several faculty attended this talk and this prompted those teaching in the beginning Biology curriculum at IISER to meet with me and exchange ideas on teaching methods. Several students presented their research to me and I was able to offer opinions and advice to them on the best way to take their projects to completion. My host, Dr Anjan Banerjee, and I discussed the possibility of organizing an international Plant Developmental Biology Symposium at IISER Pune and we are exploring funding sources. I ended my visit with a research presentation at NIPGR, Delhi, and interactions with students and faculty there. I thank INSA for making this wonderful visit possible.

Dr V Ramalingaswami Chair Award (2015-16)

Report by Dr Vincent Caudrelier

Department of Mathematics, City University London

It is a pleasure to acknowledge the hospitality of the Bose Centre and the Saha Institute in Kolkata as well as the kind invitations from the Jawaharlal Nehru University and Delhi University in New Delhi during my visit as the Dr Ramalingaswami INSA Chair 2015 in Kolkata from June 23 to July 28. I also want to warmly thank the INSA for this award and Professor Anjan Kundu for nominating me in the first place.

The visit in Kolkata was most fruitful. It enabled me to pursue an exciting collaboration with Professor Anjan Kundu from the Saha Institute for Nuclear Physics on a project involving two other external collaborators, from France and the UK. This international collaboration is the result of my visit. The concrete output is a preprint available at http://arxiv.org/abs/1510.01173: "*Lagrangian and Hamiltonian structures in an integrable hierarchy and space-time duality",* Jean Avan, Vincent Caudrelier, Anastasia Doikou, Anjan Kundu. The paper is currently being reviewed for publication. It establishes new important result in the theory of the classical r-matrix approach of classical integrable systems and is the basis for further investigations about multidimensional integrable systems.

I spent most of my time as a visitor at the Bose Centre, which also gave me the excellent opportunity to meet and interact with Professor P Guha. What started with informal discussions about our research interests developed gradually into a deeper sharing of ideas on some common interests, like the geometric approach to classical field theory and, more particularly, to integrable systems.

Towards the end of my stay, I spend a few days in New Delhi, thanks to the kind hospitality of Professor Ramaswamy. I gave a seminar at Jawaharlal Nehru University, where my local contact was Professor Debashis Ghoshal, and at Delhi University, where Professor Debajyoti Choudhury organised the local logistics. It was a privilege to deliver a talk at those places and to meet many scientists.

I am very grateful to all the peoples and bodies that have made my visit possible and so nice and fruitful: an international collaboration was created between three countries (India, UK and France) and four people and one paper is being reviewed for publication.

ANNEXURE-XVI

LIST OF INSA SENIOR SCIENTISTS AND HONORARY SCIENTISTS

Senior Scientists

1. Professor TK Adhya, FNA, School of Biotechnology, KIIT University, Bhubaneswar.
2. Dr Samit Adhya, FNA, CSIR-Indian Institute of Chemical Biology, Kolkata.
3. Professor Sher Ali, FNA, Centre for Interdisciplinary Research in Basic Sciences, Jamia Millia Islamia, New Delhi.
4. Professor G Ananthakrishnan, FNA, Emeritus Professor, Material Research Centre, Indian Institute of Science, Bengaluru.
5. Professor S Ananthakrishnan, FNA, Adjunct Professor, Electronic Science Department, Pune University Campus, Ganeshkhind, Pune.
6. Professor KK Balasubramanian, FNA, Department of Biotechnology, Indian Institute of Technology Madras, Chennai.
7. Professor HS Balyan, FNA, Department of Genetics & Plant Breeding, Chaudhary Charan Singh University, Meerut.
8. Professor AC Banerjea, FNA, Laboratory of Virology, National Institute of Immunology, New Delhi.
9. Professor Manju Bansal, FNA, Molecular Biophysics Unit, Indian Institute of Science, Bengaluru.
10. Professor VA Bapat, FNA, CSIR Emeritus Scientist, Department of Biotechnology, Shivaji University Campus, Kolhapur.
11. Professor SV Bhat, FNA, Department of Physics, Indian Institute of Science, Bengaluru.
12. Professor Archana Bhattacharyya, FNA, Indian Institute of Geomagnetism, Mumbai.
13. Professor B Bhattacharyya, FNA, Emeritus Professor, Department of Biochemistry, Bose Institute, Kolkata.
14. Proferssor SM Bhatwadekar, FNA, Visiting Professor, Bhaskaracharya Pratishthan, Pune.
15. Professor CK Dasgupta, FNA, Department of Life Science and Biotechnology, Jadavpur University, Kolkata.
16. Professor Alok Kumar Datta, FNA, CSIR-Indian Institute of Chemical Biology, Kolkata.
17. Professor Amitava Datta, FNA, Indian Institute of Science Education & Research (IISER), Kolkata.
18. Professor BM Deb, FNA, Visva-Bharti University, Shantiniketan.
19. Dr MG Deo, FNA, Moving Academy of Medicine & Biomedicine, Pune.
20. Professor VP Dimri, FNA, Formerly Director, CSIR-National Geophysical Research Institute, Hyderabad.
21. Professor Sampa Das, FNA, Division of Plant Biology, Bose Institute, Kolkata.
22. Dr Anuradha Dube, FNA, Division of Parasitology, CSIR-Central Drug Research Institute, Lucknow.
23. Professor C Durga Rao, FNA, Department of Microbiology & Cell Biology, Indian Institute of Science, Bengaluru.
24. Professor Amit Ghosh, FNA, Emeritus Scientist, National Institute of Cholera & Enteric Diseases, Kolkata.
25. Professor Kunal Ghosh, FNA, Raman Centre for Applied and Interdisciplinary Sciences, Kolkata.
26. Professor C Ganguly, FNA, Engineering Staff College of India, Gachibowli, Hyderabad.
27. Professor NK Gupta, FNA, Department of Applied Mechanics, Indian Institute of Technology Delhi, New Delhi.
28. Professor PK Gupta, FNA, Emeritus Professor, Department of Genetics & Plant Breeding, Chaudhary Charan Singh University, Meerut.
29. Professor KT Jacob, FNA, Emeritus Professor, Department of Materials Engineering, Indian Institute of Science, Bengaluru.
30. Professor AK Jain, FNA, CSIR-Central Building Research Institute, Roorkee.
31. Professor AS Joshipura, FNA, Theoretical Physics Group, Physical Research Laboratory, Ahmedabad.
32. Professor KP Joy, FNA, Formerly Professor of Zoology & Coordinator CAS, Banaras Hindu University, Varanasi.
33. Professor H Junjappa, FNA, Research Professor, Reva Institute of Science & Management, Bengaluru.
34. Professor Tarun Kant, FNA, Department of Civil Engineering, Indian Institute of Technology Bombay, Mumbai.
35. Professor SN Kaul, FNA, School of Physics, University of Hyderabad, Hyderabad.
36. Professor SK Khanduja, FNA, Indian Institute of Science Education & Research (IISER), Mohali.
37. Dr Renu Khanna-Chopra, FNA, Stress Physiology & Biochemistry Laboratory, Water Technology Centre, Indian Agricultural Research Institute, New Delhi.
38. Professor Avinash V Khare, FNA, Department of Physics, Savitribai Phule Pune University, Pune.
39. Professor G Krishnamoorthy, FNA, Department of Biotechnology, Anna University, Chennai.
40. Dr BD Kulkarni, FNA, CSIR-National Chemical Laboratory, Pune.
41. Dr Anil Kumar, FNA, Physical Chemistry Division, CSIR-National Chemical Laboratory, Pune.
42. Professor AN Lahiri Majumder, FNA, Division of Plant Biology and Achraya JC Bose Biotechnology Innovation Centre, Bose Institute, Kolkata.
43. Professor SC Lakhotia, FNA, Cytogenetics Laboratory, Department of Zoology, Banaras Hindu University, Varanasi.

44. Professor M Lakshmanan, FNA, Centre for Nonlinear Dynamics, Bharathidasan University, Tiruchirapalli.
45. Professor J Maharana, FNA, Institute of Physics, Bhubaneswar.
46. Dr HK Majumder, FNA, CSIR-Indian Institute of Chemical Biology, Kolkata.
47. Dr Chitra Mandal, FNA, CSIR-Indian Institute of Chemical Biology, Kolkata.
48. Professor PT Manoharan, FNA, Department of Chemistry, Indian Institute of Technology Madras, Chennai.
49. Professor G Marimuthu, FNA, Department of Animal Behaviour & Physiology, School of Biological Sciences, Madurai Kamraj University, Madurai.
50. Professor Samaresh Mitra, FNA, CSIR-Indian Institute of Chemical Biology, Kolkata.
51. Professor JP Mittal, FNA, Bhabha Atomic Research Centre, Mumbai.
52. Professor ML Munjal, FNA, Department of Mechanical Engineering, Indian Institute of Science, Bengaluru.
53. Professor MRN Murthy, FNA, Molecular Biophysics Unit, Indian Institute of Science, Bengaluru.
54. Dr R Nagaraj, FNA, CSIR-Centre for Cellular and Molecular Biology, Hyderabad.
55. Professor BC Nakra, FNA, Department of Mechanical Engineering, Indian Institute of Technology Delhi, New Delhi.
56. Professor G Padmanaban, FNA, Honorary Professor, Department of Biochemistry, Indian Institute of Science, Bengaluru.
57. Professor M Palaniandavar, FNA, Department of Chemistry, Bharathidasan University, Tiruchirapalli.
58. Dr Veena K Parnaik, FNA, CSIR-Centre for Cellular & Molecular Biology, Hyderabad.
59. Professor R Parthasarathy, FNA, School of Mathematics, Tata Institute of Fundamental Research, Mumbai.
60. Professor KN Pathak, FNA, Formerly VC & Emeritus Professor, Department of Physics, Panjab University, Chandigarh.
61. Professor LM Patnaik, FNA, Department of Electronic Systems Engineering, Indian Institute of Science, Bengaluru.
62. Professor Deepak Pental, FNA, Centre for Genetic Manipulation of Crop Plants, University of Delhi, New Delhi.
63. Professor LC Rai, FNA, Formerly Head & Coordinator, Centre of Advanced Study in Botany, Molecular Biology Section, Banaras Hindu University, Varanasi.
64. Professor BC Ranu, FNA, Department of Organic Chemistry, Indian Association for the Cultivation of Science, Kolkata.
65. Professor Deb Shankar Ray, FNA, Department of Physical Chemistry, Indian Association for the Cultivation of Science, Kolkata.
66. Dr AJ Rao, FNA, Department of Biochemistry, Indian Institute of Science, Bengaluru.
67. Professor DP Roy, FNA, Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, Mumbai.
68. Professor Probir Roy, FNA, Saha Institute of Nuclear Physics & Bose Institute, Kolkata.
69. Professor SM Roy, FNA, Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research, Mumbai.
70. Professor Syamal Roy, FNA, CSIR-Indian Institute of Chemical Biology, Kolkata.
71. Dr M Sanjappa, FNA, University of Agricultural Sciences, Bengaluru.
72. Professor MM Sarin, FNA, Geosciences Division, Physical Research Laboratory, Ahmedabad.
73. Professor Sudipta Sengupta, FNA, Professor, Department of Geological Sciences, Jadavpur University, Kolkata.
74. Professor Bhagyashri A Shanbhag, FNA, Department Marine Biology, Karnatak University Post Graduate Centre, Karnataka.
75. Professor TN Shorey, FNA, Department of Mathematics, Indian Institute of Technology Bombay, Mumbai.
76. Professor Shyam Lal, FNA, Physical Research Laboratory, Ahmedabad.
77. Professor Bijay Singh, FNA, Department of Soil Science, Punjab Agricultural University, Ludhiana.
78. Professor JS Singh, FNA, Emeritus Professor, Department of Botany, Banaras Hindu University, Varanasi.
79. Professor PK Singh, FNA, Department of Botany, Banaras Hindu University, Varanasi.
80. Professor RN Singh, FNA, CSIR-National Geophysical Research Institute, Hyderabad.
81. Professor SP Singh, FNA, Central Himalayan Environment Association (CHEA) Nainital.
82. Professor TP Singh, FNA, Department of Biophysics, All India Institute of Medical Sciences, New Delhi.
83. Professor Yadvinder Singh, FNA, Department of Soil Science, Punjab Agricultural University, Ludhiana.
84. Professor Yashwant Singh, FNA, Emeritus Professor, Department of Physics, Banaras Hindu University, Varanasi.
85. Dr AK Singhvi, FNA, AMOPH Division, Physical Research Laboratory, Ahmedabad.
86. Dr S Sivaram, FNA, Polymers and Advanced Materials Laboratory, CSIR-National Chemical Laboratory, Pune.
87. Professor R Srinivasan, FNA, Indian Institute of Science, Bengaluru.
88. Professor S Subramanian, FNA, Adjunct Professor, Department of Chemistry, Indian Institute of Technology Madras, Chennai.
89. Dr Ghanshyam Swarup, FNA, CSIR-Centre for Cellular and Molecular Biology, Hyderabad.

90. Professor KC Upadhyaya, FNA, Formerly Professor & Dean, School of Life Sciences, Jawaharlal Nehru University, New Delhi.
91. Professor N Viswanadham, FNA, Indian Institute of Science, Bengaluru.

Honorary Scientists

1. Professor IP Abrol, FNA, Director, Centre for Advancement of Sustainable Agriculture (CASA), NASC Complex, New Delhi.
2. Professor YP Abrol, FNA, President, Indian Nitrogen Group, NASC Complex, New Delhi.
3. Professor BK Agarwal, FNA, Formerly Head, Department of Physics, Allahabad University, Allahabad.
4. Professor G Ananthakrishnan, FNA, Emeritus Professor, Material Research Centre, Indian Institute of Science, Bengaluru.
5. Professor DJ Bagyaraj, FNA, Centre for Natural Biological Resource & Community Development, Bengaluru.
6. Dr Mahtab S Bamji, FNA, Formerly Scientist (Director-Grade), NIN, Hyderabad, Dangoria Charitable Trust, Hyderabad.
7. Professor DM Banerjee, FNA, Formerly Professor, Department of Geology, University of Delhi, Delhi.
8. Professor N Bhandari, FNA, Formerly Professor, Basic Science Research Institute, Navrangpura, Ahmedabad.
9. Professor ON Bhargava, FNA, 103, Sector 7, Panchkula.
10. Professor NM Bujurke, FNA, PG Department of Studies in Mathematics, Karnatak University, Dharwad, Karnataka.
11. Professor Dipankar Chakravorty, FNA, Emeritus Professor, Indian Association for the Cultivation of Science, Kolkata.
12. Professor IB Chatterjee, FNA, Joint Co-ordinator, Dr BC Guha Centre for Genetic Engineering & Biotechnology, University College of Science, Kolkata.
13. Professor DK Chattoraj, FNA, Formerly Professor & Head, Department of Food Technology and Biochemical Engineering, Jadavpur University, Kolkata.
14. Professor SM Chitre, FNA, Emeritus Professor, Centre for Excellence in Basic Sciences, University of Mumbai, Mumbai.
15. Professor HK Das, FNA, Formerly Director, Genetic Engineering Unit, Jawaharlal Nehru University, New Delhi.
16. Professor SK Dogra, FNA, Formerly Professor & Head, Department of Chemistry, Indian Institute of Technology, Kanpur.
17. Professor SC Dutta Roy, FNA, Formerly Professor, Department of Electrical Engineering, Indian Institute of Technology, New Delhi.
18. Professor KRK Easwaran, FNA, Emeritus Professor, Molecular Biophysics Unit, Indian Institute of Science, Bengaluru.
19. Professor RP Gandhi, FNA, Formerly Professor, Indian Institute of Technology Delhi, New Delhi.
20. Professor K Gopalan, FNA, CSIR-National Geophysical Research Institute, Hyderabad.
21. Professor KP Gopinathan, FNA, Professor, Department of Microbiology & Cell Biology, Indian Institute of Science, Bengaluru.
22. Professor G Govil, FNA, INSA-Golden Jubilee Research Professor, Tata Institute of Fundamental Research, Mumbai.
23. Professor RV Gurjar, FNA, School of Mathematics, Tata Institute of Fundamental Research, Mumbai.
24. Professor Alok K Gupta, FNA, National Centre of Experimental Mineralogy and Petrology, University of Allahabad, Allahabad.
25. Professor DVS Jain, FNA, Department of Chemistry and UGC Advanced Centre, Panjab University, Chandigarh.
26. Dr SK Jain, FNA, Formerly Director, Institute of Ethnobiology, Jiwaji University, Gwalior.
27. Professor MS Jairajpuri, FNA, Formerly Professor, Department of Zoology, Aligarh Muslim University, Aligarh.
28. Professor SK Joshi, FNA, M 56 South City 1, Gurgaon.
29. Professor VP Kamboj, FNA, Formerly Director, CDRI Lucknow and Formerly Chairman, BIBCOL, Bulandshahr.
30. Professor AK Kamra, FNA, Indian Institute of Tropical Meteorology, Pune.
31. Professor SS Kapoor, FNA, Formerly Director, Physics and Electronics & Instrumentation Groups, Bhabha Atomic Research Centre, Mumbai.
32. Professor Sushil Kumar, FNA, Formerly Director, CIMAP and NBRI, Lucknow.
33. Professor KK Mahajan, FNA, Formerly Head, Radio and Atmospheric Sciences Division, CSIR-National Physical Laboratory, New Delhi.
34. Professor SC Maheshwari, FNA, School of Life Science, Jaipur National University, Jaipur.
35. Professor PT Manoharan, FNA, Department of Chemistry, Indian Institute of Technology Madras, Chennai.
36. Professor JP Mittal, FNA, Bhabha Atomic Research Centre, Mumbai.
37. Professor SP Moulik, FNA, Centre for Surface Science, Department of Chemistry, Jadavpur University, Kolkata.
38. Professor D Mukhopadhyay, FNA, Raman Centre for Applied and Interdisciplinary Sciences, Kolkata.
39. Professor K Nag, FNA, Emeritus Professor, Department of Inorganic Chemistry, Indian Association for the Cultivation of Science, Kolkata.
40. Professor Prem Narain, FNA, Formerly Emeritus Professor, IARI & Director, IASRI, Pusa, New Delhi.

41. Professor AV Narlikar, FNA, UGC-DAE Consortium for Scientific Research, University Campus, Indore.
42. Professor P Natarajan, FNA, National Centre for Ultrafast Processes, University of Madras, Chennai.
43. Professor SC Pakrashi, FNA, Formerly Director, CSIR-Indian Institute of Chemical Biology, Kolkata.
44. Professor TJ Pandian, FNA, 9 Old Natham Road, Madurai.
45. Professor DK Paul, FNA, Department of Geology, Presidency College, Kolkata.
46. Professor Rajendra Prasad, FNA, Formerly ICAR National Professor, Division of Agronomy, IARI, New Delhi.
47. Professor PD Prasada Rao, FNA, National Environmental Engineering Research Institute, Nagpur.
48. Professor ES Rajagopal, FNA, Emeritus Scientist, Department of Physics, Indian Institute of Science, Bengaluru.
49. Professor R Ramamurthi, FNA, Formerly VC & ISRO Honorary Scientist, Department of Fishery Science, SV University, Tirupati.
50. Professor T Ramasarma, FNA, Formerly Professor, Department of Biochemistry, Indian Institute of Science, Bengaluru.
51. Professor HS Randhawa, FNA, Formerly Professor of Medical Mycology and Director, Vallabhbhai Patel Chest Institute, Delhi University, New Delhi.
52. Professor R Raghavendra Rao, FNA, Formerly Scientist, Central Institute of Medicinal and Aromatic Plants, Bengaluru.
53. Professor RP Rastogi, FNA, Emeritus Professor, Gorakhpur University, Gorakhpur.
54. Professor RG Rastogi, FNA, Formerly Director IIG, Mumbai and Visiting Professor, Physical Research Laboratory, Ahmedabad.
55. Professor AB Roy, FNA, Emeritus Professor, Department of Geology, Presidency University, Kolkata.
56. Professor JS Sandhu, FNA, Department of Chemistry, Punjabi University, Patiala.
57. Professor Anil Saran, FNA, Department of Pharmaceutical Chemistry, Bombay College of Pharmacy, Mumbai.
58. Professor PK Sarkar, FNA, Division of Neurobiology, CSIR-Indian Institute of Chemical Biology, Kolkata.
59. Professor RP Sharma, FNA, Formerly Project Director, National Research Centre on Plant Biotechnology, IARI, New Delhi.
60. Professor KR Shivanna, FNA, Honorary Senior Fellow, ATREE (Ashoka Trust for Research in Ecology and the Environment), Bengaluru.
61. Professor SK Sikka, FNA, Formerly Director, Atomic and Condensed Matter Physics Group, Bhabha Atomic Research Centre, Mumbai.
62. Professor Ajit Iqbal Singh, FNA, Indian Statistical Institute, New Delhi.
63. Professor IB Singh, FNA, Department of Geology, Lucknow University, Lucknow.
64. Professor Sarvajit Singh, FNA, Emeritus Professor, Department of Mathematics, Maharshi Dayanand University, Rohtak, Haryana.
65. Professor SR Singh, FNA, Formerly Vice-Chancellor, Rajendra Agricultural University, Pusa, Bihar.
66. Professor Bikash C Sinha, FNA, DAE Homi Bhabha Professor, Variable Energy Cyclotron Centre, Department of Atomic Energy, Kolkata.
67. Professor KP Sinha, FNA, Emeritus Professor, Department of Physics, Indian Institute of Science, Bengaluru.
68. Professor A Sridharan, FNA, Emeritus Professor, Department of Civil Engineering, Indian Institute of Science, Bengaluru.
69. Professor GSR Subba Rao, FNA, Department of Organic Chemistry, Indian Institute of Science, Bengaluru.
70. Professor Kalluri Subba Rao, FNA, School of Medical Sciences, University of Hyderabad, Hyderabad.
71. Professor PN Takkar, FNA, Formerly Director, Indian Institute of Soil Science, Bhopal.
72. Professor Anupam Varma, FNA, Formerly National Professor, Advanced Centre for Plant Virology, Division of Plant Pathology, IARI, New Delhi.

ANNEXURE-XVII

PROJECT INVESTIGATORS AMONGST INSA YOUNG SCIENTIST AWARDEES

1. Dr PC Abhilash, Assistant Professor, Institute of Environment and Sustainable Development, Banaras Hindu University, Varanasi.
2. Dr Ranjit Prasad Bahadur, Associate Professor, Department of Biotechnology, Indian Institute of Technology Kharagpur, Kharagpur.
3. Dr Melinda Kumar Bera, Assistant Professor, Geology & Geophysics, Indian Institute of Technology Kharagpur.
4. Dr Partha Bhattacharyya, Assistant Professor, Department of Electronics and Telecommunication Engineering, Indian Institute of Engineering Science and Technology, Howrah.
5. Dr Imran Habib Biswas, Reader, TIFR Centre for

Applicable Mathematics, Bengaluru.

6. Dr Krishanu Biswas, Associate Professor, Department of Materials Science, Defense Applications and Engineering, Indian Institute of Technology Kanpur, Kanpur.
7. Dr Sangita Bose, Reader 'F', Center for Excellence in Basic Sciences, University of Mumbai, Mumbai.
8. Dr Suryasarathi Bose, Assistant Professor, Department of Materials Engineering, Indian Institute of Science, Bengaluru.
9. Dr VK Chandrasekar, Assistant Professor (III), Center for Nonlinear Science and Engineering, School of Electrical and Electronics Engineering, SASTRA University, Thanjavur.
10. Dr Abhijit Chatterjee, Associate Professor, Department of Chemical Engineering, Indian Institute of Technology Bombay, Mumbai.
11. Dr Suman Dasgupta, Assistant Professor, Department of Molecular Biology & Biotechnology, Tezpur University, Tezpur.
12. Dr Ayan Datta, Associate Professor, Department of Spectroscopy, Indian Association for the Cultivation of Science, Kolkata.
13. Dr N Nishad Fathima, Principal Scientist, Chemical Laboratory, CSIR-Central Leather Research Institute, Chennai.
14. Dr Sujit Kumar Ghosh, Associate Professor, Department of Chemistry, Indian Institute of Science Education & Research, Pune.
15. Dr Aravind Gopalan, Assistant Professor, Department of Physics, Indian Institute of Technology Madras, Chennai.
16. Dr Abhinav Grover, Assistant Professor, School of Biotechnology, Jawaharlal Nehru University, New Delhi.
17. Professor Tarun Gupta, Professor, Department of Civil Engineering, Indian Institute of Technology Kanpur, Kanpur.
18. Dr Sanyog Jain, Assistant Professor, Department of Pharmaceutics, National Institute of Pharmaceutical Education and Research (NIPER), Chandigarh.
19. Dr Masilamani Jeganmohan, Assistant Professor, Department of Chemistry, Indian Institute of Science Education and Research Pune (IISER), Pune.
20. Dr Susanta Kar, Scientist, Parasitology Division, CSIR-Central Drug Research Institute, Lucknow.
21. Dr Dhiraj Kumar, Group Leader, Immunology Group, International Centre for Genetic Engineering & Biotechnology, New Delhi.
22. Dr Mahesh Kumar, Assistant Professor, Department of Mechanical Engineering, Indian Institute of Technology Jodhpur, Jodhpur.
23. Dr Niti Kumar, Scientist, Parasitology Division, CSIR-Central Drug Research Institute, Lucknow.
24. Dr GV Pavan Kumar, Assistant Professor, Department of Physics, Indian Institute of Science Education and Research Pune (IISER), Pune.
25. Dr Debabrata Maiti, Associate Professor, Department of Chemistry, Indian Institute of Technology Bombay, Mumbai.
26. Dr Pradipta Maji, Associate Professor, Machine Intelligence Unit, Indian Statistical Institute, Kolkata.
27. Dr Sumantra Mandal, Assistant Professor, Department of Materials and Metallurgical Engineering, Indian Institute of Technology Kharagpur, Kharagpur.
28. Dr Saravanan Matheshwaran, Assistant Professor, Department of Biological Sciences and Bio-engineering, Indian Institute of Technology, Kanpur.
29. Dr Abha Mishra, Associate Professor, Department of Instrumentation and Applied Physics, Indian Institute of Science, Bengaluru.
30. Dr Partha Pratim Mondal, Associate Professor, Department of Instrumentation and Applied Physics, Indian Institute of Science, Bengaluru.
31. Dr Animesh Mukherjee, Associate Professor, Department of Computer Science and Engineering, Indian Institute of Technology, Kharagpur.
32. Dr Saptarshi Mukherjee, Associate Professor, Department of Chemistry, Indian Institute of Science Education & Research, Bhopal.
33. Dr Mohd. Naimuddin, Assistant Professor, Department of Physics & Astrophysics, University of Delhi, Delhi.
34. Dr Dhananjay Nandi, Associate Professor, Department of Physical Sciences, Indian Institute of Science Education and Research Kolkata (IISER), Kolkata.
35. Dr Tapan Kanti Paine, Professor & Head, Department of Inorganic Chemistry, Indian Association for the Cultivation of Science, Kolkata.
36. Dr Santanu Kumar Pal, Associate Professor, Department of Chemical Sciences, Indian Institute of Science Education and Research Pune (IISER), Mohali.
37. Dr Gayathri Pananghat, Principal Investigator, INSPIRE Faculty, Department of Biology, Indian Institute of Science Education and Research Pune (IISER), Pune.
38. Dr U Deva Priyakumar, Associate Professor, Centre for Computational Natural Sciences & Bioinformatics, International Institute of Information Technology, Hyderabad.
39. Professor Mihir Kumar Purkait, Associate Professor, Department of Chemical Engineering, Indian Institute of Technology Guwahati, Guwahati.
40. Dr G Rajaraman, Associate Professor, Department of Chemistry, Indian Institute of Technology Bombay, Mumbai.
41. Dr Surinder Singh Rana, Associate Professor, Department of Gastroenterology, Postgraduate Institute of Medical, Education & Research (PGIMER), Chandigarh.
42. Dr Amit Roy, Assistant Professor, Department of Biotechnology, National Institute of Pharmaceutical

Education and Research (NIPER), Hajipur.
43. Dr Abdur Rub, Assistant Professor, Department of Biotechnology, Jamia Millia Islamia (A Central University), New Delhi.
44. Dr Kirti Chandra Sahu, Associate Professor, Department of Chemical Engineering, Indian Institute of Technology Hyderabad, Hyderabad.
45. Dr Pratik Sen, Associate Professor, Department of Chemistry, Indian Institute of Technology Kanpur, Kanpur.
46. Dr Sonali Sengupta, Staff Scientist, Division of Plant Biology, Bose Institute, Kolkata.
47. Dr Maheswaran Shanmugam, Assistant Professor, Department of Chemistry, Indian Institute of Technology Bombay, Mumbai.
48. Dr Rakesh K Shukla, Scientist-B, Central Institute of Medicinal and Aromatic Plants, Lucknow.
49. Dr Amit Kumar Singh, Assistant Professor, Department of Biotechnology, School of Engineering & Technology, Sharda University, Greater Noida.
50. Dr Rajender Singh, Senior Scientist, Endocrinology Division, Central Drug Research Institute, Lucknow.
51. Dr Vimal Chandra Srivastava, Associate Professor, Department of Chemical Engineering, Indian Institute of Technology Roorkee, Roorkee.
52. Dr Arun Kumar Trivedi, Senior Scientist, Biochemistry Division, CSIR-Central Drug Research Institute (CDRI), Lucknow.
53. Dr Rahul Vaish, Assistant Professor, School of Engineering, Indian Institute of Technology Mandi, Mandi.
54. Dr Rahul Vaze, Reader, School of Technology and Computer Science, Tata Institute of Fundamental Research, Mumbai.
55. Dr Gaurav Verma, Science Enthusiast, School of Biotechnology, Jawaharlal Nehru University, New Delhi.
56. Dr Gitanjali Yadav, Staff Scientist IV, National Institute of Plant Genome Research (NIPGR), New Delhi.
57. Dr Shri Ram Yadav, Assistant Professor, Department of Biotechnology, Indian Institute of Technology Roorkee, Roorkee.

ANNEXURE-XVIII

CONFERENCE/ SEMINAR /SYMPOSIUM /WORKSHOP SUPPORTED BY INSA DURING 2015-16

1. 2nd International Conference on "Communication Systems" held at BK Birla Institute of Engineering & Technology, Pilani during October 18-20, 2015.
2. International Conference on "Current Scenario & Future Prospects of Biotechnology & Diverse Sectors" held at Bannari Amman Institute of Technology, Sathyamangalam, Tamil Nadu during October 22-24, 2015.
3. Workshop on "Functional Genomics - Hands on Training in RT PCR, Microarray, NGS and Data Analysis" held at Osmania University, Hyderabad during October 26-30, 2015.
4. A three days workshop on "Advanced Techniques for Surface Characterization" held at Thapar University, Patiala during October 28-30, 2015.
5. International Symposium on "Photonics Application and Nanomaterials" held at Hotel Residency Tower, Kerala during October 28-30, 2015.
6. 18th International Conference on "Radiation Effects in Insulators" held at University of Rajasthan, Jaipur during October 26-31, 2015.
7. Conference on "Infection and Molecular Epidemiology" held at Udaipur during October 29-31, 2015.
8. 12th Postgraduate Course in "Endocrine Surgery" and International Workshop in "Endocrine Surgery" held at Sanjay Gandhi Post Graduate Institute of Medical Sciences, Lucknow during October 29 - November 1, 2015.
9. National Conference on "Current Issues in Cosmology Astrophysics and High Energy Physics" held at Dibrugarh University, Assam during November 2-5, 2015.
10. 11th International Food Data Conference held at National Institute of Nutrition, Hyderabad during November 3-5, 2015.
11. 17th National Conference on "Surfactants, Emulsions & Biocolloids (NATCOSEB XVII)" held at Pt. Ravishankar Shukla University, Raipur during November 4-6, 2015.
12. 2nd National Seminar on "Climate Change and Socio-Ecological Transformation with Special Reference to the North-East India" held at Mizoram University, Aizawl during November 5-6, 2015.
13. 3rd IIT Madras-Tokyo Tech Joint Symposium on "Algorithms and Applications of Bioinformatics" held at Indian Institute of Technology Madras during November 5-6, 2015.
14. 5th Biennial Conference of Gastrointestinal Infection Society of India (GISICON-2015) held at Government Medical College & Hospital, Jammu during November 6-7, 2015.
15. International Symposium on "Perspective Move towards Ecology and Health Management of Asiatic

Elephant" held at NASC Complex, Pusa, New Delhi during November 10-11, 2015.

16. 3rd Asian Conference of Arachnology held at JPPS Mahavidhyalaya Amravati, during November 16-19, 2015.
17. National Conference on "Indian Botanic Gardens" held at CSIR-National Botanical Research Institute, Lucknow during November 18-20, 2015.
18. International Symposium on "Ocean Electronics" held at Cochin University of Science & Technology, Kerala during November 18-20, 2015.
19. International Seminar on "Advancements in Angiosperm Systematics and Conservation" held at University of Calicut, Kerala during November 19-21, 2015.
20. 10th National Conference on "Thermodynamics of Pharmaceutical, Chemical & Biological Systems" held at Punjab University, Chandigarh during November 20-21, 2015.
21. Two days National Seminar on "Cloud Security Services" held at Sri Ramakrishna Engineering College, Coimbatore during November 20-21, 2015.
22. 63rd National Conference of "Anatomical Society of India" held at K.G. Medical University, Lucknow during November 20-23, 2015.
23. 7th International Conference on "Seabuckthorn-Emerging Technologies for Health Protection & Environmental Conservation" held at NASC Complex, Pusa Campus, New Delhi during November 24-26, 2015.
24. National Conference on "Carbon Materials (NCCM2015)" held at India International Centre, New Delhi during November 26-28, 2015.
25. International Lighting Conference "Lux Pacifica 2015" held at ITC Sonar Hotel, Kolkata during November 27-29, 2015.
26. National Seminar on "Recent Advances in Natural Products Chemistry for Drug discovery" held at Netaji Subhas Mahavidyalaya, Udaipur during November 28-29, 2015.
27. International Conference on "Computational Heat & Mass Transfer – 2015" held at National Institute of Technology, Warangal during November 30 - December 02, 2015.
28. 4th International and 7th National Conference of Indian Society for Rational Pharmatherapeutics ISRPTCON 2015 held at PGIMER, Chandigarh during December 4-6, 2015.
29. International Workshop on "Emerging Areas in Photonics and Future Applications" held at CSIR-Central Glass and Ceramic Research Institute (CGCRI), Kolkata during December 7-12, 2015.
30. 9th International Conference on "Yeast Biology" held at Jadavpur University, Kolkata during December 9-12, 2015.
31. 3rd National Conference of Forum for Ethics Review Committees in India, Theme: "Accreditation and Quality Ethics Review" held at Sanjay Gandhi Post Graduate Institute of Medical Sciences (SGPGIMS), Lucknow during December 11-12, 2015.
32. National Level Seminar on "Animal Welfare and Ethics" held at Karunya University, Coimbatore during December 11-12, 2015.
33. 3rd International Plant Physiology Congress on "Challenges and Strategies in Plant Biology Research" held at Jawaharlal Nehru University, New Delhi during December 11-14, 2015.
34. International Symposium on "Computational Biology" held at Maulana Azad National Institute of Technology, Bhopal during December 11-14, 2015.
35. Four days International Conference on "Nanoscience, Nanotechnology and Advanced Materials" held at Gandhi Institute of Technology and Management (GITAM) University, Vishakhapatnam during December 14-17, 2015.
36. 12th International Conference on "Vibration Problems" held at Indian Institute of Technology, Guwahati during December 14-17, 2015.
37. International Conference on "Ocean Acidification Research-2015" held at Marine Field Research at Madurai Kamaraj University, Pudumadam during December 15-17, 2015.
38. XXXV INCA International Congress on "Spatial Governance for Development, Planning Smart Cities and Disaster Management" held at Jawaharlal Nehru University, New Delhi during December 15-17, 2015.
39. Short Term Advance Training Programme on "Integral Transformations, Distributions and Wavelet Analysis" held at Indian School of Mines, Dhanbad during December 14-18, 2015.
40. 6th International Conference on "Computers and Devices for Communication (CODEC-15)" held at Swissotel, Kolkata during December 16-18, 2015.
41. International Conference on "60th Congress of Indian Society of Theoretical & Applied Mechanics (ISTAM-2015)" held at Malaviya National Institute of Technology, Jaipur during December 16-19, 2015.
42. 12th IEEE India International Conference, INDICON-2015, on "Electronics, Energy, Environment, Communication Computer, Control (E3 C3)" held at Jamia Millia Islamia, New Delhi during December 17-20, 2015.
43. International Conference on "Cutting-Edge Pharmacology: Contemporary Issues & Future Challenges" held at Saurashtra University, Rajkot during December 18-20, 2015.
44. 29th Annual Meeting of Society for Neurochemistry, India: National Workshop and Conference on "Advances in Computational Neurochemistry and Neurobiology" held at North-Eastern Hill University (NEHU), Shillong during December 16-21, 2015.
45. 1st International Conference on "Trends in Cell and Molecular Biology" held at BITS Pilani, Goa Campus during December 19-21, 2015.

46. International Conference on "Analysis and its Applications (ICAA-2015)" held at Aligarh Muslim University, Aligarh during December 19-21, 2015.
47. National Seminar on "Advances in Mathematical Sciences" held at Guwahati University, Guwahati during December 22, 2015.
48. 11th National Conference on "Solid State Ionics (NCSSI-11)" held at Tezpur University, Assam during December 21-23, 2015.
49. National Symposium on "Rotor Dynamics (NSRD-2016)" held at National Institute of Technology, Rourkela during January 7-9, 2016.
50. 3rd International Conference on "Foundations & Frontiers in Computer, Communications and Electrical Engineering: Celebrating the 100 Years of First Transcontinental Telephone Call" held at Supreme Knowledge Foundation Group of Institutions (SKFGI), Kolkata during January 15-16, 2016.
51. 2nd International Conference on "Advances in Computing and Management (ICACM)" held at DY Patil Institute of Master and Computer Applications, Pune during January 15-17, 2016.
52. International Conference on "Recent Trends in Energy Technologies (ICRTET 2016)" held at Haldia Institute of Technology during January 21-23, 2016.
53. International Conference on "Cardiovascular Translational Research and 13th Annual Conference of International Society for Heart Research" held at Indian Institute of Technology Madras, Chennai, during January 22-24, 2016.
54. National Symposium on "Biotechnology in Crop Improvement: Prospects & Constraints" held at Zakir Husain Delhi College, Delhi during January 29, 2016.
55. International Conference on "Innovative Designs and Implements for Global Environment and Entrepreneurial Needs Optimizing Utilitarian Sources" "INDIGENOUS" held at College of Veterinary Science, Hyderabad during January 28-31, 2016.
56. International Conference on "The Occasion of Silver Jubilee of the Indian Society of Industrial and Applied Mathematics (ISIAM)" held at Sharda University, Greater Noida during January 29-31, 2016.
57. National Level Instructional Workshop on "Geo-informatics tools for Biodiversity, Environment and Health Care Management" held at Loyola College, Chennai, during February 9-13, 2016.
58. International Conference on "Materials, Design and Manufacturing Processes" held at Anna University, Chennai during February 17-19, 2016.
59. International Symposium: Second Indo-Canadian Symposium on "Nano-Science & Technology-2016" held at The National Institute of Engineering, Mysuru, Karnataka during February 18-19, 2016.
60. International Conference on "Frontiers in Nano Science and Technology" held at Cochin University of Science &Technology, Cochin during February 20-23, 2016.
61. National Conference on "MICRON 2016" held at Assam University, Silchar during February 24-26, 2016.
62. National Symposium on "Plant Biotechnology for Crop Improvement" held at CSIR-National Botanical Research Institute, Lucknow during February 25-27, 2016.
63. Indo-German Workshop on "Modelling, Simulation and Optimization in Applications" held at Bankura University, Bankura, during March 2-4, 2016.
64. National Conference on "Strategies in Plant Physiological Research for Meeting Challenges in Agriculture" held at Banaras Hindu University, Varanasi during March 3-5, 2016.
65. International Conference on "Advanced Materials for Energy, Environment and Health" held at Indian Institute of Technology, Roorkee during March 4-7, 2016.
66. International Conference on "Contemporary Antimicrobial Research 2016" held at Assam University, Silchar during March 5-8, 2016.
67. 11th National Conference of Society of Indian Human and Animal Mycologist 2016 (SIHAM) held at Kufri Holiday Resort, Shimla during March 18-20, 2016.

ANNEXURE-XIX

HIGHLIGHTS OF RESEARCH WORK UNDER SCIENCE PROMOTION SCHEME

RESEARCH PROFESSORS

HY Mohan Ram, FNA

Shriram Institute for Industrial Research, Delhi

Gardens

It was proposed that the work report for the year 2015-2016 would be addressed to 'Plants and Environment'. When we started exploring the subject is vast. Considering the main theme of the project 'Plants in Human Well-being', we decided to concentrate on the aspect of "Gardens" which only man has been able to create among all the living beings.

The 12th South Asia Edition of concise Oxford Dictionary issued in 2011 defines, 'Garden' as a piece of ground adjoining a house, used for growing flowers, fruits or vegetables. However, broadly gardens would be ornamental grounds laid out for public enjoyment. We have adopted this definition.

In general, a garden can have a planned space laid out with flowers, trees and ornamental shrubs, set aside for the display, recreation and for public enjoyment. The garden encompasses both natural and fabricated materials. Gardens may exhibit structural enhancements, sometimes called follies, including water features such as fountains, ponds (with or without fish), waterfalls or creeks, dry creek beds, statutory, arbors, trellises and more. Whereas many gardens are strictly meant for ornamental purposes, some also produce food crops, sometimes in separate areas, intermixed with ornamental plants.

There is an increasing concern about declining levels of physical and psychological health of city dwellers. The reason behind this is the change in living habits such as dependency on cars and trains, covering long commuter distances, polluted and unsafe environments –all of which make it difficult to undertake the physical exercise needed to combat many serious diseases.

John Burroughs (1837-1921), American naturalist and writer stated, "I go to nature to be soothed and healed, and to have my senses put in time once more". Gardening is a healthy hobby and can change the way you feel. The therapeutic feeling people get from gardening or growing food, coupled with outdoor environment, create a strong and positive impact on physical and mental well-being.

If we properly understand our relationship to plants and nature, we can create comprehensive garden designs that boost our mood by releasing endorphins – our body's own natural feel-good hormones. Regular gardening helps bringing a new structure to our life by providing great opportunity to meet new people and it provides a great opportunity to explore ones creativity.

One of the great things about gardening is that it appeals to a wide range of people –young and old in both urban and rural areas.

A garden can have aesthetic, functional, and recreational benefits. Broadly, gardening helps in five ways towards our well-being:

- Connect with others: become less isolated
- Become more active: by taking part in gardening outdoor, gaining physical and mental health benefits.
- Take notice of the world: being outdoors and experiencing the joys of nature.
- Keep learning: develop new skills and gain in confidence
- Give to others: through sharing and supporting others and working as a team.

An illustrated account of some of the most famous and beautiful gardens of the world including Delhi is presented in our detailed report (2015-2016).

N Mukunda, FNA

Formerly Professor, Indian Institute of Science, Bengaluru

Studies in Mechanics, Optics and Information Science

During the year the work on two problems begun earlier have progressed and are near to completion. These are:

1. "Geometric Phase as the Key to Superposition in Phase Space: Integral Representations for States and Matrix Elements" - this work , in collaboration with R Simon and S Chaturvedi, presents a new approach to the phase space description of continuous variable Cartesian quantum mechanics. This is at the level of Hilbert space vectors and not at the density matrix level such as Wigner distributions. Important concepts from the theory of geometric phases, mainly the Pancharatnam concept of two Hilbert space vectors being in phase combined with the authors' kinematic approach, are used to develop a framework for integral representations for important states in terms of coherent states. These also lead to interesting representations for operator matrix elements of physical importance.
2. " 'Hairy ball theorem' and topological obstructions in the plane wave expansion of free electromagnetic field"—this work in collaboration with R Simon explores the topological problems encountered in choosing a globally smooth polarization basis for plane electromagnetic fields with all possible propagation directions, at a fixed frequency. The uses of properties

of coset spaces in some Lie groups relevant to the problem are highlighted. The impossibility of using linear polarisation states alone, or circular polarisations alone, are explicitly shown. Some of the generic features of globally smooth bases, which do exist as demonstrated by the authors and others in earlier work on classical optical geometric phases, are obtained.

Lecture activities:

During end December 2015 - early January 2016 I gave a course of six lectures on" Interaction of electromagnetic radiation with matter" at a INSA IASc NASI Refresher Course for teachers on "Applications of Quantum Mechanics : Atoms, Molecules and Radiation" held at the Department of Physics, University of Mumbai.

During February–March 2016 a set of 12 lectures was given at IISER Mohali (as part of a Course taught with Professor Arvind) covering the first two topics as in 2015, namely "Dirac Theory of Constrained Systems" and "Theory of Geometric Phases".

SENIOR SCIENTISTS

Subramaniam Ananthakrishnan, FNA

Department of Electronic Science, University of Pune, Pune

Radio Astronomy and Radio Science Instrumentation

1. Continuing with research on Sun by collaboration with Professor P Janardhan of PRL, Ahmedabad and his team to use GMRT and other radio telescopes to study the evolution of magnetic fields on the Sun. The surprising finding is that solar magnetic fields are steadily decaying since the last nearly 20 years. These results which used both ground based optical telescopes and radio telescopes in USA and Japan have been published in the journals JGR and Geosphere & Sun.
2. A radio interferometer consisting of 2 nos. of 4.5 m dish antennas are being made operational in the Department of Electronic science, University of Pune by involving 3 students and faculty of a local engineering college. The electronic circuitry for controlling the telescope has been made ready using indigenous components. This interferometer will be used then by students to initiate study of Sun in the frequencies 1.4 GHz and 3.8 GHz.
3. A laboratory prototype active antenna and magnetic loop antenna have been developed and a FPGA back end for observing electric and magnetic fields in space at frequencies from < 1 MHz to 20 MHz, by developing a satellite payload that can be put on one of the Indian satellites, post 2020. We have formalized an MOU for collaborating with Space Application Centre of ISRO, Ahmedabad for this purpose. ISRO-SP Pune University cell has sanctioned a grant of Rs 27 Lakhs towards the above project for the next 2 years.
4. As an elected Vice-President of URSI (International Radio Science Union, Ghent, Belgium) I was actively involved in organizing and conducting the 2nd URSI Regional Conference in Radio Science (URSI-RCRS) in JNU, New Delhi during November 16-19, 2015. I was the General Chairman for this conference and 150 papers were presented. Our group presented a paper on the above space payload which has been submitted to the Journal MAPAN.
5. I taught a full 4 credit course of Communication system design for MSc (Electronics Science) students of Pune University during August to November 2015 and a two credit course on antennas in the semester January to April 2016.
6. I was also a Guest Scientist in Harvard University's Centre for Astrophysics, Boston during June 1 to July 31, 2015.
7. I was involved in reviews of major projects like the ASTROSAT and the commissioning of Devasthal Optical Telescope (DOT) in Himalayas. ASTROSAT, launched on September 28, 2015, marks India's entry into space astronomy in a big way. DOT was inaugurated by the Honorable Prime Minister of India on March 31, 2016. I am continuing with Chairmanship of various national committees in DST and DAE and ISRO institutions like IIA, Bangalore, ARIES, Nainital, BARC, Mumbai and ISRO cell project evaluation committee in Pune. I am also a regular participant in INSA-DST-INSPIRE faculty selection programme.
8. I continued as an Ad-hoc Chairman of the Atmospheric Science Board of SV Pune University as well as an Academic Council Member till March 31, 2016. I continue as a member of the First Court of Kashmir Central University.

Publications:

Janardhan P, Bisoi Susanta Kumar, Ananthakrishnan S, Sridharan R, Jose L, Solar and Interplanetary Signatures of a Maunder-like Grand Solar Minimum around the Corner-Implications to Near-Earth Space. *Sun and Geosphere*, **10/2** (2015) 147-156.

Janardhan P, Bisoi Susanta Kumar, Ananthakrishnan S, Tokumaru M, Fujiki K, Jose L and R Sridharan, A 20 year decline in solar photospheric magnetic fields: Inner-heliospheric signatures and possible implications. *J. Geophys. Res. Space Physics*, DOI: 10.1002/2015JA021123, **120** (2015) 5306-5317.

VA Bapat, FNA
Department of Biotechnology, Shivaji University, Kolhapur

Studies on Silver Nanoparticles and Bio Active Molecules from Plant Sources

a. Bio-Functionalized Silver Nanoparticles: a Novel Colorimetric Probe for Cysteine Detection

Chemical interactions between nanoparticles and biomolecules are vital for applying nanoparticles in medicine and life science. Development of sensitive, rapid, low-cost, and eco-friendly sensors for the detection of molecules acting as disease indicator is need of an hour. In the present investigation, a green trend for silver nanoparticle synthesis was followed using leaf extract of *Calotropis procera*. Silver nanoparticles exhibited surface Plasmon absorption peak at 421 nm, spherical shape with average size of 10 nm, and zeta potential of –22.4 mV. The as-synthesized silver nanoparticles were used for selective and sensitive detection of cysteine. Cysteine induces aggregation in stable silver nanoparticles owing to selective and strong interaction of –SH group of cysteine with silver nanoparticle surface. Cysteine-induced silver nanoparticle aggregation can be observed visually by change in color of silver nanoparticles from yellow to pink. Cysteine concentration was estimated colorimetrically by measuring absorption at surface plasmon wavelength. Limit of detection for cysteine using silver nanoparticles is ultralow, i.e., 100 nM. The mechanistic insight into cysteine detection by silver nanoparticles was investigated using FT-IR, TEM, DLS, and TLC analysis. Proposed method can be applied for the detection of cysteine in blood plasma and may give rise to a new insight into development of eco-friendly fabricated nano diagnostic device in future.

b. Studies on *Mucuna* species for L DOPA analysis

Melanin's are predominantly indolic polymers which are having extensive applications in cosmetics, agri-culture and medicine. In the present study, optimization of nutritional parameters influencing melanin production by *Mucuna monosperma* callus cultures was attempted using the response surface methodology (RSM). Melanin production was confirmed by spectrophotometric and chemical analysis. This study demonstrates the production of melanin by *M. monosperma* callus, using a laboratory scale column reactor.

A new species of *Mucuna, M. sanjappae* from north-Western Ghats of India, has been analyzed for the presence of L-DOPA and a reasonable level of this drug (7.3 %) was detected. The necessary biochemical characterization of the seeds extract of this plant showed nutritional and anti nutritional components. This new plant species will be a potential candidate for extraction of L-DOPA and will be a good addition to the existing natural sources of anti-Parkinson's drug since demand for L-DOPA is continuously escalating. Additionally, the strong antioxidant activity of *M. sanjappae* may provide a platform for future drug discoveries and novel treatment strategies in oxidative stress related diseases like Parkinson's disease (PD). *M. macrocarpa* beans from North-Eastern region of India were also tested for their biological significance. Reverse phase high performance liquid chromatography (RP-HPLC) analysis revealed that, *M. macrocarpa* contains 84.41±4.02mg/gm of L-DOPA which is the highest content of L-DOPA among the species from Indian subcontinent.

c. Analysis of selected Crinum species for galanthamine alkaloid: an anti-Alzheimer drug

Galanthamine, an isoquinoline alkaloid and the current drug of choice for treatment of mild to moderate Alzheimer disease, is mainly obtained from Amaryllidaceae members. Aim of this study is to determine galanthamine content in five Indian *Crinum* species. The bulbs of each *Crinum* species were extracted with methanol. Extracts were analyzed by high performance liquid chromatography. Among all the *Crinum* species studied, the highest galanthamine content was found in the bulbs of *C. malabaricum*. Currently, studies on checking the efficacy of this plant source of galanthamine on animal models are underway. This study identifies novel plant sources of galanthamine, which may be helpful for the pharmaceutical production of galanthamine.

SV Bhat, FNA
Department of Physics, Indian Institute of Science, Bengaluru

Electron Magnetic Resonance (EMR) and Magnetic Studies on Bulk and Nano Manganites

During the past year, our research focused on finding answers to certain important, unresolved issues in manganite physics: 1) effect of size reduction to nanoscale on the phenomenon of electron-hole asymmetry in manganites 2) effect of size reduction on systems exhibiting different types of magnetic ordering and 3) the origin of different temperature dependences of EMR linewidths in different manganite systems. To this end, bulk and nanoparticle samples of various doped rare earth manganites $Nd_{1-x}Ca_xMnO_3$, (x= 0.4, 0.6), $Sm_{1-x}Ca_xMnO_3$ (x = 0.35, 0.65 and 0.92), $Nd_{0.65}Ca_{0.35}Mn_{01-x}Cr_xO_3$ (x=0.0, 0.06, 0.1) were prepared. Nanoparticles were prepared by using sol-gel technique and the bulk samples by either annealing the nanoparticles at high temperatures or by using the solid state reaction method. The samples were comprehensively

characterized using powder X-ray diffraction (XRD), transmission electron microscopy(TEM), energy dispersive X-ray analysis(EDAX), and inductively coupled plasma emission spectroscopy (ICPES) techniques to ensure phase, chemical and structural purity before subjecting them to detailed magnetic and electron magnetic resonance investigations. As a result of these investigations it was found that,

- reduction to nanosize leads to the vanishing of electron-hole asymmetry observed in bulk manganites;
- even if bulk manganites have different magnetic ground states, in nanoparticle form they exhibit the same ground state;
- Cr doping in Mn site, along with reduction of particle size to nanoscale leads to ferromagnetic order in otherwise antiferromagnetic manganites.

CK Dasgupta, FNA

Department of Life Science & Biotechnology, Jadavpur University, Kolkata

Protein folding by Ribosome

We discovered that proteins from various organisms, prokaryotic and eukaryotic, with different sizes and shapes and dissimilar in the primary, secondary and tertiary structures, are folded in vivo and in vitro by ribosome from all cells and organelles. The unfolded proteins bind to specific nucleotides in the large RNA of the large subunit of ribosome and released from them following some order. We could derive that folding takes place from the N- to the C-terminal of proteins. If all proteins fold through interaction with the same nucleotides in RNA, then they should also have some similarity. Searching hundreds of proteins then revealed some pattern of amino acid distribution in them that was far from random. This is true for all the cytoplasmic and membrane associated proteins. The regularity in the sequence of amino acids is most pronounced with respect to their hydrophobicity, as we see when we substitute the amino acid sequence with their hydrophobicity indices. This kind of representation makes sense because protein folding takes place in water.

In our experiments, all of the six randomly chosen structurally and functionally different proteins showed five of their amino acids from different regions to bind to the same five nucleotides in the peptidyl transferase center (PTC) of the 23S rRNA of *E.coli* ribosome. This is like clamping each protein at five sites to divide it into six segments. The binding to RNA and release is a slow process, taking minutes. So, prior to release, the six segments of each protein gets enough time to form secondary structures independently. On release from the clamps sequentially more or less from the N- to the C-termini, the secondary structures of the peptide segments can fold to tertiary forms with six order of reduced interference compared with the spontaneous folding of the protein. The notable observations are:

1. The amino acids which bind to specific RNA nucleotides are all in the random coil regions (where rare codon occur at high concentration) and would not interfere with the formation of secondary structures between two consecutive binding sites.
2. For a large number of proteins belonging to the two classes, cytoplasmic or membrane anchored, the cumulative plot of average hydrophobicity of equal fractional length segments of amino acids against the position of amino acids, almost overlapped with very small standard errors. So, we get two representative cumulative hydrophobicity plots for the two classes of proteins.
3. We hypothesized that the remarkable similarity in the linear amino acid plots of all proteins should be reflected in some similarity in the three dimensional motif of proteins. We looked for conservation of motifs and found three such pairs of amino acids in all proteins. These are ASP-SER, ASP-ARG and ASP-THR.
4. The identity was also found in the number density of water molecules along the radius of the globular proteins in all of about fifty cytoplasmic protein crystals.
5. The order of release of polypeptide segments from the PTC-RNA nucleotides led to smooth downfall of the folding protein through the energy funnel, without encountering significant barrier.

AK Datta, FNA

CSIR-Indian Institute of Chemical Biology, Kolkata

Cyclophilin Reactivation of Adenosine Kinase

Development of chemotherapy against leishmaniasis, a group of diseases including kala-azar, caused by the etiologic purine auxotrophic parasitic protozoan *Leishmania spp.*, is often hampered due to appearance of drug resistance and similarities of its biochemical pathways with those of the hosts. Hence, purine salvage pathway enzyme, adenosine kinase (AdK), responsible for assimilation of purine bases in purine auxotrophs especially parasitic protozoa, for various other biological energy needs and also for its role in essential brain function, is considered as one of the focal point of attack. Studies on regulation of this enzyme by artificially chemically designed/ and or naturally available chemotherapeutic regimens has been the subject of intensive research all over the world. While working with the enzyme from the aforesaid parasitic protozoan, we made a seminal observation that a chaperone protein, *viz*. cyclophilin (LdCyP), from this purine auxotroph, apart from its well-known intrinsic peptidyl-prolyl *cis-trans* (PPIase) activity, has the ability to disaggregate and reactivate the inactive aggregates of adenosine kinase (AdK), the gateway purine-salvage pathway enzyme of the purine auxotrophic organism [*J.Biol.Chem*, **277** (2002)

47451-47460]. Interestingly, the protein disaggregating property of LdCyP was found to be cyclosporin A (CsA), a drug known to inhibit the PPIase activity of LdCyP, insensitive. It was demonstrated in our laboratory that a C-terminal fragment of LdCyP, devoid of 88 amino acids from the N-terminal end displayed a similar type of activity. Detailed studies have described mechanistic aspects of the disaggregation process [*Biochemistry*, **43** (2004) 11862-11872; *Biochemistry*, **45** (2006) 263-271; *Biochemistry*, **46** (2007) 7832-7843]. While looking at the aggregating behaviour of the active AdK monomers, it was found that, apart from its natural tendency to aggregate, ADP, one of the products of AdK-mediated reaction is the causative agent for aggregation of the enzyme [*Arch. Biochem. Biophys.*, **537** (2013) 82-90]. Our continuing effort to look for a still smaller oligopeptide that could carry out such an important function have led to identification of a 10-amino acid LdCyP-oligopeptide stretch that appeared to be functionally as active as the full-length LdCyP. Identification of the peptide sequence ^{147}RHVVFGKVLD^{156} raises a hope that the small peptide might provide an useful lead for developing small peptide as peptidomimetics in regulation of the enzyme activity, essential for the parasite growth. Clearly, structural characterization and conformational analysis of the AdK and LdCyP and AdK-LdCyP peptide interaction is expected to throw more light on the molecular mechanism by which LdCyP-chaperone stimulates the enzyme, the most essential information needed for developing congeners/ and or antagonists. Towards this goal, we, in collaboration with Prof. Rahul Banerjee, have succeded in crystallizing LdCyP and study the CsA-binding behaviour of the protein [*Acta. Crystal F*, **63** (2007) 1-5; *Acta. Crystal D*, **65** (2009) 1187-1195]. We have also initiated studies on the unfolding of LdCyP and have started characterisation of possible intermediate states of unfolded LdCyP [*Int. J. Biol. Macromolecules*, **69** (2014) 353-360].

BM Deb, FNA

Visva-Bharati University, Kolkata

a. Theoretical Studies on Atoms and Molecules, and b. Studies on Indian Heritage

a. Theoretical Studies on Atoms and Molecules: *Dynamics of electronic motion in hydrogen atom under parallel strong oscillating magnetic field and intense laser fields* [1]:

The mechanism of ionization of an H atom interacting with intense laser electric fields is altered when a strong, oscillating magnetic field is applied along a direction parallel to the laser field. In this first study of its kind, these two strongly non-perturbative situations have been combined together and the corresponding time-dependent (TD) Schrödinger equation has been numerically solved without using any basis set. The electric field arising out of the magnetic field and the magnetic field arising out of the laser electric field are found to be negligibly small, thereby not affecting the results. There are two main, apparently *counter-intuitive* results from this study of parallel fields of the *same frequency but different field strengths*: (1) In presence of an oscillating magnetic field, the ionization rate due to the laser field diminishes, and (2) increasing the laser intensity, keeping the magnetic field strength the same, makes the electron density ionize with a lesser rate, in contrast to the situation with intense lasers in the absence of a strong TD magnetic field.

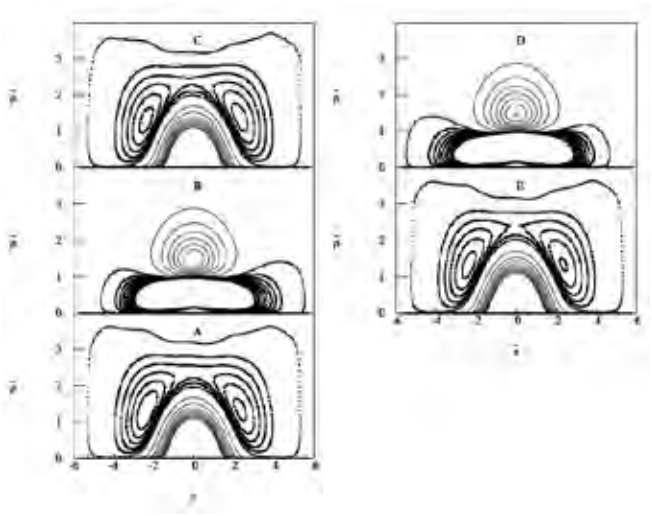

Figure 1: *Density changes, $\Delta\rho$ (r, t), in a.u., for laser intensity $I = 1 \times 10^{13}$ W/cm^2 and magnetic field strength $\beta_{max} = ,1$, at the end of the 20th optical cycle. Positive, negative and zero difference densities are depicted by barbed, solid and dotted lines respectively. The outer and inner contour values for positive $\Delta\rho$ are 0.001 and 0.011 while for negative $\Delta\rho$ they are -0.001 and -0.011 respectively. A, B, C, D and E denote five instants of time.*

b. Studies on Indian Heritage [2]:

An attempt has been made to provide an encyclopedic account of the three major entangled strands of Indian Science, Literature and Art from 3300 B.C. to around 1600 A.D., with numerous information, insights, networks of interconnecting concepts as well as connections between the past and the present, extensively supported by carefully selected visuals and citations. This work, involving highly detailed studies, was published in 2015.

Publications:

Sadhukhan M, Roy AK, Panigrahi PK and Deb BM, *Int. J. Quantum Chem.*, **116** (2016) 377-387.

Deb BM, The Peacock in Splendour : Science, Literature and Art in Ancient and Medieval India, Publishing Department, Visva-Bharati University, Kolkata (2015) 624 pages.

MG Deo, FNA

Moving Academy of Medicine and Biomedicine, Pune

Adivasis (Schedule Tribes; STs), who are possibly India's oldest inhabitants, constitute 8.6% of the total population numbering 104.28 million (2011 Census). ST population

of Maharashtra, the site of the present study, is about 10 million, which is 9.4% of the state population. Since STs are highly endogamous they may show tribe-specific disease pattern. There are a total of 45 STs recognized by the Government of Maharashstra (GMO). Kokana and Katkaris are the dominant tribes in Nandurbar and Raigad districts respectively in Northern-Western and Southern-Coastal Maharashtra. Last year, we conducted a study on health parameters in Katkari's. Similar studies were conducted this year in the Kokana community.

Total number of 355 (F=191) and 412 (F=219) peoples of Kokana and Karkari communities respectively participated in the two studies. Prevalence is expressed as per 100 individuals in the study populations. The results in the two communities Kokana/Katkaris are as follows: Average age (yr) 37.8/34.4; Undernutrition (BMI <18.5) 37.5/43.2; Systolic hypertension (>140 mm Hg) 12.1/16.8; Diabetes (CBS >126)5.6/7.3. However, the sample is too small and the differences are not significant statistically.

Epidemiology and molecular biology of alpha-thalassemia and sickle cell disease: Anemia (Hb<10 g/dl) is a major health problem in females in both STs. However, as compared to Kokana (prevalence 47.8%) it is much higher in Katakaris (62%). These differences are statistically significant. Prevalence of α thalassemia was much higher in Katkaris and haplotype frequency for deletion -$\alpha^{3.7}$ was 0.9**.** Corresponding figures for Kokana was 0.63. Further studies are required to explain these differences. Sickle cell disease (HbAS) was recorded in 8% people in both tribes. In all cases it was associated with deletion (-$\alpha^{3.7}$) alpha thalassemia; 60% had double gene deletion and the rest single gene deletion. In the former, Hbs was <25 g/dl while in the later it was between 30 and 35 g/dl. In people without comorbidities the HbAS level is around 45%. Comorbidity- simultaneous presence of alpha thalassemia and HbAS- offers some protection for the later. Its mechanism needs further investigations.

Distribution of ABO blood groups in the Kokana tribes is similar to general Indian population. However, the Katkari community showed higher 'B' group compared to the general population. Differences in the blood group and prevalence of alpha thalassemia suggest that the two STs may differ genetically.

Scouting and Nurturing of Science Talent in marginalized communities: Some 175 students participated in our "school science programs" that were held in tribal and village schools. These programs were described in details in the last report. Forty one students 8, 17 and 16 from schools in major cities, rural sector and Adivasi schools respectively participated in the program of **"**Discovering Little Scientists" which is a two-month summer vacation research program for secondary school children. The students worked on community based research topics and made formal presentation of their results at the Research Conference.

The 3rd Research Conference of Little Scientists was held jointly with IISER, Pune in its new campus on 7-8 July 2015. There were a total of 84 registered delegates (41 'little scientists' and 43 others) for the conference. Thirty four "Little scientists" made presentation of the research conducted by them. Also there were lectures by leading Indian scientists and physicians on current topics such as Excitements in Chemistry and Physics, Current status of HIV in India, Lessons from Nature and Ethics in biomedical research.

VP Dimri, FNA
CSIR-National Geophysical Research Institute, Hyderabad

Application of Fractal for Acquisition, Processing and Interpretation (API) for Geophysical Studies

It has been observed that the sources of geophysical anomaly are neither constant nor random. Rather these sources like density, susceptibility, conductivity, reflectivity, etc. follow scaling/fractal distribution. Geophysical investigations strongly rely on Acquisition, Processing, and Interpretation, together known as API. Thus, clear and sound understanding in API becomes an indispensable part of geophysical investigations before coming to any conclusions. All 3 are important and need careful understanding. Geophysical surveys are generally carried out along the existing roads. Such a convenient survey can miss an anomaly of interest. The proper design of survey network during data acquisition can delineate anomaly of interest. Fractal theory has been applied to decide a survey network. Optimum station spacing for enhanced detectability limit of subsurface features based on the fractal dimension of various networks (grids) can be designed according to the dimension of a study area. The detectability limit of a large-scale geophysical survey depends on the fractal dimension of the measuring network and the source of anomaly. The geophysical anomaly resulting from the fractal nature of sources, such as non-random distribution of density and susceptibility, cannot be measured accurately unless its fractal dimension does not exceed the difference of the 2-D Euclidean and fractal dimension of the network. Similarly the second step, data processing for interpolation of missing data is key to reduce spurious anomaly due to aliased/interpolated data. The fractal dimension of measuring network characterizes the data distribution and represents the density of data distribution in the simplest way, unlike other techniques. Using fractal dimension, optimum gridding interval can be obtained, which is used for optimum interpolation interval obeying Shannon's sampling theorem. In seismic data processing deconvolution plays a crucial role to obtain reflectivity sequence. The percentage error involved with recovery of reflectivity series using fractal based scaling deconvolution is less than that compared to the standard deconvolution. Finally the interpretation is main step which depends on the nature of source. A spectral method based on random distribution of source has been

suggested to estimate thickness of sedimentary basins from gravity and magnetic data. Later the concept of fractal distribution was introduced for preliminary interpretation of geophysical data. So, new interpretation methods such as scaling spectral method (SSM) and modified centroid method have been developed to accommodate scaling/ fractal distribution of source for scaling geology. The SSM provides better estimation of depth as compared to conventional spectral method. One of the important advantages of modified centroid method is that it doesn't require any pre-filtering of data. The length of survey is very crucial parameter to detect the anomaly of subsurface body. It has been identified that the survey grid/length is related to the depth of the anomalous source, and hence can be designed properly with fractal approach prior to embark on field. It is also observed that the depths to the bottom of magnetic sources estimated using a modified centroid-depth method adapted for a fractal distribution of magnetic sources gives quite realistic results.

Amit Ghosh, FNA

National Institute of Cholera and Enteric Diseases, Kolkata

Studies on the Genomic Epidemiology of *Vibrio cholerae* O1

In the recent years there is an increasing trend in the emergence of *V. cholerae* O1, the causative agent of the disease cholera, resistant to most drugs commonly used in the treatment of cholera. Multidrug resistance is associated with the presence of mobile and mobilizable genetic elements, such as Integrative and Conjugative elements (ICEs). To date more than 12 types of ICEs belonging to SXT/R391 family have been identified. It is in this context we examined the drug resistance profile and the presence of ICE elements in 349 strains of *V. cholerae* O1 strains isolated from the patients admitted into the Infectious Diseases Hospital, Kolkata between 2008 and 2012 (both years included). It was observed that Streptomycin and co-trimoxazole (tri-methoprim/sulfamethaxazole) resistance were simultaneously present in most of the strains. Since the ICE element SXT is known to confer resistance to these drugs, we examined the strains for the presence of this element by PCR assay with appropriately designed primers. Simillarly, PCR assays were performed to detect the presence of *floR* (chloramphenicol resis-tance), *str*A and *str*B (Streptomycin resistance), *sul*2 (Sulfonamide resistance) and tetracycline resistance genes. From these, 40 representative strains isolated between 2008 and 2012 (eight from each year) were selected for Whole Genome Sequencing.

Whole genome sequencing showed that SXT sequence present in some of these strains were not identical to the SXT sequence available in the NCBI database. Analysis of the sequence revealed the existence of two types SXT elements; The first type, SXT (TET) [henceforth designated SXT-T] carried a tetracycline efflux pump (*tet*A) and the second type called SXT (GEN) [henceforth designated SXT-G] because it is very similar (99 percent similarity) to the ICE *Vch*Ind5 the most common ICE circulating all over the world including India, harbored chloramphenicol efflux pump (*flo*R). In contrast, SXT-T had only 99 percent identity for 70 percent query coverage with respect to the same. However, both SXT-T and SXT-G had *sul*2, *str*BA in the resistance cluster conferring resistance to co-trimoxazole and streptomycin respectively.

Size wise SXT-G was found to be larger than SXT-T (96.7Kb > 91.5 Kb). It was seen that *flo*R gene of SXT-G is replaced by *tet*A in the SXT-T. Besides, in the "backbone" also there was sequence dissimilarity – different ORFs were present between *so*24 and *tra*I in the two SXT elements. Although these two types of ICEs had same *tra*FHG locus an insertion of ORFs encoding transposases and ATPase were found within the *tra*D and *tra*E locus in SXT-T which was absent in SXT-G.

Prevalence of SXT-T decreased from 57.9 per cent in 2008 to 47.5 per cent in 2009 to 9.4 per cent in 2010 to nil. In contrast SXT-G bearing strains were found all through; Frequency of its detection increased from 32.9 per cent in 2008 to 45 per cent in 2009 to 90.5 per cent in 2010. It showed a dip in 2011 to 58.3 percent only to rise to 90.8 percent in 2012. No strain could be detected which had both SXT-G and SXT-T. The reason for this could be that despite the dissimilarities described above, both SXTs shared the same exclusion group (EexR), which precluded the possibility of their co-existance within the same strain.

Kunal Ghosh, FNA

Raman Centre for Applied and Interdisciplinary Sciences, Kolkata

Photochemical Decomposition Losses of Soil Organic Matter

Photochemical decomposition of SOC and HAs in five different soil samples collected from different agroclimatic zones were evaluated after three years of exposure to sunlight. Additionally, field studies were conducted to evaluate the effect of different treatments such as pH, additives and the function of a litter layer in order to be able to suggest remedial measures to reduce SOC oxidative losses. The pattern of decomposition followed a similar trend as in the previous two years. Particularly, there was a remarkable increase in total SOC and HA oxidized in the 3rd year compared to the first two years. Decomposition was generally more than double in the third year compared to the 2nd year. Photodecomposition to smaller molecules occurring initially, causes a rapid oxidation in the subsequent years. Soils with initially higher SOC lost greater amounts of total SOC although in terms of percentage losses these were higher in Alfisols with lower SOC contents. Heating effect of sunlight caused greater SOC and HA losses compared to the effect of light itself. Field studies corroborated results obtained

in the laboratory. The influence of soil pH is significant particularly at pH 9 when SOC oxidation is highest. Lowering of pH by addition of gypsum to the soil reduced SOC oxidation. Oxidation also reduced with the addition of ferrous salt due to SOC stabilization by chelation. The most remarkable reduction is, however, shown by the litter layer treatment. Maintaining a litter layer of leaves appears to provide a viable and effective method of reducing SOC oxidative losses.

PK Gupta, FNA
Department of Genetics and Plant Breeding, CCSU, Meerut

1. Molecular Breeding in Bread Wheat

During 2015-16, Professor PK Gupta (jointly with his colleagues) continued research work in the field of crop biotechnology with following major activities involving hexaploid wheat (*Triticum aestivum*): (i) QTL analysis and association mapping for a number of traits including tolerance against drought and heat. (ii) Study of the genetics of nitrogen and phosphorus use efficiency in wheat with the ultimate objective of developing nutrient use efficient wheat cultivars. (iii) Study of the genetics of nutritional composition of wheat grain. (iv) Study of the genetics of grain size in wheat. (v) Cloning and characterization of genes induced due to leaf rust infection in wheat: gene *Lr28* for seedling resistance and *Lr48* for adult plant resistance (a DBT funded project). (vi) Study of the gene(s) encoding AGPase, a rate-limiting enzyme involved in wheat starch biosynthesis and heat tolerance. (vii) Marker assisted selection (MAS) for a number of traits, including pre-harvest sprouting tolerance (PHST) and grain protein content (GPC); this material will be subjected to field trials, before it is finally released for the farmers. Some of the above activities are reflected in the list of publications.

2. Two ongoing DBT projects

INSA Senior Scientist was also busy throughout the year in the following two DBT projects. (i) "Cloning and characterization of genes induced due to leaf rust infection in wheat: gene *Lr28* for seedling resistance and *Lr48* for adult plant resistance"; (ii) Marker assisted selection (MAS) for a number of traits in wheat, including pre-harvest sprouting tolerance (PHST) and grain protein content (GPC); this material is be subjected to field trials, before it is finally released for the farmers. Some of the material for these projects is growing in the field and is being subjected to recording and analysis of data for achieving the goals of these two projects.

3. USAID project on development of heat tolerant and climate resilient wheat varieties

This is an ongoing collaborative project with Washington State University, in Pullman (USA); activity under this project increased during 2016 in anticipation of BIRAC/ DBT funding. This will involve field work, wet-lab work and travel.

4. Number of papers (published or communicated during 2015-16): 10 papers

5. Recent Books (authored) published: three

6. Lectures delivered: 15

7. Conferences attended: eight

8. Conferences/Workshops organized: two

a. A workshop on "Using R Package for Genetics" at CCSU, Meerut: January 9-10, 2016.
b. A Symposium on "Genomics & Molecular Breeding": March 28-29, 2016.

9. Other academic assignment

a. September 16, 2015 and May 7, 8 2016. Chairman, UPCAR Research Monitoring Committee for SVBPUAT.
b. Screening Committee, NAAS Fellowship (Meeting, September 17-18, 2015).
c. Research Committee (RC) Meetings, CSIR-NBRI, Lucknow, (September 19, 2015; January 2, 2016; April 22, 2016).

KP Joy, FNA
Department of Biotechnology, Cochin University of Science and Technology, Kochi

Cloning and Characterization of Gonadotropin-Releasing Hormone and Kisspeptin Genes/Receptor, and Gnrh-Kisspeptin Control of Reproduction in the Catfish *Heteropneustes fossilis*

The project work was initiated with the work on catfish GnRH. There are two forms of GnRH in catfishes; the group-specific catfish GnRH (GnRH I) and the universal all vertebrate type or chicken- II GnRH (c-II GnRH or catfish GnRH II). GnRH-II was amplified with *Clarias gariepinus* (African catfish) GnRH II-specific gene primers. A 229 bp partial sequence cloned and sequenced from the brain of *H. fossilis* was blasted with *H. fossilis* brain transcriptome cDNA library and a full length cDNA was obtained. The full length sequence is 611 bp long with an ORF of 261 bp, starting from a putative initiation codon at nt 73, a 72 bp 5' untranslated region (UTR), and a 278 bp, 3' UTR. The ORF encodes a putative protein of 86 amino acids. The highest sequence identity of H. fossilis (hf) GnRH II is with the African catfish GnRH II (accession no. X78047; 94%). The nucleotides corresponding to the polyadenylation signal (AATAAA) are also present at 3' UTR. The deduced amino acid sequence of hfGnRH II precursor is composed

of a signal peptide, composed of conserved regions that include 24-25 aa, c-II GnRH sequence of 10 aa and the GnRH-associated peptide (GAP) which is connected to the hormone moiety by a Gly-Lys-Arg (GKR) sequence. In phylogenetic analysis, the hfGnRH II allied with GnRH II of other teleosts in the Ostariophysi subclade, distinct from the Acanthopterygii subclade. HfGNRH II is highly expressed in the brain and moderately expressed in gonads of two sexes with high expression in females. In the brain, the expression is the highest in the hypothalamus, followed by medulla oblongata, the expression being highest in females. Pituitary and telencephalon showed weak expression. In the seasonal study, brain and ovary showed distinct patterns of expression: in the brain the expression is high in the recrudescent phase with the highest fold increase in the preparatory phase. The expression decreased in the spawning phase and reached the lowest level in postspawning phase. In the ovary, the expression increased to the highest level in the spawning phase and declined after spawning. The work on cloning and characterization of GnRH I in the catfish is in progress. The above project work is under preparation for submission to DST for funding.

In addition, the other academic activities undertaken were corrections of Ph.D thesis of 4 students and submissions to Banaras Hindu University, handling of manuscripts as Associate Editor of Fish Physiology and Biochemistry Journal (Springer), review of manuscripts for various journals, teaching of M.Sc. Biotechnology students (one unit of Molecular Neurobiology). I was invited to deliver a plenary lecture (CEIP2015), Department of Zoology, University of Kerala, Thiruvanathapuram, August 2015. I was associated with organizing the annual meeting and symposium of Society of Biotechnologists (India), December 2015.

SN Kaul, FNA

School of Physics, University of Hyderabad, Hyderabad

Magnetism at Nanometer Length Scale

In nanocrystalline Gd, besides a major contribution to residual resistivity, RR, arising from the scattering of conduction electrons from grain surfaces/interfaces/boundaries, coherent electron-magnon scattering makes a small contribution to RR, which gets progressively suppressed as the applied magnetic field (H) increases in strength. As a function of temperature, (negative) magnetoresistance (MR) goes through a dip at a temperature $T_{min} = T^*$, which increases with H as $H^{2/3}$. At $T = T_{min}$, MR increases with H and attains as large values as 17 % at H = 90 kOe (nearly five times greater than in crystalline Gd). This unusually large MR is shown to result from an anomalous softening of spin-wave modes at $T = T_{min}$, which, in turn, marks the onset of the Bose-Einstein condensation of magnons. Contrasted with crystalline Gd, which behaves as a three-dimensional (3D) pure uniaxial dipolar ferromagnet in the asymptotic critical region, nanocrystalline Gd exhibits a critical behavior akin to a 3D random uniaxial dipolar ferromagnet.

Weak itinerant-electron ferromagnet Ni3Al is driven to magnetic instability (quantum critical point, QCP, where the long range ferromagnetic order of the bulk ceases to exist) by reducing the average crystallite size to d = 50 nm. 'Zero-field' (H = 0) linear and nonlinear ac-susceptibilities, measured on Ni_3Al nanoparticle aggregates, with d = 50 nm (S_1) and d = 5 nm (S_2), provide strong evidence for two spin glass (SG)-like thermodynamic phase transitions: one at $Ti(H=0) \simeq 30$ K ($Ti^{\sharp}(H=0) \simeq 230$ K) and the other at a lower temperature $Tp(H=0) \simeq 8$ K ($T_h(H=0) \simeq 52$ K) in $S_1(S_2)$. The thermodynamic nature of these transitions is preserved in finite fields. Based on a detailed comparison of the presently determined H–T phase diagrams for the samples S_1 and S_2 with those predicted by the Kotliar–Sompolinsky and Gabay–Toulouse mean-field models and Monte Carlo simulations, based on the chirality-driven spin glass (SG) ordering scenario, for a three-dimensional nearest-neighbor Heisenberg SG system with or without weak random anisotropy, we unambiguously identify various 'zero-field' and 'in-field' SG phase transitions as: (i) the simultaneous paramagnetic (PM) – chiral glass (CG) and PM-SG phase transitions at $Ti(H)$, (ii) the PM-CG transition at $Ti^{\sharp}(H)$, (iii) the replica symmetry-breaking SG transition at $Tp(H)$, and (iv) the continuous spin-rotation symmetry-breaking SG transition at $T_h(H)$. In the presence of random anisotropy, magnetization fails to saturate even at 90 kOe in S_1 whereas negligibly small anisotropy allows even fields as weak as 1 kOe to saturate magnetization and induce ferromagnetism in S_2. Due to the proximity to CG/SG-QCP, magnetization and susceptibility both exhibit non-Fermi liquid behavior over a wide range at low temperatures.

Dynamic magnetic response of $Cr_{70}Fe_{30}$ thin films with thickness in the range 11 nm $\leq t \leq$ 978 nm and composition above the critical concentration for ferromagnetism reveals that the asymptotic critical behavior of the films with $t \geq 21$ nm is that of a three-dimensional (3D) isotropic dipolar ferromagnet. Interplay between long range dipole-dipole and short-range exchange interactions causes a crossover to the 3D isotropic Heisenberg critical behavior when the temperature is increased above the Curie temperature, TC, outside the asymptotic critical region (ACR). By contrast, in the ACR, the film with t = 11 nm behaves as a 3D Ising ferromagnet. TC decreases with film thickness in accordance with the finite-size scaling with the value for the spin-spin correlation length exponent that corresponds to the 3D isotropic dipolar universality class. In the films with $t \leq 42$ nm, besides the macroscopic length scale of the ferromagnetic order in the static limit, there exists a length scale that corresponds to finite spin clusters, whose dynamics is spin glass like.

Publications:

Mathew SP and Kaul SN, Bose-Einstein condensation of magnons in nanocrystalline gadolinium. *J. Phys.: Condens. Matter*, **27** (2015) 056003.

Kaul SN and Meesala Umasankar, Chirality-driven intrinsic spin-glass ordering, field-induced ferromagnetism and non-Fermi liquid behavior of magnetization near the quantum critical point in Ni_3Al nanoparticle aggregates. *J. Magn. Magn. Mater.,* **401** (2016) 539.

Bandapelli Ravi Kumar and Kaul SN, Magnetic order-disorder phase transition in $Cr_{70}Fe_{30}$ thin films. *J. Alloys & Compounds,* **652** (2015) 479.

G Krishnamoorthy, FNA

Department of Biotechnology, Anna University, Chennai

Dynamics of Proteins and DNA Protein Complexes Using Time-Resolved Fluorescence

The influence of molecular crowding on the structure and dynamics of biomolecules was studied in a small protein, barstar as a model system. Polyethylene glycol of av. Mo. Wt. 8000 was used as a crowding agent. Intramolecular distance and distance distributions in the protein was monitored by time-resolved Forster Resonance Energy Transfer. Motional dynamics was monitored by time-resolved fluorescence anisotropy. The results showed that molecular crowding caused compaction of the unfolded protein, reduction in the width of intramolecular distance distribution and dampening of motional dynamics of several partially buried side-chains. This work was published as below:

Mondal S, Kallianpur MV, Udgaonkar JB and Krishnamoorthy G, Molecular Crowding Causes Narrowing of Population Heterogeneity and restricts motional dynamics in a protein. *Methods and Applications of Fluorescence*, **4** (2016) 014003.

Jnanadeva Maharana, FNA

Institute of Physics, Bhubaneswar

Analyticity Properties and Asymptotic Behavior of Scattering Amplitude in Higher Dimensional Theories

The high energy scattering processes of massive, nutral and spinless particles in higher dimensional field theories are investigated. The axiomatic formulation of Lehmann, Symanzik and Zimmermann is adopted. It is argued that the amplitudes are tempered distributions. The analyticity properties of causal, retarded and advanced functions associated with the four point amplitudes are studied. First, the analog of Lehmann-Jost-Dyson theorem is generalized to higher spacetime dimensions. The generalized J-L-D theorem is utilized to derive an extension of the domain of analyticity of the scattering amplitude which is a generalization of the Lehmann ellpses. Then a fixed-t dispersion relation can be written down for the amplitude with at most finite number of subtractions. The consequences unitarity will to derive an enlarged domain of analyticity in s and t variables.

Ganapathy Marimuthu, FNA

School of Biological Sciences, Madurai Kamaraj University, Madurai

A Survey on the Day Roosts of the Indian Flying Fox *Pteropus giganteus*

The Indian flying fox is one of the largest fruit bats in the world. It is distributed throughout the Indian subcontinent. Its body weight is around 1 kg and the wingspan is a little more than 1 m. It feeds upon fruits such as mango, papaya, grapes, guava, figs, sapota, etc. It roosts in the branches of trees such as banyan, Ashoka, eucalyptus, tamarind, etc. Its lives in colonies ranged from 100s to 1000s of individuals. The individuals are exposed themselves to direct sunlight. It is a flying mammal, copulates during October/November and gives birth to a single baby during March/April. The infants attached themselves to the ventral part of their mothers even when the latter flying. After attaining about a month old the mothers prefer to leave their babies in the trees nearer to their foraging grounds and join with them intermittently over the nights. It plays an important role in pollination and seed dispersal.

We made a survey to locate the day roost of the Indian flying fox and one of the largest fruit bats in the world, *Pteropus giganteus.* We identified a total of 382 day roost trees in 63 places in various regions of southern Tamil Nadu. Roosts were found in large and well established trees. Twenty one roost trees belonging to 14 families were identified. Colonies of *P. giganteus* occupied trees of families such as Combretaceae (*Terminalia arjuna*, n=80), Moraceae (*Ficus* species, n=65), Annonaceae (*Polyalthia longifolia*, n=56), Caesalpiniaceae (*Tamarindus indica*, n=51), Arecaceae (*Borassus flabellifer* and *Cocos nucifera*, n=48) and Sapotaceae (*Bassia latifolia*, n=32). In addition, trees belonging to Myrtaceae, Anacardiaceae, Meliaceae, Fabaceae, Rutaceae, Verbenaceae, Bombacaceae and Bignoniaceae are also used as day roost in low numbers. A total of 356 trees were observed as the nearby trees to the roost trees. Examples for such nearby trees are *Artocarpus heterophyllus* (Moraceae), *Areca catechu* (Arecaceae), *Morinda tinctoria* (Rubiaceae), *Musa paradisiaca* (Musaceae) and *Prosopis juliflora* (Fabaceae). Among the 21 roost tree species 19 tree species were also observed as nearby trees. The colony size of *P. giganteus* ranged from 25 to more than 5000 individuals. In two places (South Athoor and Edaiyamelur) more than 5000 individuals had occupied single *F. benghalensis* trees. A pond was found adjacent to the trees, in both places.

ML Munjal, FNA

Department of Mechanical Engineering, Indian Institute of Science, Bengaluru

1. Technical Acoustics; Acoustics of Ducts and Mufflers

Objectives: Flow-Acoustic Analysis and Design of Complex Muffler Configurations

Achievements:

1. Flow-Acoustic Analysis of the Perforated-Baffle Three-Chamber Hybrid Muffler Configuration

Presence of perforated baffles necessitates use of the Integrated Transfer Matrix (ITM) approach for the one-dimensional analysis because the sound fields in the adjacent chambers would be multiply coupled with each other. The mean flow distribution in each of these configurations has been evaluated by means of a lumped flow resistance network. The resulting values of the grazing flow and bias flow have been used to calculate the perforates' acoustic impedance. TL calculated with the help of the 1D analysis shows good agreement with the simulated results from the 3D FEA. Apart from the three-chamber U-bend hybrid muffler, three additional configurations have been analyzed, and the effects of the absorptive material, porosity of the baffle plates, porosity of the perforated pipes, and the length of perforation of the perforated pipes have been studied. Based on the above studies, design guidelines have been developed for these types of muffler configurations in order to improve their performance.

2. Pressure Drop Characteristics of Perforated Pipes with Particular Application to the Concentric Tube Resonator

The bias flow in the Concentric Tube Resonator (CTR) is a flow-induced phenomenon in which the pressure gradient along the radial direction is produced by the kinetic energy of the flow. As a result, the flow dynamics in CTR is characterized by bias flow into the annular cavity in the upstream and outflow from the annular cavity in the downstream of the flow. This is due to the change in direction of the radial component of the bias flow at a point called the point of recovery, as a consequence of mass conservation. The pressure drop of CTR is a complex function of the momentum flux and other geometric parameters such as porosity, open area ratio, discharge coefficient of the perforated holes, bias inflow, bias outflow, grazing flow and length. In this study, numerical experiments are conducted to obtain an empirical formula for the friction factor of perforated pipes which are extensively used in automotive mufflers. The finite element based numerical results are validated with test results reported in the literature and are found to be in good agreement.

3. Design and Analysis of a Novel Muffler for Wide-Band Transmission Loss Low Back Pressure and Reduced Flow-Induced Noise

Three-pass double-reversal muffler is often used in automotive exhaust systems. This muffler is characterized by a fairly wideband transmission loss (TL) curve as well as relatively low back pressure. However in the flow-reversal end chambers, it produces a lot of aerodynamic noise due to impingement of jets on the end plates, generation of free shear layer and vortex shedding. This investigation deals with the design and analysis of the muffler with a novel feature (tubular bridges in the end-chambers) specially configured to minimize the free shear layer in the end chambers of the three-pass double-reversal muffler as well as to provide adequate acoustic transmission loss and to further reduce the back pressure of the muffler. The TL curve predicted by means of the 1-D integrated transfer matrix (ITM) approach is validated against the 3-D FEM and compared with that of the base muffler (without tubular bridges). Back pressure of the configuration with tubular bridges, estimated by means of the lumped flow-resistance network, is shown to be considerably less than that of the base muffler.

4. Teaching

I offered a regular course 'Noise and Vibration Control' during the August-December semester of 2015 to the graduate students of Department of Mechanical Engineering, IISc.

5. Continuing Education

I offered a series of lectures (spread over 12 Saturdays) on 'Acoustics of Ducts and Mufflers' to a group of scientists from Gas Turbine Research Establishment, with application to control of screech in the afterburner.

Govindarajan Padmanaban, FNA

Department of Biochemistry, Indian Institute of Science, Bengaluru

Role of Heme in Malaria Parasite Biology and Mechanism of Antimalarial Action of Curcumin: Clinical Trial with Artesunate Combination in Malaria Patients

Research was carried out in the area of malaria parasite biology with a view to identify new drug targets and also assess the anti-malarial property of curcumin from the spice turmeric. In the first project, the parasite heme-biosynthetic pathway (discovered in this laboratory) was found to be essential for the growth of the parasite (*P. berghei*) in the mosquito and fresh infection in mouse liver. This was shown by making gene knock outs of two genes of the heme-biosynthetic pathway, namely PbALAS KO (δ-aminolevulinate synthase knock out) and PbFCKO (ferrochelatse knock out). These mutated parasites

could not grow in the mosquito or infect liver. However, PbALASKO could be rescued by providing ALA to the mosquito. On this basis PbALASKO sporozoites have been found to protect mice against fresh infection, indicating its potential as a genetically attenuated vaccine. We have also found that asparagine is essential for parasite growth in the mosquito. This was on the basis of the behavior of PbASKO (aspargaine synthetase knock-out) and use of asparaginase to deplete host asparagine. Thus, these two pathways have provided ideal drug targets in the transmission stages. There is now global emphasis on strategies to block parasite transmission, which is crucial for eradication of malaria.

In the second project, curcumin (C) from turmeric was shown to prevent parasite recrudescence in mice. 5-10% 0f malaria patients undergoing drug treatment return with complications due to parasite recrudescence. A parasite recrudescence model was developed in mice by giving a sub-optimal dose of α,β-arteether (AE)to *P berghei*-infected mice. However, if three oral doses of curcumin were given along with AE (AC), recrudescence was completely prevented. The potency of curcumin was also tested in the Experimental Cerebral Malaria (ECM) model in mice, since mortality in cerebral malaria patients is as high as 25%, even with the artemisinin-derivative treatment. The studies showed that curcumin alone can prevent neurological symptoms in ECM and the combination AC therapy can completely cure and give 100% protection against mortality in mice. On the basis of these results, a clinical trial is about to be initiated with four other partners to assess the efficacy of curcumin as an adjunct drug in the treatment of uncomplicated and cerebral malaria. The trials are planned in Rourkela and Chattisgarh. DCGI approval is awaited.

In addition, several lectures (around 30) were given in different institutions and articles written in popular journals, including newspapers. The subjects included: Malaria, Growth of Biotechnology, GM Crops, Synthetic Biology. There were 6 research-based publications in international journals and 10 popular write ups. List of publications is provided under Annexure 1. In addition, contributions were made as Chairman and member of several technical committees and Research Councils of various institutions.

Research Publications:

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Padmanaban G and Bhargava Pushpa, Alberts Moderator Bruce, Science Debate: Scientists clash swords over future of GM foods in India. *Science*, **340** (2013) 539-540.

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Padmanaban G, Innovation- Which Way? (Guest Editorial). *Curr. Sci.*, **109** (2015) 1759-1760.

Aswath CR, Krishnaraj PU and Padmanaban G, Why India Needs Biotechnology to Ensure Food and Nutrition Security? in Genetically Modified Organisms in Food; Production, Safety, Regulation and Public Health (Eds Watson RR and Preedy VR), (2015) Academic Press.

Mallayan Palaniandavar, FNA

Department of Chemistry, Bharathidasan University, Tiruchirapalli

Synthesis, Structures, and Study of Interaction with DNA and Proteins and Cytotoxicity

Chemotherapy is one of the most effective treatments for patients with cancer. The covalently DNA binding chemotherapeutic agents like the currently used cisplatin possess inherent limitations such as side effects and low administration dosage. Therefore, the research project proposed by the INSA Senior Scientist involves the design of non-covalent DNA binding copper(II) and ruthenium(II)-based anticancer drugs and their

characterization and study on cytotoxicity towards cancer cell lines. His work focuses mainly on the design of DNA- and protein-targeted mixed ligand copper(II) complexes of various primary ligands including antibacterial drug molecules, with prominent anticancer activities. He continued to integrate results from his previous studies on many copper(II) and ruthenium(II) complexes and submit manuscripts after taking up INSA Senior Scientist position at Bharathidasan University. Also, he has now collaborated with Dr M Velusamy, NEHU and written a ms on Ru(II)-arene complexes, which is to be submitted shortly.

Publications:

Loganathan R, Ganeshpandian M, Bhuvanesh NSP, Palaniandavar M, Amsaveni M, Ghosh SK, Riyasdeen A and Akbarsha MA, DNA and Protein Binding, Double-strand DNA Cleavage and Cytotoxicity of Mixed Ligand Copper(II) Complexes of the Antibacterial Drug Nalidixic Acid. (Under Preparation).

Khamrang T, Velusamy M, Palaniandavar M, Rajendiran V and Karthikeyan, Synthesis, Structures, and DNA and Protein Binding of Ruthenium(II)-Cymene Complexes of Substituted Pyridylimidazo[1,5-*a*]pyridine: Enhanced Cytotoxicity of a Complex with Ligand-appended Phenothiazine a Prototypical Pharmaceutical Lead Molecule. (To be communicated).

Balamurugan M, Suresh E, Palaniandavar M, μ-Oxo- and Bis(μ-carboxylato)-bridged Diiron(III) Complexes of a 3N Ligand as Catalysts for Alkane Hydroxylation: Steroelectronic Factors of Carboxylate Bridge Determine the Catalytic Efficiency. *Dalton Transactions*, (Accepted), Ms ID: DT-ART-03-2016-001059.R.

VK Parnaik, FNA

CSIR-Centre for Cellular and Molecular Biology, Hyderabad

Characterization of Ubiquitin Ligases that are Upregulated in Laminopathic Cells

Lamins are major architectural proteins of the nuclear lamina and are important determinants of nuclear organisation and function in animal cells. Mutations in lamins are associated with several degenerative diseases which are collectively termed as laminopathies. Expression of laminopathic mutations in cells leads to abnormal nuclear morphology and defects in chromatin organisation, DNA replication and repair as well as cell cycle progression. We have recently proposed the novel hypothesis that the aberrant assembly of the lamina upon lamin misexpression causes the disruption of normal interactions between lamins and key chromatin proteins or lamin-binding proteins, leading to release of bound proteins that are subsequently targeted for degradation by their cognate ubiquitin ligases, with deleterious effects on cellular functions. We have earlier shown that laminopathic mutations can induce ubiquitin-mediated proteasomal degradation of heterochromatin protein 1 isoforms as well as the key DNA damage sensor ATR kinase by upregulation of specific E3 ubiquitin ligase components, namely, the monomeric RING ligase RNF123, the HECT ligase HECW2 and the substrate adaptor for a multimeric RING ligase FBXW10.

In this project, we are interested in identifying additional substrates for these ligases as this will give important insights into the effects of targeted ubiquitin-mediated protein degradation on cellular functions in laminopathic cells. Our current studies are focused on HECW2 ligase. Proliferating cell nuclear antigen (PCNA), a processivity factor for DNA polymerase δ, which is essential for elongation phase of replication, was identified as a potential substrate for HECW2 in a proteomics screen reported previously. Lamins have been shown to bind to PCNA and lamin disruption causes PCNA aggregation. We have observed that expression of laminopathic mutants in cells causes proteasomal degradation of PCNA mediated by HECW2. We have found by co-immunoprecipitation studies that HECW2 interacts with PCNA. Ectopic expression of HECW2 results in ubiquitination and degradation of PCNA which is restored upon treatment with proteasomal inhibitors or downregulation of HECW2. HECW2 overexpression causes stalling of cells in S phase of cell cycle, leading to slower growth rate of cells, which might be mediated by reduction of PCNA levels. Hence we have identified PCNA, an important DNA replication protein as a substrate for HECW2 ligase.

LM Patnaik, FNA

National Institute of Advanced Studies, Bengaluru

Studies in Machine Cognition via Simulation of Conscious Agents

Testing for consciousness is a very hard problem. With recent research interest in machine consciousness gaining importance, in this research work it is envisaged to develop methodologies and functional criteria those can be used to assess the level of consciousness of an artificial agent.

A machine is said to be conscious if it possesses abilities for perception, action, learning, and associative memory; it has a central executive that controls all the processes of the machine. The central executive is driven by the machine's motivation and goal selection, attention switching, and uses cognitive perception and cognitive understanding of motivations, thoughts, or plans to control learning, attention, motivations, and monitor actions.

Initially it is proposed to develop a computational model to integrate the functionalities of biological systems in a virtual machine. The aim is to take clues from biological systems to model consciousness and realize it in machines. The functional organization of conscious processing of biological systems is being studied in detail. The model attempts to extend the features of sensory-motor, episodic memory and learning and central executive.

In human beings, consciousness corresponds to a collection of different features of human cognition.

We are interested in understanding, and if possible in replicating them in agents. There are two paradigms in Artificial Intelligence which have emerged in the context of consciousness.

1. Weak Artificial Consciousness: design and construction of a machine that simulates consciousness or cognitive processes usually correlated with consciousness.
2. Strong Artificial Consciousness: design and construction of conscious machines.

AI has long avoided addressing consciousness in agents. Yet consciousness corresponds to many aspects of human cognition which are essential for our cognitive capabilities such as learning, attention, autonomy etc.

The motivation of this research work is to develop computational models of consciousness that can be used to design conscious intelligent machines. Work is directed towards development of computational models of intelligence, and related modeling requirements for consciousness that may become a foundation of building computational models of conscious machines. In recent times, there has been lot of interest in simulating consciousness, where the aim is to capture some aspect of the neural/behavioural/ cognitive features of consciousness in a computational model, as in using computers to simulate other physical processes.

The research work is directed towards using various software tools to simulate consciousness and to test the simulator on simple tasks to see if an agent can behave consciously. We need to lay down some essential properties that should be considered when designing machines that could be said to be conscious. This may lead to the proposing of a set of axioms which define a minimal set of necessary material conditions for cognitive mechanisms to support consciousness in an agent.

Accurate testing for consciousness is still an unsolved problem when applied to humans and other mammals. Alternate strategies based on neurobiological studies are being developed to determine the level of consciousness of biological organisms. Such methods cannot be directly applied to artificial systems. We attempt to adopt an alternate approach of proposing some functional criteria those can be used to assess the level of consciousness of an artificial agent.

BC Ranu, FNA

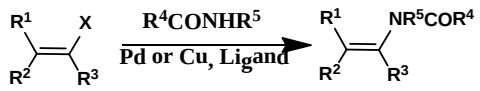
Department of Organic Chemistry, Indian Association for the Cultivation of Science, Kolkata

Supported Metal and Metal Nanoparticles as Green Catalyst

a. Nickel-Copper Catalyzed C(sp^2)-N Cross Coupling of Cyclic and Bridged Amides: An Access to Cyclic Enamides and Alkenyl Vince Lactams

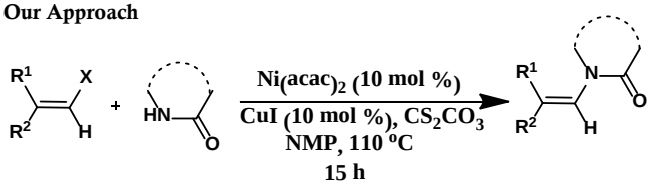
Enamides are of much importance as they constitute the key structural motifs in many natural products and are used as versatile synthetic intermediates. However, to our knowledge, metal catalyzed alkenylation of bridged amide by coupling reaction is not reported so far. Considering the importance of enamides and functionalized Vince lactams we sought to develop a more convenient protocol for alkenylation of bridged amides using a less expensive metal and avoiding a ligand. Being motivated with our recent works on carbon-carbon and carbon-heteroatom bond formation using Ni/Cu system we report here a Ni-catalyzed C(sp^2)-N cross coupling of styrenyl/vinyl halides with bridged and cyclic amides in the presence of CuI.

Previous Report



X = OTf, Br, I

Our Approach



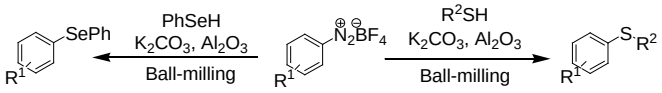
A series of alkenyl derivatives of Vince lactams (bridged amide) and cyclic amides are obtained by this procedure. Halogen containing styrenyl bromides also underwent coupling with amides to provide the products. The coupling is highly chemoselective as during the reactions the halogens (Br, Cl, F) on the aromatic ring remained intact and these can be used for further functionalization to make these enamides more useful. Although the (*E*)-styrenyl halides produced the corresponding (*E*)-styrenyl enamides, reaction with (*Z*)-styrenyl halides produced 1,3-di-ynes instead of (Z)-styrenyl enamides. This may be explained by the possibility of *E2* type elimination of (*Z*)-styrenyl halides in the presence of a strong base like Cs_2CO_3 followed by homocoupling. This catalyst system works efficiently for the N-arylation too along with N-styrenylation and vinylation. The bridged as well as cyclic amide successfully coupled with substituted aryl halides to provide the corresponding products. In general, the reactions are clean and high yielding. The operations are very simple and the products are obtained pure by standard column chromatography. The reaction is compatible with variety of amides and alkenyl bromides.

The role of nickel acetonyl acetonate and copper(I) iodide in this reaction have been established and a possible reaction pathway has been outlined.

The significant feature of this protocol is alkenylation of Vince lactams *via* C(sp^2)-N cross coupling, which is not reported so far and these products are of much potential in pharmaceutical industry.

b. First Transition metal- and solvent-free synthesis of unsymmetrical diaryl sulfides and selenides under ball-milling

The organic chalcogenides have useful applications in organic synthesis as intermediates and catalysts. Hence there has been an obvious interest towards the development of synthetic methodologies for the synthesis of these compounds. We report here an alternative method for the synthesis of unsymmetrical diaryl sulfides and selenides by the reaction of aryl tetrafluoroborate with thiol and selenol on alumina surface in presence of a base under ball milling.



Both electron donating and electron withdrawing group substituted aryl diazonium fluoroborates reacted smoothly with a variety of thiols and the functional groups remained inert under the reaction conditions. Moreover, diversely substituted thiophenols also underwent reactions without any difficulty. Significantly, sterically hindered thiophenol, 2,6-dimethylthiophenol reacted cleanly with 4-cyanobenzene and 2-bromobenzene diazonium tetrafluoroborate to produce the corresponding products. 2-Mercaptopyridine also participated in this reaction to produce the corresponding aryl heteroaryl sulfide. Aliphatic thiols, octadecanethiol and benzyl mercaptan were successfully converted to the corresponding aryl-alkyl sulfides. A wide variety of diversely substituted aryldiazonium fluoroborates underwent reactions with phenylselenol under similar reaction conditions to produce the corresponding unsymmetrical aryl phenyl selenides.

The notable advantages of this procedure are high yield and high purity of products, short reaction time (5-8 min.), recyclability of grinding auxiliary, no use of transition metal, catalyst and solvent. We believe that this will make an useful addition to the existing methods for the synthesis of sulfides and selenides.

c. Ascorbic Acid Promoted Oxidative Arylation of Vinyl Arenes to 2-Aryl Acetophenones without Irradiation at Room Temperature under Aerobic Conditions

The ease of generation of aryl radicals from arene diazonium salts under visible light photo catalysis in presence of eosin Y or $[Ru(bpy)_3]Cl_2$ has offered a powerful tool for arylation of various substrates leading to the synthesis of a wide variety of useful organic molecules. We report here a metal free oxidative arylation of vinyl arenes by aryl radical generated in situ from aryl diazonium fluoroborate promoted by ascorbic acid at room temperature without any irradiation leading to the synthesis of 2-aryl acetophenones. 2-Aryl acetophenones are versatile synthons, used as a common precursor for the synthesis of a large variety of organic molecules such as heterocycles (quinoxaline, furan, imidazole[1]), terminal alkenes, α-hydroxy ketones, 1,2-diketones, ketones, and aryl-substituted 2-aryl acetophenones.

Publications:

Mukherjee N, Chatterjee T, Ranu BC, First Application of Heterogeneous Cobalt Catalysis in C_{sp2}-N Cross Coupling of Activated Chloroarenes under Ligand-Free Conditions. *Eur. J. Org. Chem.*, (2015) 4018.

Kundu D, Tripathy M, Maity P and Ranu BC, Cobalt Catalyzed Intermolecular C(sp^2)-O Cross-Coupling. *Chem-Euro J.*, **21** (2015) 8727.

Maity P, Kundu D, Ranu BC, Visible Light Photocatalyzed Metal Free C-H Heteroarylation of Heteroarenes at Room Temperature: A Sustainable Synthesis of Biheteroaryls. *Eur. J. Org. Chem.*, (2015) 1727.

Maity P, Kundu D, Ranu BC, Nickel-Copper Catalyzed C(sp2)-N Cross Coupling of Cyclic and Bridged Amides: An Access to Cyclic Enamides and Alkenyl Vince Lactams. *Adv. Synth. Catal.*, **357** (2015) 3617.

Mukherjee N, Chatterjee T, Ranu BC, Transition Metal- and Solvent-free Synthesis of Unsymmetrical Diaryl Sulfides and Selenides under Ball-milling. *ARKIVOC*, (2016) (II) 53.

Majhi B, Kundu D, Ranu BC, Ascorbic Acid Promoted Oxidative Arylation of Vinyl Arenes to 2-Aryl Acetophenones without Irradiation at Room Temperature under Aerobic Conditions. *J. Org. Chem.*, **80** (2015) 7739.

Annexure-II

An efficient C(sp^2)-N cross coupling of styrenyl- and vinyl halides with cyclic and bridged amides catalyzed by nickel acetonyl acetonate $[Ni(acac)_2]$ and copper(I) iodide (CuI) in the absence of any ligand has been developed. A series of alkenyl derivatives of Vince lactams (bridged amide) and cyclic amides are obtained by this procedure.

A transition metal- and solvent-free procedure for the reaction of aryl diazonium tetraflouroborates and thiols or selenols over alumina surface under ball-milling at ambient temperature, has been developed for the synthesis of unsymmetrical diaryl or aryl-alkyl sulfides and selenides. A wide range of functionalized diaryl or aryl-alkyl sulfides and selenides were obtained in high yields and high purity.

A convenient and general protocol for oxidative arylation of vinyl arenes by aryl radicals generated in situ from arene diazonium fluoroborates promoted by ascorbic acid in air at room temperature has been developed in absence of any additive and visible light irradiation. A series of diversely substituted 2-aryl acetophenones have been obtained in good yields by this procedure.

Annexure-III

New applications of Ni/Cu and Co/Cu for C(sp^2)-P Cross Coupling will be investigated. These reactions are challenging and useful in organic synthesis. The synthesis of useful precursors by application of these protocols will be undertaken.

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Signalling Pathways Involved in Regulation of SLPI Gene Expression in Bewo Choriocarcinoma Cells and Rat Uterine Epithelial Cells

Over the last two decades we have been trying to understand the complex process of cellular differentiation using cells from endocrine organs like placenta, Leydig cells and Sertoli cells as model systems. As part of this study, we have made an attempt to elucidate the changes in the gene expression during differentiation of human placental cytotrophoblasts into syncytiotrophoblasts by DD-RT-PCR and microarray analysis. One of the most important observations of these studies was the highly significant up-regulation of expression of secretory leukocyte protease inhibitor (SLPI) in the differentiated syncytiotrophoblasts cells. Results of studies on hormonal regulation of SLPI in human BeWo cells and rat clearly indicated that while in the BeWo cells it is regulated by Progesterone, it is regulated by estradiol 17-β in the case of rat. But considering the degree of induction of SLPI by P4, it was very surprising that we were not able to find PR binding site on the SLPI promoter or ER receptor or the transcriptional enhancers of ER in the rat SLPI gene promoter also. This information along with the fact that SLPI is up-regulated as early as 3 hours post incubation of BeWo cells with progesterone prompted us to search for alternative signalling mechanisms. We have found that, Staurosporine a known inhibitor of Protein kinaseC, inhibited the up-regulation of SLPI induction in BeWo cells in Progesterone and Forskolin induced differentiation of BeWo cells. Protein kinase C inhibitor could also inhibit that differentiation of BeWo cells as well as SLPI expression. This brings out the importance of protein kinases in Progesterone induced up regulation of SLPI. Another proof for this is that estradiol induced up regulation of SLPI in rat uterine epithelial cells is also inhibited by Staurosporine which emphasizes the non-genomic role of steroid hormones in regulation of SLPI gene expression. The importance of protein kinase A and protein tyrosine is also demonstrated by use of inhibitors H-89 and genistein, which inhibited the Progesterone induced up-regulation of SLPI in BeWo cells. It is known that these protein kinase pathways converge to MAP kinase. We have also found that MAP kinase activation within minutes of progesterone treatment and inhibition of MAP kinase activity when protein kinases are inactivated in BeWo cells. This establishes the role of non–genomic action of progesterone in BeWo cells in inducing SLPI gene expression SLPI is a highly conserved gene and organization of its nucleotide and amino acid sequence is reasonably well conserved. SLPI is a ubiquitously expressed molecule in a variety of tissues. It is highly up-regulated in several cancers and its up-regulation is correlated with poor prognosis. The results of our studies indicate that there appears to be involvement of a non-nuclear mode of action of hormone in regulation of expression of SLPI which will aid in the use of steroid hormone receptor antagonists in treating some cancers.

Probir Roy, FNA
Bose Institute, Kolkata

Studies beyond the Standard Model

A summary of the research done under this project follows.
Investigations of a Nonthermal Two-Component Dark Matter Model
(Collaborators: Anirban Biswas and Debasish Majumdar of Saha Institute)

1. Model for FermiLAT gamma excess and 3.55 keV X-ray line

A two-component model of nonthermal Dark Matter is formulated to simultaneously explain the gamma excess in the 1 - 3 GeV energy range from our galactic Centre observed by FermiLAT and the detection of an X-ray line at 3.55 keV from extragalactic sources by the XMM Newton observatory. Two additional Standard Model singlet scalars are introduced into the Higgs portal and all scalar interactions are controlled by a discrete Z_2 x Z_2 symmetry broken softly into a remnant Z_2 symmetry; the latter undergoes a spontaneous breakdown through a vacuum expectation value of order MeV. Apart from the Standard Model Higgs, two other physical scalars are predicted: a light warm DM candidate with a mass of 7.1 keV and a WIMP with a mass between 50 and 80 GeV. Both sets of data can now be successfully explained and any problem due to possible domain wall formation is shown to be avoidable.
Resulting publication: *Jour. High Energy Physics*, **1504** (2015) 055

2. Model for dwarf galaxy gamma excess and 3.55 keV X-ray line

Recent data from the dwarf galaxy Reticulum II have required the energy range of the gamma excess observed from the Galactic Centre to be 2-10 GeV. The parameters of our nonthermal Dark Matter model are adjusted to accommodate this. The heavier of our two Higgs scalars now needs to have a mass ~250 GeV while the lighter one remains at 7.1 keV. A new seed mechanism is now required for the gamma excess and new Boltzmann equations for the DM relic density are called for. All concerned data can now be fitted and consistency with other indirect limits attained.

Publication
Resulting publication: *Europhys. Lett.*, **113 (2)** (2016) 29001.

3. Extended scaling and residual flavor symmetry in the neutrino Majorana mass matrix

(Collaborators: Rome Samanta and Ambar Ghosal of Saha Institute)

The residual symmetry approach, along with a complex extension for some flavor invariance, is a powerful tool to uncover the flavour structure of the 3x3 neutrino Majorana mass matrix Mv towards gaining insights into neutrino mixing. We utilize this to propose a complex extension of the real scaling ansatz for M_v which was introduced some years ago. Unlike the latter, our proposal allows a nonzero mass for each of the three eight neutrinos as well as a nonvanishing θ_{13} plus a normal mass ordering. Dirac CP-violation must be maximal while atmospheric neutrino mixing need not be exactly maximal. Moreover, each of the two allowed Majorana phases has to be at one of its two CP-conserving values. Our predictions will be tested in ongoing and forthcoming neutrino oscillation experiments at T2K, NOvA and DUNE.
(arXiv: 1604.0673 [hep-ph])

In addition, I have given the following scientific lecture course/lectures during 2015 -16:

DATE	INSTITUTIONS	TITLE
13/10/2015	AAPCOS International Conference, Saha Institute	Dark Energy of the Universe
13/12/2015	WHEPP XIV Workshop, IIT, Kanpur	Complex Extension of Mu-Tau Ex-change Symmetry
18/2/2016	Science Club, IISER, Pune	Dark Energy of the Universe
18/3/2016	Talk at NuHoRIzon VI Conference, Harish Chandra Research Institute, Allahabad	Complex Scaling in the Neutrino Mass Matrix

SM Roy, FNA

Tata Institute of Fundamental Research, Mumbai

Quantum Foundations, Quantum Information Processing and High Energy Theorems

Overview: My work involved

(i) research on the above topics, partly in collaboration with André Martin at CERN

(ii) lecturing in the NIUS camps organised by HBCSE for meritorious undergraduate students from IIT's, Universities and Colleges in India, and

(iii) guiding projects by NIUS students.

Publications:

1. Roy SM, Arthurs-Kelly Joint Measurements and Applications. *Current Science*, **109** (2015) 2029-2038. [expanded version of lecture at DMQM-2014, Bangalore, 24 Oct. 2014].

   Abstract: The idea of 'quantum tracking' for a single observable first occurred in the measurement theory of von Neumann, and generalized to two canonically conjugate observables by Arthurs and Kelly Jr. The nomenclature was probably used first by Arthurs and Goodman who discovered the joint measurement uncertainty relation which implies that the minimum uncertainty product is twice that in Heisenberg's preparation uncertainty relation. Originally devised as an extension of von Neumann measurement Hamiltonian to joint measurement of conjugate variables, the Arthurs-Kelly Hamiltonian has been found to have many other practical applications. I review in particular, experimental bounds on von Neumann entropy, noiseless quantum tracking of conjugate observables, remote tomography, entanlement swapping, and exact measurement of correlation between conjugate observables. Many of these applications require initial states of the apparatus particles which are more general than those used by Arthurs and Kelly.

2. Martin André and Roy SM, Froissart Bound on Inelastic Cross Section Without Unknown Constants. *Phys. Rev. D*, **91** (2015) 076006; arXiv:1503.01261v2 [hep-ph].

   Abstract: We use unitarity and analyticity to determine, without any high energy approximation, upper bounds on energy-averaged inelastic cross sections in terms of low energy data in the crossed channel. These are Froissart-type bounds without any unknown coefficient or unknown scale factors and can be tested experimentally. Alternatively, their asymptotic forms, together with the Martin-Roy absolute bounds on pion-pion D-waves below threshold, yield absolute bounds on energy-averaged inelastic cross sections in terms of pion-mass alone.

3. Roy SM, A two component picture for high energy scattering: unitarity, analyticity and LHC data. (2016) Preprint, http://arxiv.org/abs/1602.03627.

   Abstract: I propose a two component analytic formula $F(s, t) = F^{(1)}(s, t) + F^{(2)}(s, t)$ for high energy $(ab \to ab) + (ab \to ab)$ scattering saturating the Froissart-Martin bound, obeying Auberson-Kinoshita-Martin (AKM1971) scaling and inelastic unitarity. Here s,t denote squares of c.m. energy and momentum transfer, $F^{(1)}$ is a Pomeron amplitude, $ImF^{(2)}$ a "grey disk" amplitude, with $ImF(s,t = 0)$ given by Particle Data Group fits (PDG2005,PDG2013) to total cross sections; I prove that $Re\ F(s,t)/ImF(s,0) \to (\pi/ln\ s)\ d/dt\ (tImF(s,t)/ImF(s,0))$ *for* $s \to \infty$ with $t(lns)^2$ fixed, and apply it to $F^{(2)}$. Using also the forward slope fit by Schegelsky-Ryskin (Schegelsky-Ryskin 2012), the model predicts for pp or pp, $\sigma inel = 73.8 \pm .94\ mb$ at $7 TeV$ and $75.3 \pm .95\ mb$ at $8 TeV$ in agreement with Totem (Totem 2011,2013,2015) values $73.1 \pm 1.3\ mb$ and $74.7 \pm 1.7 mb$ respectively; the model yields for $\sqrt{s} > 0.5\ TeV$, $\sigma inel\ (s) = 21.46 + 0.180\ \ln s + 0.1567\ (\ln s)^2 mb$, $\sigma inel / \sigma tot \to 0.55$, $s \to \infty$, where s is in GeV^2 units. Continuation to positive t suggests an 'effective' t-channel singularity at $\sqrt{t} \sim 1.4\ GeV$.

Manmohan Sarin, FNA
Department of Geosciences Physical Research Laboratory, Ahmedabad

Summary of Achievements

The effects of changing climate and feedback due to anthropogenic activities require observational approach over regional and temporal scale. The atmospheric chemical interactions are dominated by mineral dust and a host of reactive species from biomass burning emissions and fossil-fuel combustion sources, and hence, demand their detailed characterization.

During the 1st year covering the period of INSA-Senior Scientist Position (beginning August 1st, 2015), major research activities that were carried out are summarized here:

1. Anthropogenic trace metals in the Continental outflow to the Bay of Bengal

Atmospheric ^{210}Pb and trace metals (Pb, Cd, Cu, Mn, Cr, Co, Ni and Zn) were studied in fine mode aerosols ($PM_{2.5}$) from a sampling site (Kharagpur: 22.3°N, 87.3°E) in the Indo-Gangetic Plain (IGP) during the continental outflow (November-March) to the Bay of Bengal (BoB). The aerosol ^{210}Pb activity (1.3 - 6.6 mBqm^{-3}) is significantly high in the wintertime (December-January) compared to model based data in the literature. The cause for higher ^{210}Pb activity is attributed to enhanced ^{222}Rn emanation from Alluvium in the IGP and lower boundary layer height. The trace metal concentrations (ng m^{-3}) also exhibit pronounced temporal variability (Pb: 8 – 296, Mn: 8 – 568, Cr: 4.5 – 33, Cu: 2.1 – 29.3, Ni: 2.3 – 14.3, Co: 0.5 – 1.6 and Cd: 1 – 29.5) and are of comparable magnitude with those documented over the BoB, suggesting dominant impact of IGP-outflow on marine atmospheric boundary layer. The enrichment factors (EF_{crust}) of Pb, Cd, Cu, Mn, Cr, Co and Ni in $PM_{2.5}$, relative to upper continental crust, vary as 105 – 1561, 1265 – 24006, 13 – 87, 3 – 99, 7 – 27, 3 – 19 and 9 – 27, respectively.

2. Atmospheric SO_2 oxidation efficiency over a semi-arid region in western India

The oxidation efficiency of atmospheric SO_2, measured as a molar ratio of SO_4^{2-} to total SO_x ($SO_x = SO_2 + SO_4^{2-}$) and referred as S-ratio, has been studied from a high altitude site (Gurushikhar, Mt. Abu: 24.6°N, 72.7°E, 1680 m ASL) in a semi-arid region of western India. A global 3-dimensional Chemical Transport Model (CTM) and GEOS-Chem (v8-03-01) are employed to interpret experimentally observed patterns. The S-ratios derived from time series SO_2 and SO_4^{2-} measurements exhibit pronounced seasonality, with relatively low ratios in February-March, high ratios in November-December and intermediate values in September-October. The lower S-ratios in February and March (median values 0.10 and 0.08 respectively) have been attributed to relatively high planetary boundary layer height that decreases SO_2 loss from the atmosphere via dry deposition. Cause for this is also attributable to lower levels of OH radical during these months. On other hand, low PBL height and significant long range transport are considered to be the possible causes for the higher S-ratios during November-December (median values 0.30 and 0.28 respectively). The seasonal pattern of S-ratios predicted by the CTM, for the GEOS-Chem 4°x5° grid cell containing the sampling site show high ratios in July-August and lower in April.

3. Aerosol optical properties over an urban site, Kanpur, in the Indo-Gangetic Plain during fog and haze events

The impact of atmospheric aerosols on radiation budget, hydrological cycle and climate are significant but highly uncertain largely due to lack of ground-based measurements of aerosol optical properties. Our study investigates three important optical parameters, absorption and scattering coefficients (b_{abs}, b_{scat}) and single scattering albedo (SSA) using a one-year chemical composition data collected from an urban site (Kanpur) in the Indo-Gangetic-Plain (IGP). In addition, absorption Angstrom exponent (AAE) was also estimated in order to understand the wavelength dependence of absorption and to decipher emission sources of carbonaceous aerosols, especially black carbon. The absorption and scattering coefficients ranged between 8.3 to 95.2 Mm^{-1} (1 Mm^{-1} = 10^{-6} m^{-1}) and 57.7 to 563.6 Mm^{-1}, respectively, and exhibit large seasonal variability with higher values occurring in winter and lower in summer season. Single scattering albedo varied from 0.65 to 0.92 whereas AAE values ranged from 0.79 to 1.40 during pre-monsoon and winter seasons, respectively. The strong seasonal variability in aerosol optical properties is attributed to the varying contributions from different emission sources of carbonaceous aerosols in the IGP.

Summary of new findings

i. The enrichment factors (EF_{crust}) of Pb, Cd, Cu, Mn, Cr, Co and Ni in $PM_{2.5}$, relative to upper continental crust, exhibit large variability in the atmospheric marine boundary layer of the Bay of Bengal. A significant linear relationship among trace metals and chemical species (non-seasalt-K^+, nss-SO_4^{2-} and EC) emphasizes their anthropogenic source. The high concentrations and EF_{crust} of Pb, Cd and Cu in the IGP-outflow has implications to increase in the aerosol toxicity and impact on biogeochemistry of ocean surface waters via air-sea deposition.

ii. The seasonal pattern of S-ratios [molar ratio of SO_4^{2-} to total SO_x ($SO_x = SO_2 + SO_4^{2-}$)] predicted by the CTM, for the GEOS-Chem 4°x5° grid cell containing the sampling site, show high ratios in July-August and lower in April. The model has been employed to study the contribution of various parameters (PBL, OH, RH, dust load, transport pattern and dry deposition) to the S-ratios. Sensitivity simulations show enhancement

in S-ratios with dust load with maximum value in May (~4.7% (median)). Similarly, the 'dry deposition' seems to increase S-ratios with maximum value in August (~66% (median)).

iii. A case study of haze and dust events provides information on extreme variability in the aerosol optical parameters, particularly in single scattering albedo (SSA), a crucial parameter for radiate forcing estimation. The large scale seasonal variability in aerosol optical properties has implications for the estimation of direct aerosol radiative forcing and heating rate of the atmosphere over the Gangetic Plain.

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Munivenkatappa Sanjappa, FNA

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Taxonomy, Conservation Assessment and Utilisation of Endemic Legumes of Western Ghats

Consulted the library of University of Agricultural Sciences and all Plant and herbarium databases on internet to prepare a checklist of all endemic legumes of Western Ghats of India with detailed distribution. A complete and up dated checklist of all endemic Legumes has been prepared with updated nomenclatural citations, detailed synonymy and distribution. The required literature pertaining to distribution, images of Type and other authentic specimens were received from different herbaria in India and a few down loaded from databases of Royal Botanic Gardens, Kew, British Museum (Natural History), London, National Herbarium of The Netherland, Leiden. Based on the prepared checklist both Field and herbarium visits have been planned.

Two field tours were conducted to Western Ghats of Karnataka (Agumbe, Kemmannagundi, Yellopore, Sakaleshpur: Shradi ghat) and Pilikula Nisarga dhama, Mangalore herbarium. Collected field data and specimens for herbarium for Cynometra travancorica, an unidentified species of Cynometra and Smithia setulosa from the above surveyed localities. The field photographs of all the 3 species collected were taken and population data were recorded.

The specimens available at University of Agricultural Sciences, Bengaluru (UASB) were also critically studied during the period.

BA Shanbhag, FNA

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Some Studies on Behavioral Ecology of Anuran Tadpoles

The tadpoles of *Duttaphrynus melanostictus* and *Sphaerotheca breviceps* inhabit ephemeral water bodies but former live in dense aggregations while the latter do not live in aggregations. The tadpoles of *Hylarana temporalis* live in loose aggregation in gently flowing streams. A study was conducted to know whether living habit and habitat of these tadpoles have any influence on their foraging behavior with reference to time taken to arrival at food patch. Three x three factorial design experiment involving three different densities of tadpoles (1, 3 and 9) and food patch of three concentrations/ qualities (250mg, 500mg and 2000mg boiled spinach) was conducted. A glass aquarium (60 L × 30 W × 15 H cm) with aged tap water of 3 cm height was used as a test tank. The test tadpoles (Gosner stage 30-33) hatched and reared in laboratory were introduced in mesh cylinder (8 cm dia. and 10 cm H) placed at one end of the test tank 30 cm away from the food patch and allowed to acclimatize for five minutes. They were released by gently lifting the mesh cylinder and time taken (min) by the first tadpole to locate the food patch was recorded using stop watch. For every trial new test tadpoles were used. Each trial was replicated 10 times. A total of 90 trials were conducted for each species.

The study revealed that with an increase in density of tadpoles, time to reach food declined significantly in all the three species suggesting information sharing among the individuals. However, with increase in concentration

of food, the time required to reach the food patch declined in the tadpoles of *H. temporalis* and *S. breviceps* in any given density group but not in case of *D. melanostictus* suggesting that individuals of former two species have better sense of perception of food of different concentrations (qualities) than the latter. The study also suggests that the tadpoles of *H. temporalis* that live in loose aggregations use both individual perception and information sharing during foraging to detect food to suit their life in gently flowing waters. Tadpoles of *S. breviceps* that do not live in aggregations use individual perception and perhaps information sharing independently to reach food. Tadpoles of *D. melanostictus* have poor individual perception of food but they use information sharing to reach food patch and is in accordance with their gregarious nature.

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Plant Species Diversity and Functional Traits, Carbon Sequestration, and Effect of Tree Species on Soil Characteristics in Dry Tropical Forest

The spatiotemporal variation among plant communities in dry tropical forest is quite significant. Seedlings are a sensitive and important stage in plant life hence a thorough understanding of ecology of individual species and characteristics of environment affecting seedling growth is desirable. Resources such as water, nutrient and light, which are the most important limiting factors, influence the establishment, survival and development of plants. However, the effect of these environmental factors is modified by grass competition in tropical dry forest. The effect of light and nutrient with and without grass on the growth of selected tree seedlings belonging to two functional groups: leguminous and non-leguminous, was examined. The seedlings were subjected to different combinations of light, nutrient and grass. Growth parameters including height, girth (circumference), total dry weight, leaf area and number of leaves were recorded to analyse the response of tree seedlings to interacting light, nutrient and grass competition. Different species behaved differently in different combination of treatments. Effect of light and nutrient interaction was significant for majority of growth parameters. Seedlings were more responsive to the nutrient addition under full sunlight. Presence of grass had overall negative effect on the growth of tree seedlings.

In a multi-institutional collaboration, a seamless vegetation type map of India (scale 1: 50,000) was prepared using medium-resolution IRS LISS-III images. The map was created using an on-screen visual interpretation technique and has an accuracy of 90%, assessed using 15,565 ground control points. This vegetation type map is the most comprehensive one developed for India so far. It was prepared using 23.5 m seasonal satellite remote sensing data, field samples and information relating to the biogeography, climate and soil. The vegetation type distribution was characterized and mapped in terms of occurrence and distribution, area occupancy, percentage of protected area (PA) covered by each vegetation type, range of elevation, mean annual temperature and precipitation over the past 100 years. The natural vegetation was classified into forests, scrub/shrub lands and grasslands on the basis of extent of vegetation cover. The distribution and potential utility of the vegetation type map was discussed in a broad range of ecological, climatic and conservation applications from global, national and local perspectives. As many as 15,565 ground control points to assess the accuracy of products available globally (i.e., GlobCover, Holdridge's life zone map and potential natural egetation (PNV) maps) were used. The digital map is now available through a web portal (http://bis.iirs.gov.in).

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Exploitation of Water Fern *Azolla*

The nitrogen fixing aquatic pteridophyte *Azolla* is an important biofertilizer for rice and according to an estimate the system has been able to provide 20-40 Kg Nha^{-1} to rice in about 20-25 days. In addition to its use as biofertilizer it has several other uses such as human food, animal feed, medicine, production of biogas, hydrogen fuel, water purifier, weed control and reduction of ammonia volatilization. Due to the potential to clean up the polluted and contaminated waters, *Azolla* plants have been extensively used in phytoremediation programs. Recently *Azolla* plants have also been exploited in the production of biofuel. However, proper exploitation of *Azolla* is constrained by the fact that it is subjected to various environmental stresses during the course of its growth. Among the various stresses salinity is one of the most serious environmental stresses restricting its growth and productivity. Very few attempts have been undertaken to understand the mechanisms adopted by *Azolla* plants in response to salinity stress and virtually no information is available on the molecular mechanisms operating in *Azolla* in response to salinity stress despite the advancement in the molecular biology. Therefore, in the present study *Azolla microphylla* plants were exposed to salinity level of 0.5 and 0.75% and the response of photosynthetic electron transport activities, ion accumulation and the proteome profile was studied by 2D-IEF PAGE followed by MALDI-TOF analysis. Plants exposed to salinity level

of 0.75% showed much higher sensitivity as compared to 0.5% as revealed by growth and biomass accumulation. However, increase in PSI activity was observed in response to exposure to salinity level of 0.5% whereas activity of PS II was found to decline. Exposure to salinity resulted in differential levels of Na^+ and K^+ accumulation and disturbed Na^+/K^+ ratio. Therefore, modulation of Na^+ and K^+ ion fluxes and inability to maintain favorable K^+/Na^+ ratio could lead to growth inhibition in *A. microphylla* plants exposed to salinity. The total proteomic profile of *A. microphylla* plants exposed to 0.5% NaCl for three day was analyzed to get further insights on the salt tolerance. Proteomic analysis revealed differential expression of 58 salt responsive proteins in response to salinity exposure. Among them 25 proteins were significantly identified from MS/MS analysis with Swiss Prot data base search and/or blast homology search. The identified proteins have been found to be involved in photosynthesis, energy metabolism, amino acid biosynthesis, protein synthesis and defence. It is evident from the present study that salinity stress negatively impacts the key metabolic processes and the down regulation of several key metabolic proteins appear to inhibit the growth of *A. microphylla*. (In collaboration with Dr G Abraham, IARI, New Delhi).

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Pattern of Change in Forest Vegetation along Environmental Gradients in Himalayas-Species Richness

Species richness is a natural measure of diversity both at community and regional levels. It underlies several ecological models and conservation plans. However, the quantification of species richness that allows comparison of samples continues to be challenging, if not elusive. The massive Himalayan mountain ranges have forest vegetation up to greater elevations than most other mountain ranges hence provide appropriate systems for studies on environmental gradients. The research activities of the first year consisted of: general vegetation survey; investigating why a certain species richness pattern is more common than others; and analyzing species richness of pteridophytes along altitudinal gradients in two Himalayan regions differing in climate and geography.

Altitudinal gradients provide a powerful natural experimental condition for determining ecological and evolutionary responses of species to change in climate and environment (Körner 2007). An analysis of a Himalayan altitudinal transect indicates that along the altitudinal gradient the temperature lapse rate (TLR) is lower (0.52°C/100m altitude) than generally taken (0.6°C/100m altitude) to estimate climatic condition of high mountains. Furthermore, TLR varies seasonally, and it has implications to vegetation and diversity patterns.

I carried out investigation into altitudinal patterns of species diversity of pteridophytes in two western Himalayan states, Jammu and Kashmir (J&K) and Uttarakhand (UK) based on information derived from literature. In this, the altitudinal ranges (from 200m-4600m) supporting pteridophyte species were divided in altitudinal belts of 200m and species number in them was counted. The altitude where species peak of pteridophytes occurs in J&K and Uttarkhand (UK) follows the model of mid-elevation species peak (also referred to as mid-domain effect model).

The two regions differ in precipitation pattern, change in land area with altitude, forest types, and human use pattern of biomass. In J&K, monsoon accounts for less than 30% of annual precipitation, while in UK nearly 80% of annual precipitation occurs during monsoon months, from June to September. In total, there were 195 species in J&K, and the species richness peaked in 2000-2200m altitudinal belt. In UK the total species number along the altitudinal range was 242, and the species peak occurred at a relatively higher altitude, 2400-2600m, which was approximately mid-point of the altitudinal gradient, 200-4800m.

The factors which are suggested to affect species diversity patterns on altitudinal gradients vary widely in nature. For example, they include environmental parameters like temperature, geographical area and geometric constraints along altitudinal gradients. Then, the scale of extent (i.e., the percentage of the full altitudinal gradient sampled) and methodological approach applied to measure species richness also vary considerably.

Yadvinder Singh, FNA

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Dry direct- seeded rice (DSR) with zero tillage (ZT) produced significantly lower grain yield compared to conventional till (CT) DSR and puddled transplanted rice

(PTR). Mean grain yield of rice was significantly higher following ZT wheat with rice residue retained as mulch compared to ZT wheat after removal of residue. Zero tillage in combination with rice residue as mulch in wheat improved soil health over PTR. This study showed that rice straw can be efficiently managed without burning in rice-wheat system using Happy Seeder for improving system productivity and soil health. Sub Surface drip (SSD) irrigation system in DSR produced grain yield similar to that of PTR but with ~70 cm less irrigation water and increased average irrigation water productivity by 92% over PTR. In wheat, SSD irrigation produced significantly higher yields compared to flood irrigation in both CT and ZT systems and saved about 4 cm of irrigation water and increased water productivity by 75-100% over flood irrigation. SSD irrigation system in both rice and wheat saved 25% of fertilizer N by increasing N use efficiency. Two practical recommendations have emerged for adoption by the farmers of the state; (i) Application of first one-third dose of fertilizer N to transplanted rice at 10 days after planting significantly increased grain yield and N use efficiency compared to that applied at the time of planting and (ii) Use leaf colour chart for efficient management of fertilizer N in Basmati rice increased N use efficiency. During the year, published five research papers in refereed journals and two book chapters.

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a. Freezing Transition in Confined Geometry

b. Intracellular Transport

A first principle theory is developed to investigate close-packed structures and phase transitions in confined geometry. The close- packed structures formed by hard objects in a given volume are pivotal in understanding the basic physical mechanism behind freezing and glass transitions and are highly relevant to numerous applications ranging from packaging macroscopic bodies and granulates to the self-assembly of colloidal and biological soft matter. The close- packed structure is the key for the controlled fabrication of nanosieves and of membranes of desired morphology.

To describe freezing (fluid-solid) transition we recently developed an exact free energy functional. We argued that, since at the fluid-solid transition the isotropy and the homogeneity of space are spontaneously broken, a qualitatively new contribution to the correlation in distribution of particles emerges. Therefore, the pair correlation functions in the symmetry broken phase are written as a sum of two terms; one that preserves the continuous symmetry of the fluid and the other that breaks it and vanishes in the fluid. An exact expression for the free energy functional was found by performing double functional integration in density space of a relation that connects the second functional derivatives of the reduced free energy with respect to the single particle density distribution to the direct pair correlation function. For the symmetry conserving part we used integral equation theory which consists of the Ornstein-Zernike (OZ) equation and a closure relation that relates correlation functions to pair potentials. For the symmetry broken part we used a perturbative series which involves three- and higher-bodies direct correlation functions of the isotropic phase. We calculated these correlation functions using the factorization *ansatz.*

The theory has been used to investigate the freezing transitions in a number of systems interacting via different potentials. In all cases we found very good agreement with simulation and experimental results. Our results have been published in internationally reputed journals (Physical Review and Journal of Chemical Physics, references are given in the last year report). The last paper of this series appeared in *Journal of Chemical Physics* in September 2015 (**143**, 124503).

Last few months we are engaged in extending our theory to describe the (i) solid-solid transition and (ii) effect of confinement on packing and on phase transitions.

It is known that many systems which freeze into body centred cubic (BCC) crystal undergo to close- packed face centred cubic (FCC) crystal at high pressure. So far there is no theory to describe these transitions in which a high symmetry crystal transforms to a low symmetry crystal on increasing pressure. The results we find from our theory is very encouraging. We hope to complete our calculation in couple of months and publish results.

We have also been able to extend our theory to incorporate the effect of external potential that arise due to the confinement. We are in process of calculating the effect of this potential on the packing of particles and on the fluid-solid and solid-solid transitions.

Ghanshyam Swarup, FNA

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Mechanisms of Neurodegeneration Caused By Mutations in Optineurin

Glaucomas are a complex, heterogeneous and multi-factorial group of neurodegenerative eye diseases, characterized by a progressive degeneration of retinal tissues, particularly retinal ganglion cells. It is a major cause of irreversible blindness worldwide. Many genetic as well as environmental factors are involved in glaucoma pathogenesis. Certain missense mutations in optineurin/OPTN and amplification of *TBK1* are associated with normal tension glaucoma. A glaucoma-associated variant of OPTN, M98K, induces autophagic degradation of transferrin receptor (TFRC) and death in retinal cells. We have explored the role of Tbk1 in M98K-OPTN-induced autophagy and cell death, and the effect of Tbk1 overexpression in retinal cells. Oour results show that a glaucoma-associated mutation, M98K, of optineurin

enhances its phosphorylation at Ser177 by activating Tbk1 protein kinase. This leads to enhanced recruitment of M98K-OPTN to autophagosomes and increased autophagy flux. Phosphorylation of M98K-OPTN at Ser177 plays a crucial role in autophagosome formation suggesting, therefore, that autophagy receptor function of OPTN, which is dependent on interaction with LC3, is important for autophagosome formation. M98K-OPTN induced retinal cell death is dependent on its phosphorylation at Ser177. We also show that Tbk1, a glaucoma-associated protein, through its catalytic activity, induces death in retinal cells and this requires autophagic function of OPTN. Therefore, this study provides evidence for cross talk between two glaucoma-associated proteins and their dependence on each other to mediate cellular functions; any perturbation in the fine balance of their regulation could lead to cell death.

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Social Networks and Big Data Approaches in the Design of Modern Supply Chain Networks

During the year, our research is focussed on practical applications in the Indian context of manufacturing supply chains. We have two international conference papers, one book chapter and three papers in the magazines. A total of 17 lectures were given in various universities, engineering and other colleges focussing on Innovation for India by India in India and start also start-ups using the emerging technologies. Also I was the Editor in chief of Sadhana, the Academy Journal of Engineering Sciences. We have achieved several land marks for Sadhana: the number of papers submitted increased fourfold; it is a monthly Journal. We provide below the summaries of contributions.

Optimization issues in Online Retail and Agriculture Mandi: During the year 2015, our research is concerned with the Online Retail and Agriculture Mandis. These two are very important issues in India, in the omni retail context, we developed algorithms for minimal cost e-fulfilment of goods in a business to customer (B2C) scenario. In particular, we focus on an Internet enabled retailer or e-retailer fulfilling the online orders. We formulate and solve the least cost optimization problem to determine the best choice among the following three options: (a) dedicated fulfilment, (b) outsourcing the fulfilment to a third party, or (c) supplier drop-shipping the items to the customer. The e-retailer wants to maximize his profit margins and reduce the delivery lead time. The main players in our model are: e-retailer, dropshipper, third party logistics, and the customers.

In case of Mandi, we consider the electronic exchange between the farmers and consumers in the agricultural supply chain. Preferential evaluations of buyer and supplier satisfactions are mathematically modelled and this preference matrix is given as input to Gale Shapely matching algorithm.

India Logistics report: Our technical report which appeared as a book chapter is concerned about the logistics services in India. We discuss the state of the Indian logistics sector and the industry clusters. Indian logistics has millions of small players and one of the issues is coordinating their functions in providing efficient delivery. We discuss the recent ICT technology innovations in the inbound and retail logistics. The retail sector in India has immense potential for technology intensive home delivery logistics. We conclude the report with recommendations for developing both hard and soft infrastructure in a coordinated fashion for making logistics in India a world class sector.

Modelling the Project Logistics Sector: The project logistics is an important activity for emerging markets such as India since it involves transfer of heavy equipment needed for power plants, manufacturing companies and other infrastructure projects. We have developed a framework for project logistics which is helpful for risk identification and mitigation, innovation identification and development and finally governance of the end to end pickup to delivery of heavy cargo.

Making Supply Chain Greener in A Cost Effective Way: Supply chains which integrate economic, social and environmental concerns are more difficult to replicate, particularly if suppliers devote asset-specific investments to engage in the design of products and processes that use low resources, carbon friendly energy sources, care for disassembly and reuse activities of their customers and developed higher levels of trust.

HONORARY SCIENTISTS

Garani Ananthakrishna, FNA
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Dynamics of Jerky Flow

This is a broad area where intermittent response to the applied force is seen. Our idea is to construct models that can explain the observed features. Two different problems falling in three different areas of jerky flow have been completed and published. The details are as follows.

Despite the long history, so far there is no general theoretical framework for calculating the acoustic emission spectrum accompanying any plastic deformation. We set-up a discrete wave equation with plastic strain rate as a source term and include Rayleigh-dissipation function to represent dissipation accompanying acoustic emission. We devise a method of bridging the widely separated time scales of plastic deformation and elastic degrees of freedom. While this equation is applicable to any type of plastic deformation, it should be supplemented by evolution equations for the dislocation microstructure for calculating the plastic strain rate. The efficacy of the framework is

illustrated by considering three distinct cases of plastic deformation. The first one is the acoustic emission during a typical continuous yield exhibiting a smooth stress-strain curve. We first construct appropriate set of evolution equations for two types of dislocation densities and then show that the shape of the model stress-strain curve and accompanying acoustic emission spectrum match very well with experimental results. The second and the third are the more complex cases of the Portevin-Le Chatelier bands and the L{\"u}ders band. These two cases are dealt within the context of the Ananthakrishna model since the model predicts the three types of the Portevin-Le Chatelier bands and also L{\"u}ders-like bands. Our results show that for the type C bands where the serration amplitude is large, the acoustic emission spectrum consist of well separated bursts of acoustic emission. At higher strain rates of hopping type B bands, the burst type acoustic emission spectrum tends to overlap forming a nearly continuous background with some sharp acoustic emission bursts. The latter can be identified with the nucleation of new bands. The acoustic emission spectrum associated with the continuously propagating type A band is continuous. These predictions are consistent with experimental results. More importantly, our study shows that the low amplitude continuous acoustic emission spectrum seen in both the type B and A band regimes are directly correlated to small amplitude serrations induced by propagating bands. The acoustic emission spectrum of the L{\"u}ders-like band also matches with recent experiments as well. In all these cases, acoustic emission signals are burst-like reflecting the intermittent character of dislocation mediated plastic flow.

The intermittent force response of small volume samples has been an object of attention for at least three decades due its relevance in estimating hardness of the sample. Yet, there has been no theoretical explanation except those from simulations which suffer from serious limitations. We develop a real time dislocation dynamical model to explain displacement jumps in load controlled nanoindentation experiments. We develop a dislocation dynamical model to explain the displacement jumps in load controlled experiments as an alterate theoretical method to simulation methods. We set-up a system of coupled nonlinear equations for the mobile and forest (or immobile) dislocation densities that is coupled to the force rate equation. The evolution equations for the dislocation densities include nucleation, multiplication and propagation thresholds for mobile dislocations, and other well-known dislocation transformation mechanisms. Both ideal Hertzian and realistic Berkovitch indenters are considered. We show that the model predicts all the generic features of nanoindentation such as the elastic branch followed by several displacement jumps of decreasing magnitudes and residual plasticity after unloading. The stress corresponding to the elastic force maximum is close to the yield stress of an ideal solid. The predicted values for all the quantities are close to those reported by experiments.

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Ab-initio Study of Graphene-based Systems

Various planar graphene honeycomb finite structures have been investigated to achieve optical, semiconducting and magnetic properties. However, in most of these studies, it is possible to transform *A* sub-lattice sites to *B* sub-lattice sites by a point group operation. However, this A ↔ B transformation is not present in the zigzag-edged triangular graphene nano disks (ZET- GNDs). Earlier, a few studies have been reported for the passivated/terminated ZET-GNDs, but no literature is available for the nanodiscs having different forms and terminated/passivated by atoms or chemical species.

Earlier, we have observed[1], for the first time, a very large magnetism in the nano-sized (7–27 Å) punched graphene nanodisks (PGNDs) i.e., zigzag-edged triangular PGNDs (ZETPGNDs) using a first-principles method. The spin value scales with the linear dimension of the ZET-PGND arising from the topological frustration of the π bonds. The magnetic moment in a particular type of a PGND increases immensely. One may, thus, enhance the magnetism of a PGND beyond the nanoscale at room temperature. These punched graphene fragments may be employed for the preparation of several kinds of the electronic and spintronic devices possessing exotic features.

In 2015-16, we continued these investigations for achieving giant magnetism and ballistic electron transport for their technological applications. The adsorption of transition atoms on the isolated graphene and that on the graphene deposited on the substrates like SiC (0001)-substrate has induced gap in the graphene as well as large magnetism in the system. We have design ed graphene-based magnetic nanostructures in view of the recent experimental observations of magnetism in graphitic materials and has made detailed investigations. The study is of great interest not only from a fundamental perspective, but also for future technological applications. The results will be sent for publication in near future.

Publication:

Agrawal BK and Agrawal S, *J. Nanopart. Res*, DOI: 10.1007/s11051-014-2857-5, (2015).

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Environmentally Sustainable Farm and Food Based Approach to Enhance Houshold Micronutrient Security

Homestead Gardens To Improve Household Access To Micronutrients (MN) – vitamins and minerals

Indian diets are qualitatively deficient in micronutrients-vitamins and minerals. Its adverse effects are not always obvious and hence it is referred to as the "hidden hunger". Yet MN deficiency inflicts heavy cost in terms of health, productivity and economic growth. In vegetarian Indian diets, vegetables and fruits, besides pulses, millets and animal products, is an important source of MN. Homestead gardens with MN-dense vegetables and fruits can help to improve household food security.

For the past several years DCT is trying to promote household (near the house or in the family farm) MN security through homestead gardens with MN endowed vegetables and fruits in Medak district, of TS. Recently, in a DST- supported project the intervention was extended to 10 more remote -many tribal villages from 3 mandals. The target is pregnant women and mothers with 6-24 months old children registered in 17 *angawadis* (ICDS centres). The first 1000 days after conception, is the most critical and vulnerable period in a child's life. An initial knowledge attitude and practice (KAP) survey was done in every alternate mother (150), to assess her understanding of child care and knowledge of nutrition, sanitation and common infectious diseases. Besides agricultural interventions, education (behavioural change communication) in the area food, nutrition, child feeding, sanitation etc formed an important part of the study.

Families with pregnant women and/or 6-24 months old preschool children received seeds and saplings of MN–dense varieties like the green leafy vegetables (GLV), beans, okra, tomatoes etc. To improve access to planting material, backyard nurseries for raising saplings of papaya, drumstick, and creeper spinach (*Basilla alba*) were set-up by some women. This brought them some income. Families were also encouraged to grow legumes, millets and fodder. Orange-flesh sweet potato rich in provitamin A, (β-carotene) and iron-fortified pearl millet (*Bajra)* were introduced in some gardens. Vermicompost and preparation and use of botanical pesticides made from neem seed or chilli garlic were also taught. During the year 267 gardens were set up diverting 34.75 acre of land to raising gardens. Vegetables worth Rs 47,460 were produced and. 73% was consumed at home. Such diversification from water guzzling crops like paddy and sugarcane also helps to bring up water table. (Figures 1 and 2)

Impact is being assessed from the acceptance of homestead gardens, improvement in KAP of mothers and household diet survey. ICDS records of weight for age are being monitored to assess the impact on child nutrition.

Production and sale of neem- seed powder by a self help group

In one village a pulveriser was given to a self- help group to enable them to collect neem seeds, powder them, package them with label and instructions for use and sell in 2Kgs and 5 Kg bags at Rs 15/Kg to encourage organic methods of farming. After making the decoction, for spraying, the residue can be used as fertiliser. Its impact will be known during this season.(Figure 3).

Augmenting Water Supply in Water-Stressed Settlements through Technological Interventions to Prevent Wastage of Bore Well Water, And Iec on Link between Water, Health and Sanitation

This is an ongoing project, started in November 2014 with grant from DST's WTI scheme. Its main aim is to prevent the wastage of bore-well water due to uncontrolled flow of water when there is power, and consequent stagnation of spilled water. To prevent wastage of water, the bore well water was diverted to a cistern with taps (see the figure). Spill water was directed into a soakage pit to prevent stagnation and to charge ground water. Hitherto 4 structures have been set up under the DST project and 3 more through funding from an industry under CSR,

1. *Amaranth garden*

2. *Backyard nursery*

3. *Neem seed pulveriser*

4. *Children collecting water from a cisern*

in as many villages. In one village, solar pump was used for pumping water from the bore well to the cistern. In addition promotion of the government programme of for pumping water from the bore well to the cistern. In addition promotion of the government programme of household latrines was done. Information education and communication (IEC) for behavioural change in the area of water health and sanitation is an important part of the project. School children are involved in preparing posters. Morbidity survey of common communicable disease like diarrhoea, respiratory infections and skin infections was done during July, August and September of 2015. Incidence of diarrhoeal diseases was low (1-8%) perhaps due to failure of monsoon. The incidence of respiratory infections was high (33-45%) and that of skin ailments like scabies 4-13%. Morbidity was highest in August, perhaps due to higher rain fall. (Figure 4).

Food Processing cum Training Centre

This is an ongoing project. Almost 20 nutritious products are made and marketed by the women of Mahila Udyog. The objectives are: women's employment, value addition to prevent wastage of farm produce, convenient ready to cook complimentary foods to reduce drudgery.

Outreach programme

Participants of the training programmes in nutrition (MSc & certificate courses) from the National Institute of Nutrition, besides Administrative Staff College and Aurora college, Hyderabad, visited the DCT centre at Narsapur. Besides explanation through a power point presentation, field visits were arranged.

Publication:

Murty PVVS, Rao Vishnuvaradhan, Bamji MS, Impact of enriching the diet of women and children through health and nutrition education, introduction of homestead gardens and backyard poultry in rural India. *Agric. Res.*, DOI: 10.1007/s40003-016-0206-x, (2016).

ON Bhargava, FNA

103, Sector 7, Panchkula

Review and Summary of Palaeozoic Stratigraphy, Himachal Pradesh

a. Field work: In

(i) Sirmaur District, and

(ii) Spiti Valley, HP, for deciphering the Cambrian Stratigraphy,

(iii) Tirthan Valley (Kullu District) reconstructing the Paleoproterozoic paleogeography.

b. Lectures:

(i) Geology of the Lesser Himalaya at the Training Institute, Geological Survey of India.

(ii) "Unique Geological Heritage Features and Geotourism" at Geology Department, Lucknow University.

(iii) Present knowledge and gaps in the Seminar organised by Geological Survey of India and INSA.

c. Reviews:

(i) Reviewed manuscripts submitted to the journals of Geological Society of India, Palaeontological Society of India, *Current Science*.

d. Seminars

(i) 30th Himalaya-Karakoram-Tibet Workshop at Dehradun, Oct. 6-8, 2015; co-chaired a session and presented a paper.

(ii) 36th IGC, Regional Brain Storming Session, Himalaya at Lucknow, 3-4 December, 2015 and chaired a session.

Publications:

Singh Birendra P, Bhargava ON, Juyal KP, Negi RS, Virmani Nancy, Sharma CA, Gill Aman, Skeletal microfauna from the Cambrian Series 2 (Stage 4) Kunzum La Formation, Parahio valley, Spiti region (Tethyan Himalaya), India. *Current Science*, (2016).

Bhargava ON, Draganits E, India Devonian (Himalaya) In: Suttner et al, Planet Earth in Deep Times. Schweizerbart

Science Publishers, Stuttgart, (2016) 119-120.

Bhargava ON, Evolution of the Tethyan and Karewa successions in Kashmir: a synthesis. *Journal of Palaeontological Society of India*, **60(1)** (2015) 51-72.

Singh Birendra P, Bhargava ON, Chaubey Ravi S, Kishore Naval and Prasad SK, Early Cambrian Trail *Archaeonassa* from the Sankholi Formation (Tal Group), Nigali Dhar Syncline (Sirmur District), Himachal Pradesh. *Journal of Geological Society of India*, **85(6)** 717-721.

Singh Birendra P, Virmani Nancy, Bhargava ON, Negi Ranveer S, Kishore Naval, Gill Aman, Trilobite fauna of basal Cambrian Series 3 (Stage 5) from the Parahio Valley (Spiti), Northwest Himalaya, India and its biostratigraphic significance. *Geology Annales de Paléontologie*, **102** (2016) 59–67.

Bhargava ON, Thoni Martin, Miller Christine, Early Paleozoic garnets in the Jutogh Group, Himachal Himalaya, India: Its regional implications. Abstract 30th Himalaya-Karakoram-Tibet workshop, October 6-8th, 2015, Dehradun.

Ghosh Nilotpal, Basu Asish R, Bhargava ON, Shukla UK, Ghatak Arundhuti, Garzione Carmala N, Ahluwalia Arun D, Catastrophic environmental transition at the Permian-Triassic Neo-Tethyan margin of Gondwanaland: Geochemical, isotopic and sedimentological evidence in the Spiti Valley, India. *Gondwana Research*, http://dx.doi.org/10.1016/j.gr.2015.04.006.

Forewords for, "Geology of the Himalayan Belt published by Elsevier, and "Bhuvigyan ka anutha sangharalya: Himachal Pradesh" published by the Government of H.P.

Impact of the research and publications

1. Cambrian biostratigraphy in the Tethyan (Spiti) and Lesser (Sirmur) Himalaya has been considerably improved.
2. New data in Spiti pertaining to cause of mass mortality along the Permian-Triassic boundary.
3. A definite Ordovician age for metamorphism based on Sm/Nd method dating established.

NM Bujurke, FNA

Department of Mathematics, Karnatak University, Dharwad

Publications:

With Shettar BM, Jacobian-free Newton Multigrid Method to Solve EHL line contact problem. *Proc. IMech. E Part C: Journal of Engineering Tribology* (Under revision).

With Kantli M, Wavelet preconditioned Newton-Krylov Method for EHL line contact problem. *Applied Mathematical Modeling* (Under review).

With Kantli M and Shettar BM, Jacobian-free Newton GMRES method for analyzing combined effects of surface asperity and couple stress character of lubricant on EHL line contact problem. *IJPAM* (Under review).

Invited talks at Conferences

1. 'Stability of flows in a two dimensional collapsible channel using Interactive boundary layer theory'. International conference on Frontiers in Mathematics, Guwahati University, April 26th–28th, 2015.
2. 'Differential Equations and Numerical Methods' (four lectures), Central University, Gulbarga, September 9th - 11th, 2015.
3. Glimpses of 'Ramanujan his life and his contribution in Number Theory'. Karnataka State Science Academy – Lecture program Gulbarga University, Gulbarga, December 29th - 30th, 2015.
4. 'Wavelet pre-conditioned Newton Krylov Subspace solvers for the analysis of EHL equations'. National Conference on Recent Advances in Mathematics, Central University, Pondicherry, February 25th - 26th, 2016.

Other academic work done during 2015-16

1. Principal Investigator, DST, Major Research Project on Wavelets in Numerical Analysis (DST: SR\SH\MS:771\12).
2. Assessment of research projects submitted to Indo-French National Center for Applied Mathematics (IISc, Bangalore).
3. Assessment of Research projects (CSIR and DST).
4. Assessment of applications of candidates (Mathematics) for the award of D.S. Kothari, Post-Doctoral Fellowship (UGC).
5. Assessment of work of candidates for the award of i) Inspire faculty position and ii) INSA Young Scientist (DST and INSA).
6. Member, Editorial Board, *IJPAM* (INSA) and *Proc. National Academy Science (A)* (NASI).
7. Guiding students and teachers under SRF of Science Academies.
8. Guiding students for Ph.D.
9. Review of articles submitted to various International Journals.

Dipankar Chakravorty, FNA

Indian Association for the Cultivation of Science, Kolkata

Nanocomposites

Reduced graphene oxide was synthesized by high energy ball milling process in inert atmosphere. The process introduced defects and removed oxygen functional groups, thereby creating the possibility of fine tuning the band gap of all intermediate stages of the structural evolution. A limit of the backbone sp^2 network structure was found which should be able to accommodate defects before amorphization set in. The amorphization of graphene oxide was achieved rather quickly in comparison to that of graphite. From thermogravimetric and differential scanning calorimetric analysis along with Fourier transform infrared (FTIR) and Raman spectroscopic studies, it was found that the number of oxygen containing groups decreased at a faster rate than that of aromatic double bonds with increasing ball milling time with a msaximum limit of 3 hours. Several characterization techniques (FTIR, Raman, UV-Visible and X-ray photoelectron spectroscopy) confirmed that the material synthesized was, indeed, reduced graphene oxide. A paper giving the details has been published in *Materials Chemistry and Physics*, **161** (2015) 123.

Magnetoconductance measurements on Graphene/$C_OFe_2O_4$ nanocomposites were carried out over the temperature range 20-300K. Below 80K, the magnetoconductance increased with decreasing temperature whereas above 80K, it showed an increase with increasing temperature. This anomalous enhancement at the higher temperature region has been explained on the basis of spin-orbit coupling operative at the interface. The nanocomposites exhibited a large magnetodielectric effect of 22% change in dielectric permittivity for an applied magnetic field of 1.8 T. This was caused by the combined effect of Maxwell-Wagner polarization and a positive magnetoconductance of the interface between $C_OFe_2O_4$ and graphene. A paper describing these results has been published in *J. Phys. D: Appl. Phys.*, **48** (2015) 435002.

Piezomagnetic behaviour was studied in α-Fe_2O_3 films grown within the 0.6 nm width nanochannels of sodium fluorophlogopite mica (Na-4 mica) structure. Due to a large difference in the values of thermal expansion coefficients of Na^{-4} mica and α-Fe_2O_3 a large compressive stress was generated on the latter as the composite was cooled from 1023K to 300K. Measurements in the temperature range 300K to 2K of the MPMS system covered a stress range from 12GPa to 16.5GPa. Magnetization measurements on the composite as a function of temperature showed the presence of piezomagnetic effect in α-Fe_2O_3. The values of piezomagnetic coefficient were estimated to be in the range 2.3×10^{-6} to 3.4×10^{-4} $\frac{emu/g}{kg/cm^2}$. This is of the some order as that reported earlier by work carried out on single crystals of macrodimensions. Magnetization measurements of α-Fe_2O_3 particles of diameter ~130nm on the other hand, showed the usual behaviour viz., a magnetic phase transition from antiferromagnetic to ferromagnetic state at 237K. A paper delineating the above results has been published in *J. Magn. Magn. Materials*, **402** (2016) 64.

Composites of nanodimensional lithium silicate glass of composition 35 Li_2O. 65 SiO_2 and mesoporous silica SBA-15 were synthesized. The glass was grown by a solution route within the nanochannels of diameter 5.5 nm of SBA-15 by suitable heat treatment of the precursor sols. A dc electrical conductivity of 10^{-4} S cm^{-1} was measured for the nanoglass at room temperature. The activation energy for Li^+ ion migration was found to be 0.1 eV. This was explained as arising due to the creation of oxygen ion vacancies caused by the presence of Si^{2+} and Si^{4+} species in the mesoporuns silica at its interface with the nanoglass. Due to a repulsive interaction between these defects and the lithium ions a reduction in attractive electrostatic force between the nonbridging oxyten ions and the migrating lithium ions occurred. These nanocomposites will find applications in lithium ion batteries for storage of renewable energy. A paper giving details of this work has been published in *J. Phys. Chem. C*, **120** (2016) 431.

IB Chatterjee, FNA

Department of Biotechnology and Dr BC Guha Centre for Genetic Engineering and Biotechnology, University College of Science, Kolkata

p-Benzoquinone Causes Alteration of the Structure of Hemoglobin and Loss of its Oxygen Binding Capacity in Smoker's Blood

Cigarette smoking has been identified as the most important source of morbidity and mortality worldwide. Generally the life expectancy of smokers is nearly 14 years less than nonsmokers. Apart from causing the various life-threatening diseases, cigarette smoke (CS) is also known to produce hypoxia. Chronic hypoxia may be a cause of early aging, morbidity and premature death. Also, smoking during pregnancy causes reduced availability of oxygenated blood to the fetus resulting in intrauterine hypoxia and various risks for the unborn child. Earlier we had shown that p-benzoquinone (p-BQ), derived from p-benzosemiquinone of CS in the smoker's lungs, gets into the blood stream and forms covalent adducts with serum albumin resulting in alteration of its structure and ligand binding capacity. Here we show by mass spectrometric analyses that in smoker's blood p-BQ forms covalent adducts with cysteine 93 residues in both the β chains of hemoglobin (Hb) producing Hb-p-BQ adducts. UV-Vis spectra and CD spectra analyses show that upon complexation with p-BQ, the structure of Hb is altered. Compared to nonsmoker's Hb, the content of α-helix decreased significantly in smoker's Hb ($p = 0.0224$). p-BQ also induces aggregation of smoker's Hb as demonstrated by SDS-PAGE, dynamic light scattering and atomic force microscopy. Alteration of Hb structure in smoker's blood is accompanied by loss of oxygen binding capacity. Our results provide the first proof that p-BQ is a cause of hypoxia in smokers.

DK Chattoraj, FNA

Formerly Professor & Head, Department of Food Technology and Biochemical Engineering, Jadavpur University, Kolkata

Physico-Chemical Studies of Multiple Interactions between Biopolymers, Lipids and Solid Surfaces in Monolayer, Micelle and Dispersed Phases

1. Using Langmuir Monolayer Balance, the surface pressure–surface area isotherms of ionized monolayers of behenic acid. Salts at pH 12.0 on air-water interface have been measured at various physico-chemical conditions. The measured values of surface pressure is equal to the sum of the ideal pressure, cohesive pressure and electrical pressure. Values of surface activity coefficients of the ionized monolayers have been computed rigorously using thermodynamic concepts.

2. Some aspects of interactions of major milk proteins, casein and betalactoglobulin, casein and fatty acids (e.g. stearic acid, arachidic acid, behenic acids were studied in monolayer phase. Using Langmuir Surface Balance, the pressure area curves of milk proteins were found to differ in their shapes depending upon surface composition of the binary mixture.
3. DNA is unable to accumulate at the air water interface for structural reasons. However, use of analytical techniques, negatively charged DNA molecules in native and denatured states is observed to be absorbed on different types of powdered rigid and soft particles under various physicochemical conditions. The thermodynamic affinities of such processes have been estimated.
4. Thermodynamics of interaction of water vapour with 20 different polyamino acids in the absence or presence of sodium chloride respectively have been elaboratively measured using isopiestic vapour pressure method. Standard free energies, enthalpies and entropies of such interactions have been critically computed with each other. The biological significance of the results has been discussed in inaugural Address of 17th NATCOSEB meeting in Raipur, 2015 by Chattoraj.

HK Das, FNA

National Research Centre for Plant Biotechnology, New Delhi

Do Non-Symbiotic Nitrogen Fixing Soil Bacteria Contribute To Nitrogen Nutrition Of Wheat Seedlings?

Inoculation of wheat seeds by different wild type species of the nitrogen fixing soil bacteria *Azotobacter* usually results in about 8% to 10% enhancement of yield of wheat grain (1). It is not certain if this enhancement is due to biological reduction of nitrogen by the bacteria, or due to mobilization of unavailable nitrogen in the soil, or due to the plant growth substances elaborated by *Azotobacter* (2). We decided to settle this issue by sowing wheat seeds into pots containing an inert solid medium (vermiculite and perlite) that does not contain any nitrogen or any other nutrient. In the negative control pots we added Hoagland's medium devoid of any nitrogen after sowing wheat seeds (HD2967). In the positive control pots we added complete Hoagland's medium (which contained fixed nitrogen) after sowing wheat seeds. In the experimental pots we sowed wheat seeds that were inoculated with *Azotobacter chroococcum* CBD15, but added Hoagland's medium devoid of any nitrogen. Ten seeds were sown per pot and five pots were there per treatment. We periodically kept a count of the number of seedlings alive and not withered. The heights of the seedlings were also measured periodically. The results are presented in Figure 1 and Figure 2.

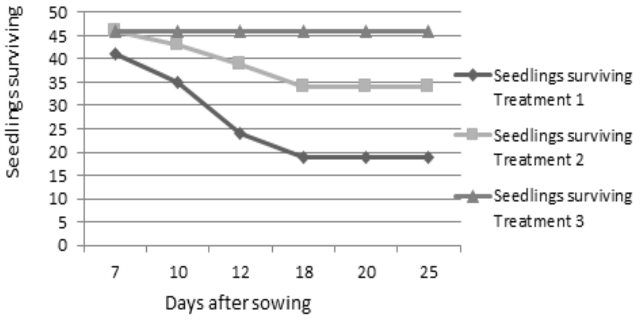


Figure 1: *Wheat seedlings surviving and not withered. Wheat seeds (HD2967) were sown in pots containing sterile Vermiculite–Perlite. Treatment 1 (♦): The seeds were not inoculated with any Azotobacter. Sterile Hoagland's medium devoid of any nitrogen was added as nutrient. Treatment 2 (■): The seeds were inoculated with Azotobacter chroococcum CBD15. Sterile Hoagland's medium devoid of any nitrogen was added as nutrient. Treatment 3 (▲): The seeds were not inoculated with any Azotobacter. Sterile complete Hoagland's medium (containing fixed nitrogen) was added as nutrient.*

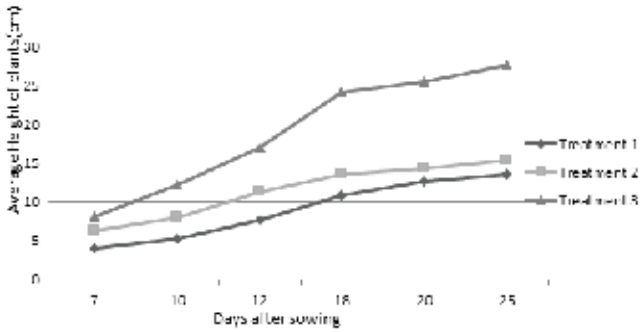


Figure 2: *Average height (cm) of wheat plants. Wheat seeds (HD2967) were sown in pots containing sterile Vermiculite–Perlite. Treatment 1 (♦): The seeds were not inoculated with any Azotobacter. Sterile Hoagland's medium devoid of any nitrogen was added as nutrient. Treatment 2 (■): The seeds were inoculated with Azotobacter chroococcum CBD15. Sterile Hoagland's medium devoid of any nitrogen was added as nutrient. Treatment 3 (▲): The seeds were not inoculated with any Azotobacter. Sterile complete Hoagland's medium (containing fixed nitrogen) was added as nutrient.*

In the positive control pots, where we had applied complete Hoagland's medium (which contained nitrogen) after sowing wheat seeds, forty six seeds germinated and all of the forty six seedlings survived and thrived well throughout the duration of the experimental period (Figure 1). The growth of these seedlings were the best (Figure 2). In the negative control pots, where we had applied Hoagland's medium devoid of any nitrogen after sowing wheat seeds, forty eight seeds germinated, but by seven days after sowing, only forty one seedlings were surviving, which dwindled to only nineteen seedlings alive at eighteen days after sowing. The growth of these seedlings were the worst (Figure 2). In the experimental pots, where we sowed wheat seeds that were inoculated with *Azotobacter chroococcum* CBD15, but had applied Hoagland's medium devoid of any nitrogen, forty six

seeds germinated and all of these seedlings were thriving after seven days of sowing. By eighteen days, there were still thirty four seedlings surviving and thriving (Figure 1). The growth of these seedlings were definitely better than the ones in the negative control pots (Figure 2).

Since there was no nitrogen in vermiculite or perlite, there was no question of unavailable nitrogen in the medium being made available by *Azotobacter.* Again since there was no nitrogen in vermiculite or perlite, any incremental growth of seedlings inoculated with *Azotobacter* cannot be because of growth substances elaborated by *Azotobacter.* The growth substances cannot enhance growth of the seedlings in the absence of fixed nitrogen supply. We conclude that beneficial effect of inoculation of wheat seeds with the nitrogen fixing soil bacteria, *Azotobacter chroococcum* CBD15 is very likely due to fixed nitrogen being made available by reduction of atmospheric nitrogen.

Publications:

Das HK, Biological nitrogen fixation in the context of Indian agriculture. *Current Science*, **60(9-10)** (1991) 551-555.

Mrkovacki N, Milic V, Use of *Azotobacter chroococcum* as potentially useful in agricultural application. *Annals Microbiol*, **51(2)** (2001) 145-158.

KP Gopinathan, FNA

Department of Microbiology & Cell Biology, Indian Institute of Science, Bengaluru

Molecular Biology and Biotechnology of Silk

In the current year, the continuation of the efforts directed to recover "Value" products from the silk industry waste materials through the collaborative consultative project initiated with the RV college of Engineering, Bangalore was continued. In Silk industry, the major wastes are broken fibres of silk Fibroin after reeling of the silk and Sericin, the glue protein associated with Fibre proteins in the silk cocoons, which are discarded. We had successfully recovered these products in a pure form for their commercial utility. Methods have been standardized to isolate pure fibroin from the silk industrial waste and sericin from the processed liquid wastes and processed cocoon materials. These materials have been converted into nano forms by Spray drying and ball milling. The nanoparticles of sericin (NSS) have been utilized to synthesize various hydrogels in combination with polyethylene glycol glutaraldehyde. The inherent gelling property of NSS was used to prepare hydrogels used for plant growth and it showed good moisture retention capacity for long periods of time.

The fibroin dissolved in ternary solution ($CaCl_2$:C_2H_5OH:H_2O) followed by dialysis to remove salts was subjected to ultra-sonication to disperse the nano-silk fibroin (NSF). NSF showed high wound healing capacity and was therefore, blended with synthetic polymers to prepare wound dressing membrane. NSF was found suitable for scaffold preparations in terms of biocompatibility, high tensile strength and mechanical resistance. These scaffolds served as a good substrate for growing bone marrow derived Osetoblast cells suggesting its utility in tissue regeneration, thus making NSF a potential biomaterial to be incorporated into scaffold fabrications for bone fracture healing treatments. There are ethical issues to be sorted out while its medical applications are being contemplated.

On the basic molecular Biology aspects of silkworms, collaborative research has been initiated with the Japanese and Chinese investigators along with other multinational experts. This time we have analyzed the Chorion locus of the silkworm which encodes the egg shell proteins. The detailed results will be provided in the future reports.

Girjesh Govil, FNA

Tata Institute of Fundamental Research, Mumbai

The position of INSA honorary scientist was offered to me in April 2014. I continued work on research, teaching and industrial applications of nuclear magnetic resonance (NMR) in chemical and biological sciences. I am grateful to the Tata Institute of Fundamental Research for all facilities for my work.

My research was focussed on studies of biological membranes, drug-membrane interaction and studies of whole cells. Scientists from "KM Kundani" college, Mumbai, and Dr Ragini Sinha, collaborated with me. A number of bioactive compounds and their analogues were synthesized and were tested for their biological activity. Interaction of these molecules with lipid bilayers was studied using multi-dimensional NMR. Studies were supplemented by other physical techniques and molecular dynamic simulations. Several papers were published, in recognised Journals, which are listed in the Appendix.

It was a pleasure to teach in Universities. I gave a ten lecture course at the Chemistry and biology departments at the Raipur University. I also introduced the students in the Advanced Centre for Science education at the same University. An eight lecture courses were given to the Chemistry and Biology students at University of Mumbai. Shorter courses were delivered at colleges in Bhopal and Mumbai and at the Forensic Research Institute in Gujarat. These visits were supported by the Royal Society of Chemistry, UK.

Publications:

Sinha Ragini, Gadhwal Manoj K, Joshi Akshada, Joshi Urmila J, Srivastava Sudha and Govil Girjesh, Localization and interaction of hydroxy flavones with lipid bilayer model membranes: A study using DSC and multi-nuclear NMR. *Eur. J. Med. Chem*, **80** (2014) 285-294.

Sinha Ragini, Srivastava Sudha, Joshi Akshada, Joshi Urmila J and Govil Girjesh, *In vitro* anti-proliferative and anti-oxidant activity of Galangin, Fiseting and Quertin: Role of localization and intermolecular interaction in model membranes. *Eur. J. Med. Chem.*, **79** (2014) 102-109.

Sinha Ragini, Joshi Urmila J, Srivastava Sudha and Govil Girjesh, Interaction of Chrysin and some novel flavones with DPPC model membranes: Study based on MD simulation, DSC and NMR. *Int. J. Pharm. Biosci*, **5** (2014) 364-381.

Sinha Ragini, Anantram Aarti, Joshi UJ, Srivastava Sudha and Govil Girjesh, Effect of methyl substitution in Flavones on its localization and interaction with DPPC model membranes: Implications for anti-proliferative activity. *Intl. Journal of Current Pharmaceutical Research*, **7** (2015) 21-26.

Govil Girjesh, An Account of the development of Nuclear Magnetic Resonance (NMR) in India. *Indian Journal of History of Science*, **50** (2015) 456-475.

AK Gupta, FNA

National Centre of Experimental Mineralogy and Petrology, University of Allahabad, Allahabad

Experimental Study of the System Forsterite-Anorthite-Nepheline in Presence of Excess Water Under 20Kb and Variable Temperatures: A Preliminary Report

Nepheline, forsterite and anorthite are essential minerals in alkali basalts. Although diopsidic pyroxene has not been included in this system, it should appear as an important phase by following reaction:

$$2Mg_2SiO_4+2CaAl_2Si_2O_8 \rightarrow CaMgSi_2O_6.CaAl_2SiO_6+Mg_3Al_2Si_3O_{12} \quad ...(1)$$

(Forsterite) (Anthotrthite) Diopside.Tschermark molecule Pyrope

In natural basalts, plagioclase is not pure anorthite, it incorporates sufficient amount of sodium as albite molecule in solid solution. In presence of nepheline ($Na_2Al_2Si_2O_8$), following substitution should occur: Ca←→2Na

It would be also interesting to see if diopside, thus produced by reaction (1), should react with nepheline to produce melilite. Note the reaction:

$$3CaMgSi_2O_6 + 2NaAlSiO_4 \rightarrow Ca_2MgSi_2O_7 - CaNaAlSi_2O + Mg_2SiO_4 + NaAlSi_3O_8 \quad \text{(Melilite)} \quad ...(2)$$

(Forsterite) + Albite molecule in the liquid

One of the important accessory minerals in basalt is Mg-spinel ($MgAl_2O_4$). It should be interesting to see if this mineral appears in the forsterite-nepheline as well as forestrite-anorthite joins under pressure. It should be pointed out that at higher pressures, foresterite and anorthite should react to produce garnet. Note the reaction:

$$Mg_2SiO_4 + CaAl_2Si_2O_8 \leftrightarrow Mg_2CaAl_2Si_3O_{12} \quad ...(3)$$

Thirty one glasses were made to study the system. They were crushed and crystallized at 800°C under atmospheric pressure. Experimental study of the ternary join under 2 Kb [$P(H_2O)=P(Total)$] and variable temperatures have been made. The starting materials shown by small circles are crystallized glasses. Phase relations for the two binary joins are shown in Figures 1 and 2 and that of Fo-Ne-An are shown in figure 3. Appearances of spinel (Sp), diopside (Di), corundum (Co) and garnet (Ga) in (Fo)- (An)-Ne join and appearance of spinel in the join forsterite-nepheline is thus, confirmed. Corundum and Sp however disappears in the solidus region. All phases are solid solutions Table-1 (can be supplied on request).

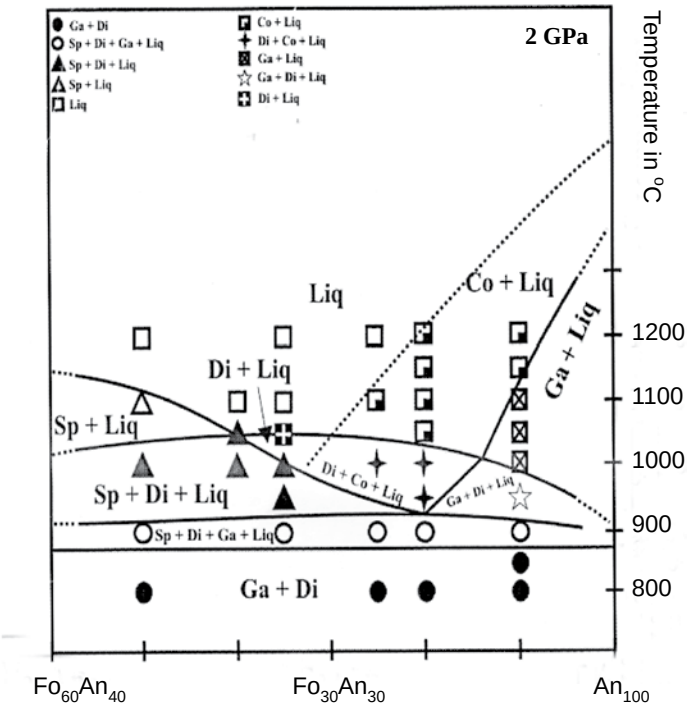


Figure 1

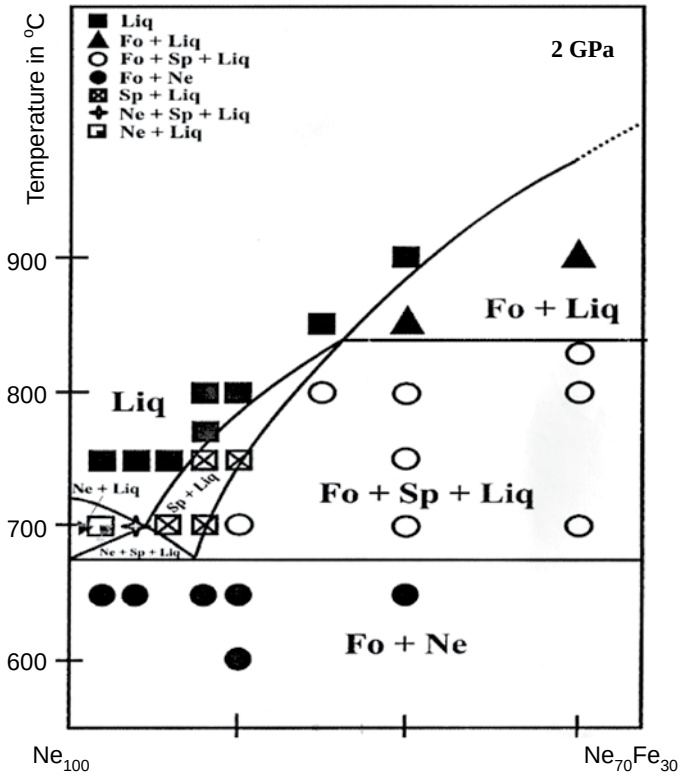


Figure 2

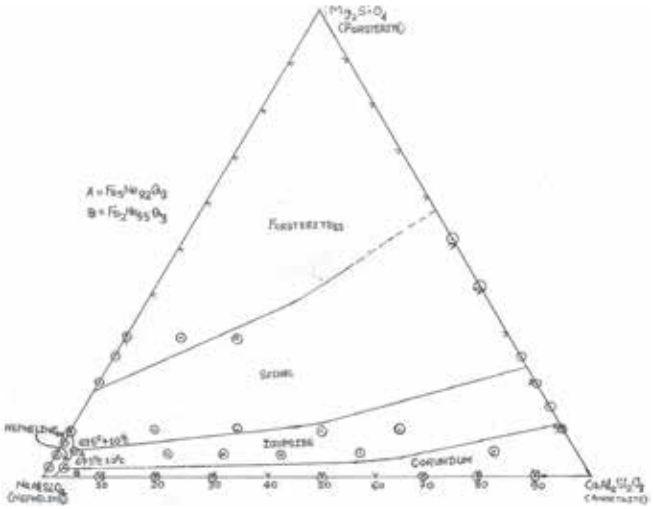


Figure 3: *Phase relations in the system Fo-Ne-An under 20 kb and different temperatures.*

It is a six component system and the Fo-Ne-An join cuts through the phase volumes of forsterite, spinel, nepheline, diodside and corundum. Composition of various phases are shown in Table-1 (can be supplied, if ask). The compositions of two-four phase points are shown in the diagram as follows: A ($Fo_5Ne_{92}Q_3$) and 695±10°C, and B ($Fo_2Ne_{95}Q_3$) and 675±10°C.

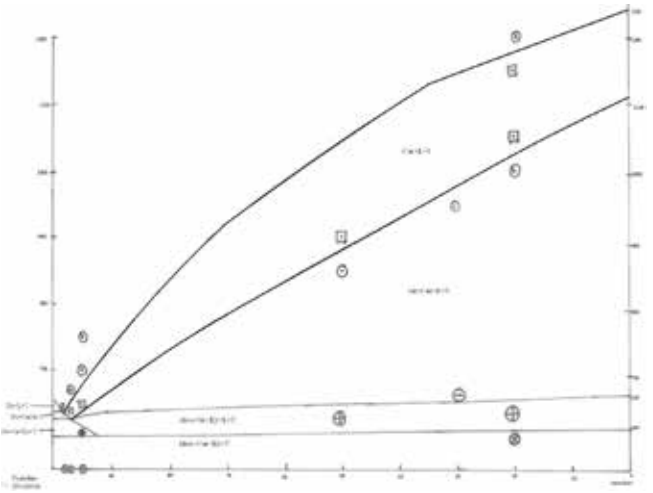


Figure 4: *The join nepheline-anorthite under 20 kb and variable temperatures*

Experimental runs related to the binary system Nepheline-Anorthite has been made since the last report was sent during April of this year. The new tables on binary systems 1. Nepheline-forsterite 2. Forsterite-Anorthite and Nepheline-Anorthite as studied under 20 kb and variable temperatures are given in tables (can be supplied, if ask).

Publications:

Mukherjee Priyanka, Gupta Soumitradas and Gupta Alok K, University of Allahabad, American Geophysical Union Fall Meeting, December, 2014: Experimental Study of the System Forsterite-Anorthite-Nepheline in Presence of Excess water under 20 kb and Variable Temperatures, A Preliminary Report.

Gupta Alok K, Origin of Potassium-rich Silica-deficient Igneous Rocks. Published by Spinger Verlag Company, New York (2015), ISBN-978-81-322-2083-1(e-book).

DVS Jain, FNA

Department of Chemistry, Panjab University, Chandigarh

Synthesis of Nanoparticles and Their Applications

In the previous year we had developed a one pot simple green method for the synthesis of gold nanoparticles using natural amino acids as reducing as well as capping agents. During this year we have successfully extended this technique for the synthesis of silver nanoparticles. We have found these have antibacterial properties. The paper is now ready for publication. We have also developed an electrochemical method for the synthesis of Prussian blue composite with gold nanoparticles. This has been used as abiosensor for analysis of hydrogen peroxide[2].

We have also synthesized doped zinc oxide nanoparticles and have been used for the photocatalytic degradation of malachite green and Methyl Orange dyes.[1-3]

Publications:

Getaye Marshet, Yadav OP, Taddesse Abi and Jain DVS, Effect on Photo-Catalytic Activity of Zinc Oxide Nanoparticles upon doping with Silver and Sulphur in Degradation Reaction of Malachite Green. *Journal of Surface Science Technology*, **31** (2015) 38-46.

Singh Suman, Jain DVS and Singla ML, In-situ electrochemical synthesis of Prussian blue composite with gold nanoparticles and its application in hydrogen peroxide biosensor. *Advanced Materials Letters*, **6(9)** (2015) 760-67.

Gebrezgbiabhiar Gaim, Yadav OP, Yadav Mamta and Jain DVS, Photocatalytic Degradation of Methyl Orange Dye using ZnS and N-doped ZnS Nanoparticles under visible Radiation. *Journal of Surface Science Technology,* **31** (2015) 184-89.

SK Jain, FNA

Formerly Director, SK Jain Institute of Ethnobiology, Jiwaji University, Gwalior

Work on all four main programmes work continued

1. Bibliography of 21st century ethnobotanical work in India. (Under Publication)
2. Compendium of last 25 year ethnobotanical research in India. (Under Publication)
3. A bibliographic overview of ethnobotanical work on Northeastern India. (Published)
4. Present economic relevance of plants referred in many centuries old Indian Puranas. (Published)

Work was completed on programme no. 3 and a large manuscript on over 300 references was completed and published.

Work was completed on some non-timber species of Puranas and a paper was published.

About 2000 references were collected on programme no. 1 namely 21st century ethnobotany. Data was recorded from over 1000 papers was recorded for programme no. 2.

Due to my visual disability work on these four programmes is being done with the help of six young research worker namely Dr Veena Chandra at Dehradun, Dr RLS Sikerwar at Chitrakoot, Drs Anita and Vertika Jain at Udaipur, Dr Harsh Singh at Lucknow and Dr Madhumita Nath at Badarpur, Assam.

Publications:

Nath M and Jain SK, Some Medicinal plants of Indian Puranas in Todays Ethnomedicinal perspective relevance. *Ind. J. Hist. Sci.*, **50(2)** (2015) 196-207 Golden Jublee Volume.

Singh H, Nath M and Jain SK, A bibliographic overview of ethnobotanical work on Northeast India. *Ethnobotany*, **26** (2014) 116-128.

Sikerwar RLS, Chandra V and Jain SK, Present economic relavence of some non-timber species of Indian Puranas. *Ins. J. of Usuf. Magt.*, **16(2)** (2015) 12-21.

Nath M, Jain V and Jain SK, Non timber species of Indian Puranas in the life of rural southern Assam. *MFP Newsletter*, September 2015.

Dash SS, Jain V and Jain SK, Notable Name Changes in Plants of Indian Puranas. *Nelumbo*, **57** December 2015.

Jain V, Nath M, Chauhan N and Jain SK, Taxonomy and Phytogeographic aspects of plants of Indian Puranas. *Phytotaxonomy*, **15** (2015) 152-165.

Advised numerous scholors on phone and e.mail about their research work and plans for future. (mainly at Udaipur, Jabalpur, Silchar, Chitrakoot, and Lucknow).

MS Jairajpuri, FNA

Aligarh Muslim University, Aligarh

Study of Plant-Parasitic and Soil-Inhabiting Nematodes

The INSA Honorary Scientist Project was largely confined to the Uttar Pradesh, but some samples were also collected from the Delhi area. It was observed that there was no specific difference in the soil-inhabiting nematode fauna of the two areas. Further, one of students from Goa brought some samples from there for my study which contained slightly different kind of nematodes inhabiting soil over there. All these identifications have been presented together as these were only very slightly different.

List of nematodes collected from soils and aquatic habitats

DORYLAIMIDA	Dorylaimellus	Psilenchus	Aphelenchus	Sporonchulus
Mesodorylaimus	Crateronema	Tylenchorhynchus	Aphelenchoides	Cobbonchus
Eudorylaimus	Lordellonema	Telotylenchus	Neotylenchus	Cobbonchulus
Mesodorylaimus	Xiphinema	Hoplolaimus	Dolichodorus	Anatonchus
Metadorylaimus	Longidorus	Belanonema	Belanolaimus	Miconchus
Pachydorylaimus	Longidorella	Pseudhalenchus	Nothotylenchus	Natonchus
Thornenema	Paralongidorus	Merlinius	Nothanguina	Iotonchus
Nygolaimus	Lordellonema	Meloidogyne	**MONOCHIDA**	Hadronchulus
Laimydorylaimus	Sectonema	Tylenchulus	Mononchus	Hadronchoides
Campydora	Labronema	Criconema	Paramononchus	Bathyodontus
Aporcelaimus	Longidorella	Criconemoides	Prionchulus	Oionchus
Sectonema	Trichodous	Hemicycliophora	Clarku	
Discolaimus	**TYLENHIDA**	Ditylenchus	Coomansus	
Crateronema	Tylenchus	Anguina	Mylonchulus	
Belondira	Filenchus	Nothanguina	Paramylonchulus	

SK Joshi, FNA

National Physical Laboratory, New Delhi

Strongly Correlated Electron Systems

Physics of strongly correlated electrons continues to remain exciting, because it helps to understand a large class of materials better. The simplest model available to us for correlated electron physics is the single orbital Hubbard model. The Hubbard model describes electrons moving in a lattice with the hopping of electrons between sites described by the parameter t, and the interaction between two electrons if these are on the same site by U.

It is believed that the superconductivity in high Tc cuprates arises from the electron-electron correlation effects described by the two-dimensional Hubbard model. Recently Kohl and colleagues (1) have presented an experimental determination of the ground state phase diagram of the two-dimensional Hubbard model using the ultra cold neutral K-40 atoms between the sites of an optical lattice potential generated by interfering laser beams. This offers us a precise measurement of the phase diagram and motivates us to attempt theoretical studies of the phase diagram of the two-dimensional Hubbard model using variety of tools and techniques. There exist calculations (2, 3) and one should improve upon them.

Publications:

Cocchi E, Miller LA, Drewes JH, Koschorreck M, Pertot D, Brennecke F and Kohl M, Equation of State of the Two-Dimensional Hubbard Model. *Phys. Rev. Lett*, **116** (2016) 17530.

LeBlanc JPF and Gull M, Equation of State of the Fermionic Two-Dimensional Hubbard Model. *Phys. Rev. B*, **88** (2013) 155108.

Khatami E and Rigol M, Thermodynamics of Strongly Interacting Fermions in Two-Dimensional Optical Lattices. *Phys. Rev. B*, **84** (2011) 053611.

VP Kamboj, FNA

Formerly Director, Central Drug Research Institute, Lucknow

I am not involved in any R&D project. Thus I can't submit the title of the project, its objectives and highlights of achievements. The outputs as INSA Honorary Scientist are given below:

a. Lectures:

1. Magic of Stem Cells, NASI lecture at Standard Inter College, Allahabad on August 26, 2016.
2. Contemporary Biotechnology for Health care: How far Social and Ethical, A prelude to 125th Birthday celebrations of Babasaheb Bhimrao Ambedkar in a Seminar on "Socio-Ethical issues in Contemporary Biotechnology" at Babasaheb Bhimrao Ambedkar University, Lucknow on September 23, 2015.
3. Biology for Therapy: Excitement & Challenges at the Department of Zoology, Panjab University, Chandigarh on October 12, 2015.
4. Biology for Therapy: Excitement & Challenges, at Teacher's training programme, Central Institute of Medicinal & Aromatic Plants, Lucknow on December 16, 2015.
5. Therapeutic Nutraceuticals in Veterinary Medicine, 15th Annual Convention of ISVPT on Nutritional Pharmacology & Toxicology beyond calories at National Diary Research Institute, Karnal on January 14, 2016.
6. Nutraceuticals to Molecular medicine, National Science Day Lecture at National Botanical Research Institute, Lucknow on February 29, 2016.
7. Competing on the Global stage: Building the credibility for Indian biosimilar industry with high quality and affordable products, 2nd Annual Biosimilars World Conference, Hyderabad on March 8, 2016.
8. Group lead discussant on Indian Biosimilar industry at the International stage, 2nd Annual World Conference, Hyderabad on March 8, 2016.
9. Group discussant on Public distribution of Vaccines in SAARC countries: Strengths and lacunae, 6th World Vaccine Summit, Hyderabad on March 9, 2016.

b. Honours & Awards:

Vigyan Ratna Award by Babasaheb Bhimrao Ambedkar University, Lucknow

AK Kamra, FNA

Indian Institute of Tropical Meteorology, Pune

Characteristics of small, intermediate and large ions and nanometre particles, and the influences of environmental conditions and local topography on the interactions of these ions and particles in the size range of 3.85–47.8 nm diameter are studied during new particle formation (NPF) events observed at Pune. Observations indicate occurrence of ion nucleation and/or advection from surrounding hills.

The mobility distribution of ions generated by splashing of raindrops is investigated. Our observations show that the mechanism responsible for the generation of intermediate ions is more efficient than that for the generation of heavy large ions during periods of high rain intensity. Relative roles of Lenard and Blanchard effects are suggested in generating excess of negative intermediate ions in the initial stages and excess of positive cluster ions, in the later stages of a rain shower, respectively.

The effect of the Western Ghats on the lightning activity across the west coast of India around the coastal metropolitan city of Mumbai during the 1998-2012 period is investigated. The shape of a zone of high lightning activity formed almost parallel to the Western Ghats during the onset and withdrawal phases of monsoon.

The time-averaged axis ratios, frequency and amplitude of oscillations of water drops of 2.67–6.6 mm diameter were determined by suspending them in a vertical wind tunnel in the absence and presence of horizontal electric fields using a high speed camera at 1000 frames per second. A systematic decrease in the drop's axis-ratio is observed with increase in its diameter and/or horizontal electric field.

Publications:

Kamra AK, Siingh D, Gautam AS, Kanawade VP, Tripathi SN, Srivastava AK, Atmospheric ions and new particle formation events at a tropical location, Pune, India. *Quarterly Journal of Royal Meteorological Society*, DOI: 10.1002/qj.2598, **141** (October 2015) 3140-3156.

Kamra AK, Gautam AS, Siingh D, Charged nanoparticles produced by splashing of raindrops. *Journal of Geophysical Research*, DOI: 10.1002/2015JD023320, **120** (July 2015) 6669-6681.

Kamra AK, Nair AA, Impact of the Western Ghats on lightning activity on the western coast of India. *Atmospheric Research*, DOI: 10.1016/j.atmosres.2015.03.006, **160** (June 2015) 82-90.

Bhalwankar R, Deshpande CG, Kamra AK, Shape and oscillations of the water drops freely suspended in horizontal electric field: A wind tunnel study. *Journal of Atmospheric and Solar Terrestrial Physics*, DOI: 10.1016/j.jastp.2015.09.004, **133** (October 2015) 169-177.

Sushil Kumar, FNA

Formerly Director, CIMAP and NBRI, Lucknow

The research activities pursued during the year 2015-16, which included some field research and some writing work, are summarized below:

1. Development of autumn wheat: A set of 1012 recombinant inbred lines of wheat, having origin in a cross involving alleles that determine flowering time were grown in a farmer's field, characterized and advanced. The objective of this experiment is to develop high yielding genotypes of wheat which are suitable for taking two crops of wheat in the Indo-Gangetic plains in tandem between September to April. A field trial of some promising genotypes for cultivation during autumn season (September-November) was also conducted. Most interestingly it has been concluded that wheat can be cultivated in all worldwide geographical areas where for a month average day and night temperature is 25°C.
2. Genetics of leaf and stipule morphogenesis: Legume flora of the Western Ghats (India) is being analysed to uncover new structures and their genetic regulation. This work is expected to eventually explain genetics of lateral appendages of plants.
3. Virus × host coevolution: The recent work on mechanisms by which viruses overcome the mismatch in codon usage of host versus theirs was reviewed and conceptualized. It has emerges that the evolution of viruses and hosts is reciprocally driven, based on their long-term interdependent relationships. (Kumar S, Kumari R and Sharma V, Coevolution mechanism that adapt viruses to genetic code variations implemented in their hosts. *J Genet*, **95** (2016) 3-12).
4. Transgenerational acquired defence against stresses in plants: The field of epigenetic modifications that control expression of genes for organ development and response to environment was reviewed. Need for discovery of chemicals for priming of transgenerational stress resistance to produce protected seeds was emphasized. (Kumar S, Kumari R and Sharma V, Transgenerational inheritance in plants of acquired defence against biotic and abiotic stresses: implications and applications. *Agr Res*, **4** (2015) 109-120).
5. Bt Cry toxin is perhaps mutagenic to targeted insects pests: Recent recordings of single or multiple dominant or recessive mutations that made insects bearing them resistant to Bt^+ corn and cotton plants were discussed. Instances of cross resistance to $CryAc^+$ and $Cry2Ab^+$ plants were cited. It was concluded that Bt toxin may be mutagenic to insects and need for alternative approaches to combat insects on cotton plant was emphasized. (Kumar S and Kumari R, Occurrence of molecularly diverse Bt Cry toxins-resistant mutations in insect pests of Bt^+ corn and cotton crops and remedial approaches. *Curr Sci*, **108** (2015) 1-8).
6. Macronucleus of unicellular ciliate oxytricha has millions of chromosomes: Current observations on the aspects of genome rearrangement of *Oxytricha trifallax* were discussed in terms of their evolutionary importance. (Kumar S and Kumari R, Origin, structure and function of millions of chromosomes present in the macronucleus of unicellular eukaryotic ciliate, *Oxytricha trifallax*: a model organism for transgenerationally programmed genome rearrangements. *J Genet*, **94** (2015) 171-176).
7. Aspects of malaria control: All areas of research bearing on malaria control, given impetus by new challenges posed by the development of resistance against artemisinin- based therapies as well as previous first-line therapies and constinued absence of vaccine, were reviewed. (Kumar S, Kumari R and Pandey R, New insight-guided approaches to detect, cure, prevent and eliminate malaria. *Protoplasma,* **252** (2015) 717-753; and Kumar S and Kumari R, Recently developed new, sensitive, time-effective and cost effective diagnostic tests of malaria. *Proc Ind Nat Sci Acad*, **81** (2015) 479-483).
8. Description of properties of seed oil of a newly developed cultivar of *Silybum marianum*, an important medicinal plant of India. (Bahl JR, Bansal RP, Goel R and Kumar S, Properties of seed oil of a dwarf cultivar of the pharmaceutical silymarin producing plant *Silybum marianum* (L. Gaertn.) developed in India. *Ind J Nat Prod and Resources*, **6** (2015) 127-133).
9. Manuscripts submitted for publication:

- Kumar S, Kumari R, Sharma V and Yadav MP, Genetics of domestication and worldwide introduction of *Bos indicus* (Zebu) and *Bos taurus* (Taurine) cattle, (2016) and
- Kumar S, Kumari R, Sharma V and Chaudhary S, Lessons from the progress in genetics of maize domestication: structure and function of major maize domestication alleles *GRASSY TILLER*, *TEOSINTE BRANCHED* and *TEOSINTE GLUME ARCHITECTURE*, (2016).

KK Mahajan, FNA
CSIR-National Physical Laboratory, New Delhi

Ionospheres of Terrestrial and Gaseous Planets: Response to Solar Quiet and Solar Explosive Events

Saturn is a gaseous planet and has its own intrinsic magnetic field. It has an extended atmosphere and therefore has an ionosphere too. However there have been only a few measurements of its ionosphere. To be precise, only 65 electron density profiles have been measured during the last 50 years by the radio occultation technique aboard various spacecrafts like the Pioneers, Voyagers and more recently Cassini. We have, however, examined this limited set of measurements to identify the major features of Saturn's ionosphere. We have found that the most prominent feature of Saturn is the presence of thinner ionosphere (i.e. lower electron densities) at the equatorial latitudes. This feature is seen in the other gaseous planet Jupiter, which too is magnetic. A similar feature was first seen in the Earth's ionosphere which too has its own intrinsic magnetic field.

It is now known that Earth's magnetic field plays a major role in the creation of this feature and therefore it seems that the thinner ionosphere at Saturn's equatorial latitudes is because of its intrinsic magnetic field, although water from the rings is also being considered as a major factor in the creation of this feature. The influx of water from the rings has to be latitudinal dependent – largest at the equator and smallest at the midlatitudes. Water provides a loss process for ionospheric plasma.

The terrestrial planet Mars has no intrinsic magnetic field and therefore its ionosphere should behave as expected from theory. However from a large set of measurements consisting of 5600 electron density profiles we found that Mars ionosphere suddenly gets displaced by as much as 15km within short intervals. This is not expected from theory and this observation indicates that there are large scale motions in the underlying neutral atmosphere. Ionospheric dynamics is of no consequence at Mars since photochemical equilibrium prevails in the main ionosphere.

SP Moulik, FNA

Centre for Surface Science, Department of Chemistry, Jadavpur University, Kolkata

Surfactant Behavior in Solution

During the above mentioned period physicochemical features of surfactant behaviour in solution such as i) their self-assembly formation, ii) interaction with synthetic and biopolymers, and iii) behaviors of mixed surfactants with respect to micelle and vesicle formation were elaborately studied. Besides additional studies of the properties of the carbohydrate polymer (inulin), triblock copolymers (L31, F127) and dispersions of curcumin in micellar and different solvent media, and its stability therein were also done.

On a general basis, the fundamentals of interfacial behaviors of amphiphiles, alkanols and ionic liquids in relation to their behaviors in solution and at the air/solution interface were studied in detail (*J. Colloid Interface Sci.*, **464** (2015) 8-16; *J. Surf. Sci. Technol.*, **31** (2015) 1-8). The fundamentals of the behaviors with reference to interfacial adsorption and bulk micelle formation were attempted to correlate based on fundamental relations and their modifications. Better understanding of the above two coupled phenomena has been presented with useful models and surface chemical concepts.

In the mixed systems of anonic and zwitterionic surfactants, and cholesterol and Gemini surfactant formation of micelles and vesicles, and their equilibrium mixtures were investigated. Formation of nano gold particles in the micellar and vesicular solutions was also studied (*Colloids Surf. A*, **481** (2015) 644-654; *RSc Adv.*, **6** (2016) 26019-26025). Combination of anionic and zwitterionic surfactants to form mixed micelles and their favorable transition to stable vesicles and vice-versa is not much studied. Effect of cholesterol (lipid) to form vesicles of gemini surfactants is also only limitedly explored. Their templating prospects (possibilities) in the synthesis of nanometallic particles also remain less explored.

Interaction of surfactants, and surface active ionic liquids with polymers viz. PVP, pluronic, protein, and DNA was also investigated. New binding features were observed; structural changes in polymers by the interplay of both electrostatic and hydrophobic interactions were realized. (*Colloids Surf. A*, **484** (2015) 35-353; *PCCP*, **17** (2015) 30560-30569; *Spectrochim. Acta Part A*, **152** (2016) 1-7; *New J. Chem.*, **40** (2016) 4617-4624. This area of study has much relevance to pharmaceutical, coacervate formation, gene delivery (transfection)), food science, etc. Structural changes in the polymers by the interaction with the surfactants and ionic liquids are the prime factors for the above which has been studied and analyzed using surface chemical, spectral and calorimetric methods.

Other studies on polymer inulin, enthalpy-entropy compensation (EEC), curcumin behavior as dispersions as well as its solution behavior in different solvents were also done during the studied period. (*Polymer*, **60** (2015) 237-243; *Soft Materials*, **13** (2015) 118-125; *J. Phys. Chem. B*, **119** (2015) 8457-8467; *J. Phys. Chem B*, **119** (2015) 15876-15884; *Colloids Surf. A*, **495** (2016) 1-7; *J. Phtochem. Phtobiol. B*, **158** (2016) 212-218). These are interesting allied fields which are contemplated to study further in future occasions. The potential publications made show the importance of the topics, and the quality of the exploration so far made.

Kamalaksha Nag, FNA

Indian Association for the Cultivation of Science, Kolkata

Nanomaterials from Metal Complexes and Structure – Property Relationships

1. Lanthanide oxysulphide (Ln_2O_2S) nanomaterials have been synthesized by solvothermal decomposition of $[NHEt_3][Ln(acda)_4]$ complexes, where $acda^-$ is the anion of 2-aminocyclopentene dithiocarboxylic acid. Morphological tuning of Eu_2O_2S nanoparticles, manifestation of peroxidase-like activity and glucose estimation use have been accomplished. Oleylamine alone or in combination with surface active agents, such as trioctylphosphine or oleic acid, at 280^0C produced Eu_2O_2S nanoparticles of three different morphologies, namely, hexagonal ultrathin plates, nanospheres and short rods. The optical band energy of the nanoparticles has been found to be 4.57 eV. Eu_2O_2S particles exhibit strong photoluminescence at room temperature with a quantum yield of about 4%. All the three forms of Eu_2O_2S nanoparticles display peroxidase-like activity towards the oxidation of 3,3',5,5'- tetramethylbenzidine in the presence of H_2O_2 and follow a Michaelis-Menten enzymatic pathway. The catalytic efficiency of the nanoparticles decreases in the order of plates > spheres > rods, which is in accordance with the decreasing surface area of

the nanoparticles. The mechanistic investigation reveals that the peroxidase-like activity is initiated by generating hydroxyl radical in the presence of H_2O_2 following the (Eu^{3+}/Eu^{2+}) Fenton/Haber-Weiss pathway. Based on peroxide activity, selective detection and estimation of glucose in the presence of related carbohydrates has been carried out.

2. Photophysical properties and supramolecular recognition of alkali metal ions by sandwich-type bis(macrocyclic) lanthanide complexes obtained with a tetraiminodiphenol macrocyclic ligand have been studied. The X-ray crystal structures determined for these compounds have revealed that the two macrocyclic ligands are considerably folded and not symmetrically bound to the metal center. In these compounds, the metal center is coordinated with two imine nitrogen atoms and two phenolate oxygen atoms of each of the ligands, whose two other uncoordinated nitrogen atoms are protonated and intramolecularly hydrogen-bonded with the phenolate oxygen atoms. The coordination polyhedron is a distorted square antiprism. The photoluminescence spectra of the Sm(III) and Eu(III) complexes have been studied in a methanol-ethanol glassy matrix at 77K. The absence of luminescence at room temperature is due to the quenching effect of the N-H…O oscillators on the emitting states of the metal ions. When these complexes in acetonirile were titrated with the perchlorate salts of lithium and sodium remarkable increase in luminescence intensity of the lanthanide complexes occurred and the spectra could be recorded at room temperature, indicating that occupancy of the alkali metal ions occurred at the uncoordinated coordination sites of the ligands. The binding constant determined for the lithium inclusion complex was found to be about two orders of magnitude greater than the corresponding sodium complex. The interaction between the sandwich host complex and the guest alkali metal is size dependent because no binding occurred with the other alkali metal ions of larger ionic radii. The X-ray crystal structures determined for the Li-inclusion complex showed that the lithium occupies the uncoordinated cavity site of each of the macrocyclic ligand, which acquire a flat configuration. Photophysical properties of the inclusion complexes have been studied in detail. Luminescence quantum yields and lifetimes of the excited states have been measured in different solvents. The energy of the ligand triplet state, as obtained from the phosphorescence spectrum of the Gd(III) complex at 77 K, has been used to rationalize the intramolecular energy transfer occurring from the macrocyclic ligand to the lanthanide ion.

Publications:

Ghosh AB, Saha N, Sarkar A, Dutta AK, Biwas P, Nag K and Adhikary B, *New J. Chem.*, **40** (2016) 1595-1604.

Bag P, Ghosh AB, Dutta AK, Flörke U and Nag K, Polyhedron, **102** (2015) 539-548.

SC Pakrashi, FNA

CSIR-Indian Institute of Chemical Biology, Kolkata

Writing a Monograph on *Aloe Vera*

The final draft of the manuscript of the monograph entitled, "Aloe vera" has been completed incorporating up-to-date literature with necessary rearrangement and revision.

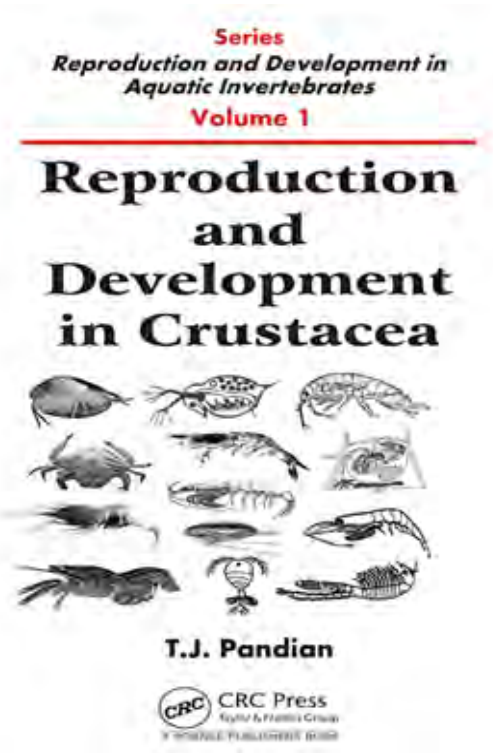
The monograph has now been divided into two parts: Part-I deals exclusively with the main text while Part-II incorporates some selected Patents with preferred methods of preparations along with a list of world literature on Patents.

The Glossary of Medical Terms and the Indices (both for the main text and patents) still remain to be completed to make it press-ready.

TJ Pandian, FNA

9 Old Natham Road, Madurai

The objective of offering me an INSA Honorary Scientistship was to author a book on Reproduction and Development in Crustacea. The book is published in March 2016 by CRC Press USA. The book represents a comprehensive synthesis of over 972 publications carefully selected from 249 journals and 101 other literary sources. The holistic approach and incisive analyses have led to harvest several new findings and formulation of new concepts.



ES Raja Gopal, FNA

Department of Physics, Indian Institute of Science, Bengaluru

Chalcogenides and Related Materials

Melt quenched chalcogenide glasses are generally p-type semiconductors and insensitive to doping. However Ge-Se glasses, upon the addition of 9 at. % of Pb, show a conduction reversal to n-type A very slow scan thermal analysis combined with X-ray and electron diffraction structural work shows that n-type PbSe forms at nano-crystallite levels at the critical conduction reversal region (x = 9 at. % of lead) and grow into microscopic sizes for larger concentration of lead in theses glasses.

In the efforts to get nearly stochiometric carbon nitride C_3N_4, a material which gained prominence some years ago due to the possibility of being superhard, adenine and triazine were tried as precursor liquids in a pyrolysis assisted chemical vapour deposition system. Amorphous films were obtained which had nano-crystallites of C_3N_4. The nitrogen content was found to be nearly 52 at. %, much closer to the ideal value of 57 at. % than was possible by many other methods. However the hardness of a bundle of the nano-wires is found to be only 11 GPa which is far below the superhard category expected. This result is in conformity with the reports of other workers who also find the material to be only normally hard.

These studies have been published in three short papers.

Publications:

Horta Sharona T, Pumlianmonga, Venkatesh R, Naresh N, Gopal ESR and Ramesh K, Nanophase separation in Ge-Se-Pb glasses near the charge carrier reversal threshold. "Nanoelectronics and Sensors", Edited by V Rajendran, K Thyagarajah and K Geckler, (2015) 65-68.

Venkatesh R, Gopal ESR and Ramesh K, Synthesis of bamboo like structured carbon nitride nanotubes. "Synthesis and Fabrication of Nanomaterials", Edited by V Rajendran, K Thyagarajah and KE Geckler, (2015) 91-95.

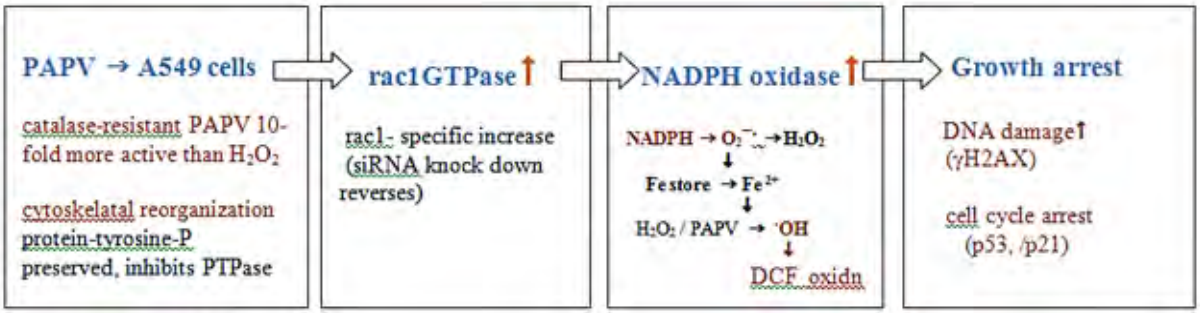
Naresh N, Venkatesh R, Gopal ESR and Ramesh K, Synthesis of nitrogen rich nanostructured carbon nitride by chemical vapour deposition method. "Synthesis and Fabrication of Nanomaterials", Edited by V Rajendran, K Thyagarajah and KE Geckler, (2015) 96-100.

Tangirala Ramasarma, FNA

Department of Biochemistry, Indian Institute of Science, Bengaluru

Growth Arrest of Lung Carcinoma Cells (A549) by Polyacrylate-Anchored Peroxovanadate

The following model for growth arrest of lung carcinoma cells (A549) by polyacrylate-anchored peroxovanadate (PAPV) emerges out of the work done in the laboratory of Prof. Gayatri Ramakrishna, CDFD, Hyderabad, now at Institute of Liver and Biliary Diseases, New Delhi, in a collaborative project with Nashreen Islam, Tezpur university, Tezpur, Assam, and with my participation. PAPV induces tyrosine phosphorylation, activates the rac1-GTPase-NADPH oxidase-ROS axis. The PAPV-mediated oxidative stress then leads to DNA damage and cell cycle arrest would ultimately to inhibition of cellular growth. Serendipitously, utility of peroxovanadate compound as a specific chemical tool to study the activation of rac1 GTPases emerged out of this work.



(Blue: major phases in the sequence; Black: known properties; Brown: our observations).

PK Sarkar, FNA

CSIR-Indian Institute of Chemical Biology, Kolkata

Research Activities

The role of astroglial cells in the survival and protection of neurons has been studied in Alzheimer Disease model system. Last year we reported that analysis of various cytokines in the culture medium of astrocytes following exposure to amyloid beta revealed a significant increase in Timp 1 and several other cytokines within the the first 6 hours of exposure. Two papers were communicated on this project at different national and international meetings.

This year, we have primarily concentrated on the mechanism of action of Timp1 on the survival and protection of neurons. Studies this year showed that Timp 1 secreted in the culture medium of astrocytes or highly purified recombinant Timp1, when applied to cultures of PC12 neurons,in the presence or absence of amyloid beta, significantly protects the neurons from the toxic effects

of amyloid beta. Timp1 has been found to increase the phosphorylation of the transcription factor AkT which in turn led to two other reactions. First it released the cytosolic NFkappa B (normally held as a complex with IKK) by phosphorylation of IKK and dissociation of NFkappa B which then is translocated to nuclei. Second, phosphorylated AkT led to phosphorylation of Foxo3a and led to its inactivation and inability to translocate into nuclei and promote the apoptotic process. Since NF kappa B is known to play both proapoptotic and antiapoptotic role following its nuclear translocation, further studies are under progress to evaluate how NFkappa B helps in the protection of amyloid beta treated neurons. Most importantly it has been established that inhibition of AkT phosphorylation leads to failure of neuroprotection by Timp 1 which confirms that the AkT phosphorylation plays the crucial role in the neuroprotection of amyloid beta treated neurons.

Publications:

Two short communications have been presented last year in a national and an international meetings. These are:

Saha P, Karri S, Gudem S, Sarkar PK and Biswas SC, Astrocytes protect neurons from toxicity by secreting Timp 1. Presented at the International conference on Alzheimers disease, Copenhagen, Denmark, July 13-17, 2014.

Saha P, Karri S, Gudem S, Sarkar PK and Biswas SC, Timp 1 secreted from astrocytes protect neurons in response to amyloid beta. Presented at the Indian Academy of Neuroscience meeting at NIMHANS, Bangalore, November 1-3, 2014.

KR Shivanna, FNA

Ashoka Trust for Research in Ecology and the Environment (ATREE), Bengaluru

Seed germination strategies of Indian weed species

Weeds are a major problem in all disturbed habitats — agricultural fields, forests, fallow lands, lawns and road sides. They are opportunistic, highly competitive and can exploit available resources effectively for their survival and spread. They have evolved a number of reproductive strategies which enable them to thrive even under extreme environments. Understanding of their reproductive strategies is essential for developing effective control measures. I have been working on reproductive strategies of Indian weed species, on which there is hardly any data, for the last three years. In the earlier reports I have presented data on their pollination strategies. The present report covers my studies on seed germination strategies of one of the weeds, *Cassia auriculata* (Fabaceae, Caesalpinoideae). This is a common, perennial weed growing on fallow lands and road sides in most of the arid and semi-arid regions of our country characterized by seasonal rainfall (monsoon), which is irregular often with long gaps. Seed germination strategies are very crucial for weeds to establish and spread in such habitats. Although many germination strategies have been identified in some weed species growing in other arid and semiarid regions of other countries, to my knowledge, no studies have been carried out to understand ecological adaptations prevalent in any Indian weed species, especially under field conditions.

Seed germination studies were investigated both in Petri plate cultures and under field conditions. Analysis of the results showed that seed dormancy in this species is controlled by both physical (impermeable seed coat) and physiological (presence of germination inhibitors) mechanisms. The seeds sown in cultures do not germinate simultaneously but show staggered germination over a period of several months. Also, the seeds are capable of withstanding repeated hydration and desiccation cycles during germination. Exposure of seeds up to three cycles of 12 h hydration (H) and 12 h germination (G) and two cycles of 24 h H and 24 h G did not affect germination responses of seeds.

Under field conditions the first set of seedlings emerged about two weeks after the initial showers and seedling continued to emerge periodically until the end of the monsoon period (spread over 6 months) as and when the soil becomes wet by infrequent showers. Of the 300 seeds sown in the soil (6 replicates of 50 seeds each), a total of 67 seedlings (22% of seeds sown) emerged during the rainy season. Most of the seedlings that were exposed to dry prolonged dry periods soon after their emergence dried and only 23 seedlings which had favorable conditions to grow by intermittent rains survived until the end of the monsoon. Of these 8 seedlings died during the 6 months of dry summer months and only 15 seedlings (5%) survived the whole of summer months until the onset of the next monsoon rains. This is a good success rate when compared to non-weedy species under arid and semi-arid conditions.

Present investigations have generated new information on ecological strategies of seed germination of *Cassia* seeds. Staggered germination and ability to withstand hydration and dehydration cycles enable at least a proportion of the seedlings to grow up to a stage sufficient to withstand ensuing dry months until the next rainy season.

Ajit Iqbal Singh, FNA

Indian Statistical Institute, New Delhi

Quantum Information Theory

I. Publications:

Role of Partial transpose and Generalized Choi maps in Quantum dynamical semigroups involving separable and entangled states. *Electronic J. Lin. Alg.*, **29** (2015) 156-193.

With Bandyopadhyay Somshubhro, Polynomial representation of Quantum entanglement. Submitted to *AMS Contemporary Mathematics*.

How permutations, partitions, projective representations and positive maps entangle well for Quantum information theory, Part I, *The Mathematics Student* **84** (2015) 1-2, 39-52 (Expository article).

II. Talks and Research interaction visits:

Some of the talks related to my recent research and useful research interaction visits with generous financial support from the organizers/hosts are as follows:

a. In USA and Canada

1. A plenary talk on "Tackling problems in Quantum entanglement and channels via factorisations of multivariable polynomials and superoperators" and an invited talk on "Perseverence with preservation of properties of operators with emphasis on Quantum entanglement" at The International workshop on "Problems and Methods in Operator Theory" and American Mathematical Society Conference Special Session on "Advances in Operator theory" respectively at University of Memphis, USA from October 15-19, 2016.
2. Three Talks / colloquium at George Washington University, Washington D.C., USA in October-November, 2015 on "Unitary bases and maximally entangled states", "Roping more by ringing less in Topology" and "Involutions and trivolutions in Algebra and Analysis". I had research interaction with faculty and students, particularly, Hugo Junghenn, Valentina Harizanov and Sudeshna Basu (with whom joint work on Geometry of Banach modules is on). I took this opportunity to attend seminars and interact with the faculty, particularly Neil Hindman at Howard University in the city.
3. Visit to Institute for Quantum Computing, University of Waterloo, Canada from October 25 to 31, 2015 to interact with faculty and students, particularly, John Watrous.
4. A Colloquium talk at University of Windsor, Canada on October 29, 2015 on "Injectivity versus surjectivity and Multipliers versus quotients in Matrices, Function algebras and operator algebras" together with interaction with Mehdi Sangani Monfared (my co-author for a recent paper).
5. A Colloquium talk on "Robustness of Quantum entanglement and complete positivity under certain perturbations" at Concordia University, Montreal, Canada on November 2, 2015 and a few discussion sessions with S. Twareque Ali and his colleagues.

b. In India

1. Regular active participation and delivering talks in seminars/conferences /workshops in various institutions in Delhi.
2. An invited talk on "What is amenability amenable to and in which form" at The 14th Discussion Meeting on Harmonic Analysis at University of Delhi on December 12, 2015.
3. An invited talk on "Algebra, Analysis and Use of Polynomials" at Indian Women and Mathematics Regional Workshop on "Research and opportunities" at Indian Institute of Technology, Guwahati on February 20, 2016.
4. Week-long visits to Harish-Chandra Research Institute at Allahabad in July, 2015 and Bose Institute at Kolkata in February, 2016 mainly to interact with Ujjwal Sen, Aditi Sen De and Somshubhro Bandyopadhyay.

Sarvajit Singh, FNA

Department of Mathematics, Maharshi Dayanand University, Rohtak

Consolidation of a Poroelastic Half-space

An analytical solution of the plane strain problem of the deformation of a homogeneous, isotropic, poroelastic layer of uniform thickness overlying a homogeneous, isotropic, elastic half-space due to two-dimensional seismic sources buried in the elastic half-space has been obtained. The integral expressions for the displacements, stresses and pore pressure have been obtained using the stress function approach by applying suitable boundary conditions at the free surface and the interface. The solution obtained is in the Laplace-Fourier transform domain. The case of a vertical dip-slip line dislocation is studied in detail. Schapery's formula is used for the Laplace inversion and the extended Simpson's formula for the Fourier inversion. Diffusion of pore pressure in the layer is studied numerically. Contour maps showing the pore pressure in the poroelastic layer have been plotted. The effect of the compressibility of the solid and fluid constituents on pore pressure has also been studied.

Publication:

Verma RC, Rani S and Singh SJ, Deformation of a poroelastic layer overlying an elastic half-space due to dip-slip faulting. *Int J Numer Anal Meth Geomech*, **40** (2016) 391-405.

KP Sinha, FNA

Department of Physics, Indian Institute of Science, Bengaluru

Theoretical Studies in Condensed Matter Physics

a. The prime work involved the model of Low Energy Nuclear Reaction (LENR) in a Solid Matrix in systems Pd(D)x or Ni(Hy). It should be noted that these system have Pd and Ni ions which have free spin atoms whose spin dependent properties cannot be ignored. We will consider this after discussing the lattice effects. An important point to note is that the LENR occurs in PdDx (or PdHx) occurs after a high degree of loading by D or H. This results in degradation of crystallinity. This produces defect structure such as line defect near the surface in which D or H from their own linear lattice. The resulting spatial vibrational mode of the defect lattice will contain anharmonic terms also.

After a suitable unitary transformation one gets the modified on site electron energy $E^*_m = E_m - E_d$ with $E_d = g^2 \hbar\omega_D$, where $\hbar\omega_D$ is the phonon energy and the hopping integral $t^*_{mn} = t_{mn} \exp(-g^2)$, where g is the dimensionless electron-phonon coupling constant. As a result the effective electron mass $m^* = m_e \exp[E_d/\hbar\omega_p] = m_e \exp(g^2)$, it is found that even for $g^2 = 1.6$, $m^* = 5m_e$. Other parameters of the system becomes $E^*_m = E_m - E_d$; $U^*_e = U_e - 2E_d$ where U_e is the coulomb repulsion of two electron on the same atom (D or H). It is seen that for $U_e < 2E_d$, U_e becomes negative. This makes the two electron ($\uparrow \downarrow$) on site localized pair (D^-). Thus we will have D^+D^- neighbours. This leads to the resonance of the configuration $D^+ + D^- \leftrightarrow D^-D^+$. The tightly bound electron pairs (the local charged bosons are named lochons) there is reduction in the repulsive potential. Further there is attraction between D^+ and D^-. The degradation of crystallinity leads to the tunneling of slow quantum wave packet and even a small dispersion of momentum can produce large increase of the transition probability. The combination of several factor answers many question why cold fusion occurs in the solid matrix assisted by phonon modes. But there are other factors to assist. We consider next the possible modes of magnons.

b. In systems such as $P_\alpha(D_x)$ or $N_i(H_y)$ the atoms can undergo spin fluctuations subject to spin-lowering (S^-_d) and spin raising (S^+_d) operators of a harmonic oscillators. Then the phonon-magnon interaction is given by $H = H_p + H_s + H_{sp}$ where H_p is the phonon Hamiltonian, H_s for the spin system and H_{sp} is the spin-phonon interactions. It is better to recast to magnon and phonon operations. Thus $H = H_p + H_m + H_{mp}$ the process is a three boson confluence where in a uniform mode magnon (=0) and a magnon of the exchange (optical) mode are simultaneously destroyed and an optical phonon of longitudinal modes is created. The process contributes to the resonance linewidth.

Publications:

Sinha KP, *Current Sciences*, **108** (2015).

Sinha KP and Meulenberg A, *American Chemical Society*, California, USA

Sinha KP and Kumar N, Interactions in magnetic solids, gives coverage of interactions of magnons, Phonons in solid. Oxford University Press (1980).

Asuri Sridharan, FNA

Department of Civil Engineering, Indian Institute of Science, Bengaluru

Predictive methods for compressibility behavior of highly plastic clays

Predictive methods for compressibility behavior of highly plastic clays are important for designing waste repositories and reclamation of phosphatic wastes. A quick estimation of void ratio vs. pressure (e vs. P) relationship is utmost important for such clays at high consolidation pressures. A relationship based on diffuse double layer (DDL) theory is found to exist between e/e_{50} vs. $1/\sqrt{P}$ and e/e_{100} vs. $1/\sqrt{P}$ (P is the consolidation pressure). The theoretical equation corroborated well with the existing empirical equation based on experimental results. Both the derived equations using e_{50} and e_{100} compared extremely well with the experimental data. A generalized e vs. P relationship, (where, P_i is experimental consolidation pressure), is proposed using theoretical analysis for highly plastic clays. The proposed generalized equation yielded very good results on experimental data. Moreover, the proposed equation is more flexible to use with data from any pressure range to predict compressibility behavior under high pressures for highly plastic clays.

PN Takkar, FNA

Indian Institute of Soil Science, Bhopal

State of Micronutrients in Indian Agriculture

Micronutrients, the basic components of soil fertility, are essential for plants, animals and human growth, development and health. In India micronutrients deficiencies of Zn (43.4%) and Fe (15%) are wide spread and that of Mn (7.9%) particularly in rice-wheat cropping system on coarse textured soils of Punjab up to 16% and of B (20.6%) in highly calcareous and acid soils in some specific crops/cropping systems. Soil organic C (OC) and pH mainly regulate their available content. Multi-micronutrients deficiency of two nutrients is prevalent only in some soil-cropping systems. Comprehensive information regarding the extent of micronutrients deficiencies under different soil-cropping system/conditions and their digitized georeferenced maps across the agro-ecological region of the country is far from adequate. Continued mining of micronutrients (about 188.3 thousand t/year by different crops) with cultivation of HYVs, use of imbalanced high-analysis NPK fertilizer and scanty use of organics depleted the soil micronutrients resource to a point of their deficiency level. But precise information and knowledge pertaining to the micronutrients budgeting under different soil-cropping system is almost negligible Micronutrients deficiencies are threatening the sustainable agricultural productivity, micronutrients nutritional quality of food grains, fodder and feed. The deficiencies of Zn, Fe, B, and Mn in specific soil-cropping systems have been managed to considerable extent with the use of developed technology of application of right inorganic and/or organic fertilizer sources or amendments, use of appropriate methods, rates and time of application as well as through their integrated supply and management systems. Still there is inadequate information regarding the residual availability of the added micronutrients fertilizers, manures and amendments in different soil-cropping systems. Also basic knowledge about the solid phases of micronutrients (minerals) in soils, and transformation of

the native and the added micronutrients, their rate of release and fixation in different soil-crop/cropping conditions and management practices is grossly inadequate.

The deficiency of Zn and Fe in human arises from their low content in the staple food grains of rice and wheat and the inadequate content in the diet comprised of these. Their deficiency diseases are impacting health of 40 to 80 % population, especially the children of less than 5-years of age and malnourished woman belonging to poor section of the society. Though agronomic bio-fortification of food grain with Zn and Fe markedly increased their concentration in the grains, yet their levels are far below compared to the adequate amount required in the diet to fully meet the human requirement for better nutrition and health. Micronutrient efficient genotypes that accumulate higher concentration of micronutrients in the grain of important staple food crops though have been identified, yet Information on the high density micronutrients-traits in genotypes is lacking for transferring them in HYV of cereals for production of high yield and high micronutrients density-grains. Knowledge is lacking regarding the definite relation/link of micronutrients deficiencies in soil with their deficiency in humans. However, the economic benefits of mitigating micronutrients deficiency in soils, crops and human with prudent use of micronutrients are immense.

Need for research on the following aspects have been recognized. Development of most efficient soil tests methods and their critical values for precise and reliable prediction of definite and hidden deficiency of micronutrients to help improve their input use efficiency, precision farming, and site-specific nutrient management systems. Studies on transformation, fixation and release rate of the added and the native micrometrics, organic and inorganic solid phases, metal-organic complexes, movement in soils and soil-root interface, modelling to aid better micronutrients management decisions for different soil-crop/cropping conditions. Developing appropriate integrated micronutrients supply and management systems considering potential availability of organic materials in local and regional perspective. Genetic and agronomic bio-fortification of food grains and fodders with micronutrients to enhance their concentration that fully meets the human and animal requirements. Identify definite relationship between micronutrients deficiency in soil with that in humans. Developing novel and nano-micronutrients materials and their smart delivery through nano-based formulations that help enhance their use efficiency.

Publications:

Takkar PN and Shukla AK, Management of Soil Fertility: Micronutrients in State of Indian Agriculture-Soil. H Pathak, SK Sanyal and PN Takkar (Eds). National Academy of Agricultural Sciences. New Delhi, India, (2015) 121-151.

Pathak H, Sanyal, SK and Takkar PN, State of Indian Agriculture-Soil H Pathak, SK Sanyal and PN Takkar (Eds). National Academy of Agricultural Sciences. New Delhi, India, (2015) xiii + 392.

Takkar PN, Long-term effects of rice-wheat cropping system on cobalt in relation to manganese and iron content in coarse textured calcareous alluvial soils. *Proc Indian Natn Acad*, **81(3)** (2015) 663-682.

Datta, SC, Takkar PN and Usha UK, Assessing Stability of Humus in Soils from Continuous Rice-Wheat and Maize-Wheat Cropping Systems using Kinetics of Humus Desorption. *Communications in Soil Science and Plant Analysis*, DOI: 0.1080/00103624.2015.1104334, **46 (22)** (2015) 2888-2900.

INSA MEDAL FOR YOUNG SCIENTISTS AWARDEES

RP Bahadur

Associate Professor, Department of Biotechnology, Indian Institute of Technology Kharagpur

Computational Analysis of Macromolecular Interactions in Proteasome Assembly

The proteasome is a multisubunit protein complex and is an important component of ATP-dependent proteolytic pathway in all eukaryotes and archaea, and in some bacteria. It plays a vital role in maintaining the protein levels inside the cell by degrading proteins conjugated to ubiquitin. This multiprotein complex comprises of a 20S core particle (CP) which has the proteolytic activity and two 19S regulatory particle (RPs). The structure of the yeast 20S is almost identical to proteasome of archaea but the former is a little more complex. The 20S core particle consists of seven different α-subunits and seven different β-subunits. These subunits are arranged in a four heptameric ring-like structure $\alpha_7\beta_7\beta_7\alpha_7$ with D7 symmetry. The basic function carried out by α-subunits is to provide docking support for the regulatory subunit and to avoid unrestricted entry of the subunits. The center region of core particle consists of two heptameric rings of β-subunit which act as the proteolytic core. This region exhibits three kinds of proteolytic activity, namely: trypsin-like, chymotrypsin-like and peptidylglutamyl-peptide hydrolyzing. The active sites have the capacity to degrade nearly all kind of amino acid sequences except the repeated sequences of glutamines. This exception is crucial in neurodegenerative diseases that result from a genetically linked series of polyglutamines. Furthermore, the ubiquitin proteasome pathway also plays important roles in the regulation of other cellular functions, ranging from the control of the cell cycle to activities that promote cancer. Indeed, inhibitors of proteasome activity have emerged as novel chemotherapeutic agents. The exact mechanism of proteasome assembly remains elusive, although it has been reported that some chaperones assist in their formation.

In this study, we have analyzed the interactions between the subunits of proteasome in terms of their structural, geometric and physicochemical properties and compared them with the binary protein-protein interfaces. The crystallized form of the entire 26S proteasome crystal

is not available but the coordinates of individual subunits (e.g. 20S) can be obtained from the Protein Data Bank (PDB). Here, in the current study we have analyzed the interactions between the different chains of the 20S subunit of yeast proteasome, in terms of alpha-alpha, alpha-beta, inter-beta and intra-beta interactions. We have studied different interface properties such as size of interfaces, the hydrophobicity, atomic packing density, electrostatic interactions, chemical composition and amino acid composition at the various interfaces of 20S subunit. Our analysis showed that the inter-beta (beta-beta) interactions are more stable and highly compacted compared to alpha-alpha interaction and alpha-beta interaction. So the structural aspects might be commensurate with the unique catalytic function of proteolytic core. Also, the relatively low atomic packing density and minimal electrostatic interaction in alpha-beta interfaces indicate the fact that this interaction can be easily broken compared to other interactions. The inferences of this study could be used to understand the mode of assembly and stability of the proteasome. Moreover, it would be helpful to understand the underlying mechanism of proteasome assembly which in turn, can be specifically targeted in combination therapies.

MK Bera

Assistant Professor, Geology & Geophysics, Indian Institute of Technology Kharagpur

Understanding the Timing and Dynamics of the India-Asia Collision Using Sequence Stratigraphic Analysis of the Tethyan Sedimentary Sequence

The proposed project aims at determining the timing of India-Asia collision and formation of the Himalayan mountain chain. The above information is very crucial for our understanding of the mountain building processes, initiation of the Asian monsoon system, and initiation/formation of World's largest river system (Ganga-Brahmaputra River System) and gigantic amount of organic carbon sequestration in their extensive delta-fans systems possibly responsible for the greenhouse-icehouse transition across the Eocene-Oligocene boundary. Therefore the project proposed to look at the past sea-level history in the collision zone by employing sequence stratigraphic rationale to decipher the relative collision timing preserved in the sedimentary record. The sequence stratigraphic study will be accompanied by the sampling, which will be later used for dating to know the exact timing of the India-Asia collision and formation of the Himalayan mountain chain. However, the collision zone is situated in the one of the remotest place, deep within the Karakoram mountain range, three days trekking will be required from the nearest road. As the sections are situated at an altitude above 4000 m, field work can only be possible during the summer, otherwise covered by snow for the rest of the year. So, fieldwork has been planned during the June, 2016. Apart from the sequence stratigraphic work for which fieldwork is pre-requisite, laboratory based works are also essential for effective execution of the project. These laboratory works encompass staining of the fossil carbonate shells and its stable isotopic analysis to check whether these samples can be used for Sr-isotope chemostratigraphy, separation of detrital zircon for its U-Pb dating. Among these laboratory works, methods for staining fossil shells by Mutvei's solution (a complex mixture of acetic acid, glutaraldehyde, alcian blue which simultaneously stain both the organic and inorganic part) has been tested and a 100W CO_2 laser system, which will be used for fossil carbonate analysis, procured through other project now has been installed and calibrated for in-situ high resolution oxygen and carbon isotopic analysis of fossil carbonate shell. Initial calibration shows that high spatial resolution up to ~125 µm can be achieved and will be very useful to do high resolution study for understanding the past seasonality or digenetic alteration if any. Experimental and extraction methods have also been established for Sr and Nd analysis, detrital zircon separation through heavy liquid for U-Pb dating and Sr-isotope chemostratigraphic work respectively.

Partha Bhattacharyya

Assistant Professor, Department of Electronics and Telecommunication Engineering, Indian Institute of Engineering Science and Technology, West Bengal

Development of Metal-Insulator-Metal based Volatile Organic Compound Sensor for Monitoring of Ripeness of Orange

Present work is motivated to development of metal oxide nanostructure based sensor devices towards efficient detection of Benzene, Toluene and Xylene (BTX) for monitoring different stages of ripeness of oranges with such VOCs as the potential marker. Nanostuctures like, nanorods, nanotubes and nanoflowers were employed owing to their high surface to volume ratio beneficial for gas sensing. High band gap material like TiO_2 and ZnO has been investigated in the present scope owing to their sensing ability towards different hydrocarbons. TiO_2 nanogranular layer and nanotube array were synthesized by sol-gel and electrochemical anodization technique, respectively; whereas ZnO nanoflowers were synthesized by chemical bath deposition (CBD) technique. Anatase titania was evident from the XRD spectrum whereas wurtzite crystallinity was observed in case of ZnO. FESEM study reveals different nanoforms of the sensing with approximate dimensions of the same. The synthesized and annealed metal oxide layer offers different oxygen vacancy content and high band gap (from PL spectroscopy) and these two features are well suited for vapour sensor application. Hall measurement confirms p-type conductivity for nanogranular TiO_2 layer and n-type conductivity of ZnO

nanoflower. Two kinds of device structure, i.e. planar and MIM, has been incorporated with Pd contact(s), deposited by e-beam evaporation technique. Sol-gel grown p-TiO_2 layer offered lower temperature (optimum temperature: 75°C) sensing, whereas appreciable response magnitude (11.06%, 6.41% and 4.57% respectively towards 1 ppm BTX) has been optimized in case of TiO_2 nanotube at slightly higher temperature (at 150°C). Variation in intrinsic property of TiO_2 was achieved by varying the water content in electrolyte. Sensing performance is highly dependent on specific surface area and non-stoichiometry. An optimization was achieved for BTX sensing with 2 vol% water containing electrolyte. On the other hand, ZnO nanoflower based devices offered relatively faster response towards BTX at 200°C with higher response magnitude, in comparison to its titania based counterparts. ZnO nanoflowers were sensitive towards very low concentration of BTX which is very useful for ripeness monitoring. From the literature, BTX sensing generally requires a high operating temperature (≥ 250°C) which has been circumvented by employing different nanostructures of the transition metal oxides. However, for such sensors, at room temperature (RT), fast response time and recovery time with an appreciably high response magnitude are difficult to attain due to (a) relatively slow gas adsorption-desorption kinetics and (b) relatively low carrier mobility of (II-VI) oxide semiconductors. In this context, graphene-based sensors have opened up a new frontier in gas sensor exhibiting remarkably superior performance because of their improved carrier mobility, increased specific surface area, low intrinsic noise and single molecular scale of detection ability. In this context, graphene derivative such as reduced graphene oxide was deposited on TiO_2 nanotubes by a two-step electrochemical process and gas-sensing performance of the device was tested with methanol (in the concentration range of 10-800 ppm) as a test species. Promising room temperature gas-sensing performance with appreciably high response magnitude (RM=96.93%) and the fastest response time (~18 sec) and recovery time (~61 sec) (at 800 ppm) was achieved for this device.

IH Biswas

Reader, TIFR Centre for Applicable Mathematics, Bengaluru

Evolutionary Partial Differential Equations with Lévy Noise

The main focus of this project is to study degenerate parabolic partial differential equations that are perturbed by Lévy noise. Since its inception on December 15th, 2015; we have made some important advances in the analytical understanding of such problems. The mathematical details are as follows:

Let $(\Omega, P, \mathcal{F}, \{\mathcal{F}_t\}_{t\geq 0})$ be a filtered probability space satisfying the usual hypothesis i.e. $\{\mathcal{F}_t\}_{t\geq 0}$ is a right-continuous filtration such that $\mathcal{F}_0$ contains all the P -null subsets of $(\Omega, \mathcal{F})$. We are interested in the Cauchy problem for a nonlinear degenerate stochastic PDE of the following type:

$$du(t,x) - \Delta\phi(u(t,x))\,dt - \mathrm{div}_x f(u(t,x))\,dt = \int_{|z|>0} \eta(x,u(t,x);z)\tilde{N}(dz,dt)$$

where $(t,x) \in (0,T)\times\mathbb{R}^n$, and u satisfies the initial condition $u(0,x) = u_0(x)$. The equation is to solved for the unknown random scalar valued function $u(t,x)$.

The function $F:\mathbb{R}\to\mathbb{R}^d$ is given flux function, and $\tilde{N}(dz,dt) = N(dz,dt) - m(dz)\,dt$; N being a Poisson random measure on $\mathbb{R}\times(0,\infty)$ with intensity measure $m(dz)$. In addition, $(x,u,z)\mapsto\eta(x,u;z)$ is a real valued function defined on the domain $\mathbb{R}^d\times\mathbb{R}\times\mathbb{R}$ and $\phi:\mathbb{R}\to\mathbb{R}$ is a given non-decreasing Lipschitz continuous function.

Remark:

Since ϕ is a real valued non-decreasing, Lipschitz continuous function, the set $A = \{r\in\mathbb{R} : \phi'(r) = 0\}$ is not empty in general and hence the problem is called degenerate problem. Even more, A is not negligible neither and the problem is strongly degenerate in the sense of [2].

We have developed a stochastic entropy solution framework for problems of the above type. In a recently concluded study, in collaboration with Ananta K. Majee and Guy Vallet, we have proven the existence and uniqueness of entropy solutions for the Cauchy/initial value problem for such equations. These results are compiled in article [1] and currently under review.

In addition, as a part of our project goal, we are currently working on Wong-Zakai type approximation results for stochastic conservation laws with Brownian white noise. This work is now at an advanced stage and is being done in collaboration with Supriyo Bhar, a postdoc here. Moreover, in collaboration with Anup Biswas from IISER Pune, we have started looking at the small noise limits and related large deviation principle for such equations.

Publications:

Biswas IH, Majee AK and Vallet G, On the Cauchy problem of a degenerate parabolic-hyperbolic PDE with Lévy noise. (In review) arXiv:1604.05009.

Carrillo J, Entropy solutions for nonlinear degenerate problems. *Arch. Rational Mech. Anal.*, **147(4)** (1999) 269-361.

Suryasarathi Bose

Assistant Professor, Department of Materials Engineering, Indian Institute of Science, Bengaluru

Carbon nanotubes based polymeric composites for EMI shielding applications

The recent developments in wireless communication system and other electronic circuitry have challenged the world to tackle with the problems arising due to the

interference of the waves emitted by them. Therefore it is necessary to shield these devices which are susceptible to electromagnetic interference (EMI). Conventionally, metallic materials are dominant over the other materials however, due to the associated problems like less corrosion resistance, high density and difficulty in processing limits their use in applications where lightweight, flexibility and oxidation resistance is of prime importance. Nowadays materials such as metallic filler, graphene, carbon nanotubes (MWNTs), ferrites etc. have been widely used for improving EMI shielding since these materials possess good electrical conductivity, magnetic and dielectric properties. It is well know that metallic materials and their alloys attenuates EMI radiations mostly by reflection whereas, magnetic particles by absorption. Magnetic materials have widely been adapted for EMI shielding application due to their high saturation magnetization, high magnetic permeability and low coercivity in the frequency range of 2-18 GHz. These materials bear high Snoek's limit due to their high saturation magnetization.

In the present work, we aim to develop lightweight polymeric composites containing small volume fractions of ferromagnetic material with different particle size and shape and intrinsically conducting nanomaterials like MWNTs. Therefore, Ni-Fe alloys with different compositions were prepared by vacuum arc melting process and mixed with MWNTs and PVDF using wet grinding process to design materials for shielding EM radiations. PVDF was chosen as a matrix because of its high dielectric constant, good mechanical properties, thermal stability and chemical resistance. Though the effect of shape and size of the magnetic nanoparticles on the overall shielding efficiency is known but the effect in presence of conducting inclusions is less well understood. Hence, in this work, PVDF based composites were developed with different particle sizes of Ni-Fe alloy and MWNTs. In addition, their structure, morphology, microwave absorption was studied systematically. Moreover, the effect of thickness on the reflection loss is discussed here in.

Ni-Fe alloys with different compositions ($Ni_x Fe_{1-x}$, x = 0.6, 0.8, 0.9 wt%) were prepared by vacuum arc melting technique from high purity elemental constituents. The as-cast alloys were subjected to hot rolling followed by homogenization anneal and then air-cooled. Ni-Fe alloy flakes were obtained by filing with a diamond file. Further, different particle sizes were obtained under controlled grinding using mortar grinder over a period of time (1 h, 2 h and 3 h) yielding different sizes. The average particle sizes thus obtained are 600 nm, 300 nm and 200 nm after 1 h, 2 h and 3 h of grinding respectively. Commercially available PVDF (Kynar 741), supplied by Arkema, was used in this work. The pristine MWNTs were obtained from Nanocyl (NC 7000). Different batches were prepared by mixing PVDF powder with Ni-Fe alloy particles using a mortar pestle for 30 min and the solvent (Dimethylformamide, DMF) was added drop-wise to make a paste. This method was adopted because of the tendency of metal powder to agglomerate during processing either in solution or in melt. The resultant paste was then vacuum dried to remove the traces of solvent followed by compression moulding at 220°C in a laboratory scale hot press. Similar process was repeated to prepare batches in presence of MWNTs in addition to Ni-Fe particles in PVDF matrix.

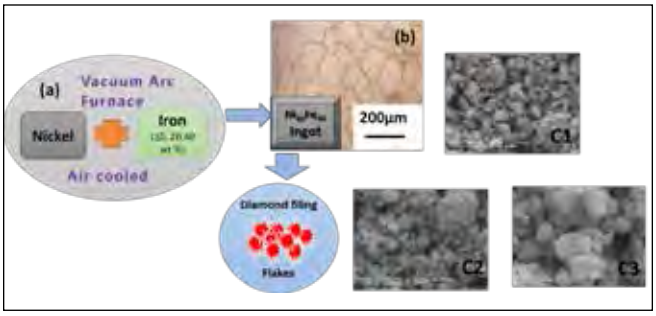


Figure 1: *(a) Processing of Ni-Fe alloys (b) Microstructure of Ni-Fe alloys c1) SEM micrograph of Ni-Fe alloys ground after 1h (scale 1μm) c2) 2h (scale 500 nm) and c3) 3h (scale 200 nm)*

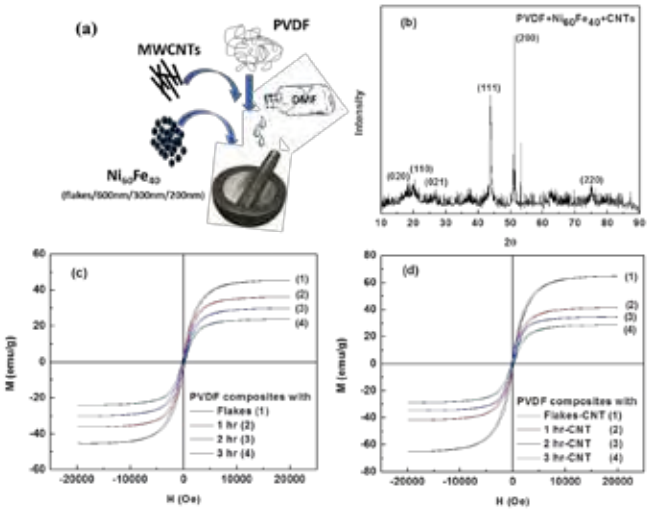


Figure 2: *a) Preparation of PVDF/Ni-Fe/MWNTs composite b) XRD pattern for PVDF/Ni-Fe/MWNTs composite c) and d) Hysteresis loop for PVDF/Ni-Fe composite in the absence and presence of MWNTs*

Shielding effectiveness is dominated by three important mechanisms viz. reflection from the shield (SE_R), absorption within the shield (SE_A) and internal multiple reflections (SE_{MR}). Therefore, the total shielding effectiveness of a material is the sum of reflection, absorption and multiple reflections from the shield:

$$SE_T = SE_R + SE_A + SE_{MR}$$

In practical situations the multiple reflection can be neglected if the absorption loss is greater than 10 dB. The above mentioned parameters are calculated with the help of scattering parameters (S_{11} and S_{12}) using the following equations.

$$SE_R = 10\log_{10}(1/(1-[S_{11}]^2))$$

$$SE_A = 10\log_{10}((1-[S_{11}]^2) / [S_{12}]^2)$$

$$SE_T = SE_R + SE_A = 10\log_{10}(1/[S_{12}]^2)$$

Figure 3 shows the shielding effectiveness of PVDF/$Ni_{60}Fe_{40}$ composite with 3 wt% MWNTs as a function of frequency. From this figure it is noticeable that SE total has scaled up to -21.7 dB after addition of 3 wt% MWNTs in PVDF matrix. A similar trend has been observed in the electrical conductivity measurements. The SE value has drastically increased to -28.9 dB after introduction of 50 wt% of flaky $Ni_{60}Fe_{40}$ powder in PVDF/MWNTs composite. The SE values of PVDF/$Ni_{60}Fe_{40}$- MWNTs composites are -31dB, -34 dB and -33 dB for nanoparticles filled composite for 600 nm, 300 nm and 200 nm particle sizes respectively.

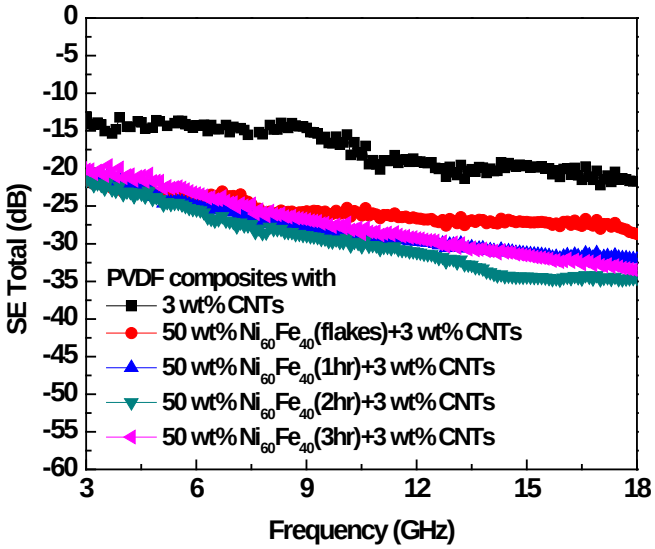


Figure 3: *Shielding effectiveness (a) PVDF composites with different particle sizes of $Ni_{60}Fe_{40}$ alloy (b) PVDF composites with different particle sizes of $Ni_{60}Fe_{40}$ alloy and MWNTs*

We are making at attempt to understand the mechanism behind the EMI shielding in these composites and trying to develop highly conductive materials and their feasibility of these samples will be checked for EMI shielding applications.

VK Chandrasekar

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Synchronization in Complex Networks: Application in Neurophysics and Spintronics

The study of synchronization in complex systems is the focus of this project. We have observed that symmetry breaking in networks of globally coupled oscillators leads to increased disorderliness in the dynamical behavior of oscillatory states and consequently results in a rich variety of dynamical states such as amplitude chimera, amplitude cluster, frequency chimera, and frequency cluster states [1]. We have also shown that coexisting domains of coherent and incoherent oscillations can be induced in an ensemble of any identical nonlinear dynamical systems using nonlocal rotational matrix coupling with an asymmetry parameter [2]. Surprisingly, we have found that the basin of attraction of an ensemble of identical bistable oscillators can indeed display coexisting coherent and incoherent domains with distinctly different nature of attractors mimicking chimera states under a common forcing, even without any explicit coupling [3]. We investigated the remarkable role of position-dependent damping in determining the parametric regions of symmetry breaking in nonlinear PT -symmetric systems. Here we have unveiled the existence of a class of twofold-PT -symmetric systems [4]. We have experimentally demonstrated that a processing delay, a finite response time, in the coupling can revoke the stability of the stable steady states, thereby facilitating the revival of oscillations in the same parameter space where the coupled oscillators suffered the quenching of oscillation [5].

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Correlating Microstructure Evolution in Lithium Ion Battery Anode Material with Electrochemical Behavior

A manuscript titled "Estimating Arrhenius Parameters Using Temperature Programmed Molecular Dynamics" is currently under review in The Journal of Chemical Physics. The manuscript describes a novel approach for determining the Arrhenius parameters of lithium diffusion in silicon. The main points are highlighted below.

Silicon is a promising anode material for lithium ion batteries due to its high theoretical specific capacity of 4200 $mAhg^{-1}$. The mechanism for Li diffusion in crystalline Si has been studied using density functional theory (DFT). These studies show that Li preferentially occupies tetrahedral sites. The prohibitive cost of DFT has prompted the use of semi-empirical interatomic potentials, such as ReaxFF and modified embedded atom method (MEAM) potentials. Unfortunately, the energy landscape for these potentials is corrugated because of the numerical form of interatomic potential being employed. Calculating the pre-exponential factor for Li diffusion becomes challenging. We employ the TPMD method to calculate the Arrhenius parameters for single Li diffusion in Si using the MEAM potential.

A periodic box of 10.854 Å × 10.854 Å × 10.854 Å, i.e., 2×2×2 unit cells was used (Fig. 1). The TPMD parameters used were T_0=450 K, τ=0.3 ns, ΔT = 150 K and T_{max}=1200 K. The large value of τ enables few transitions to be observed even at 450 K. Fig. 1 shows three other Tet sites in white circles. Nearly 8% of the transitions involved a move from Tet-Hex. While residing in the hexagonal site the Li distance to the six nearest Si neighbours is nearly 2.4 Å. Since Li in hexagonal site is an intermediate for the Tet-Tet it is possible that Li was trapped in the Hex site for sufficiently long (2 ps or more) for the event to be detected as a transition.

The distribution for all waiting times collected using TPMD is shown in Fig. 2. Most transitions were observed at 750, 900 and 1250 K. The pre-exponential factor and barrier for Tet-Tet moves was found to be 70.3 ps^{-1} and 0.71 eV. The analytical TPMD distribution are plotted using the Arrhenius parameters for Tet-Tet moves. The analytical distribution is in close agreement with the collected waiting times suggesting that diffusion proceeds mainly via Tet-Tet moves. The Tet-Tet barriers are in close agreement with experimental values of 0.57-0.79 eV. DFT calculations based on the HTST approximation have estimated a pre-exponential factor of nearly 10 ps^{-1} for these moves. The diffusivity $D = kl^2 / 6$ where k is the overall Li hopping rate from TPMD and l is the hopping distance is estimated to be 2.4×10^{-13} cm^2/s, which is within an order of magnitude of the experimentally reported value.

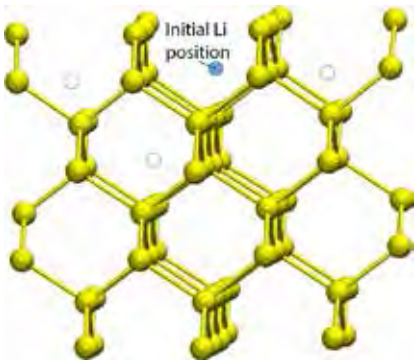


Figure 1: *Single Li atom at a tetrahedral site (blue circle) in 2×2×2 unit cells of Si can jump to neighbouring tetrahedral sites (open circles).*

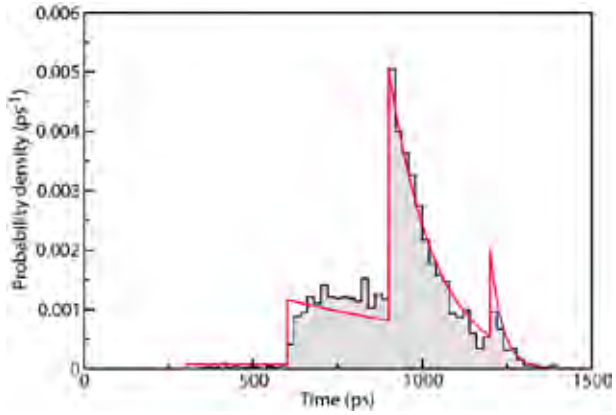
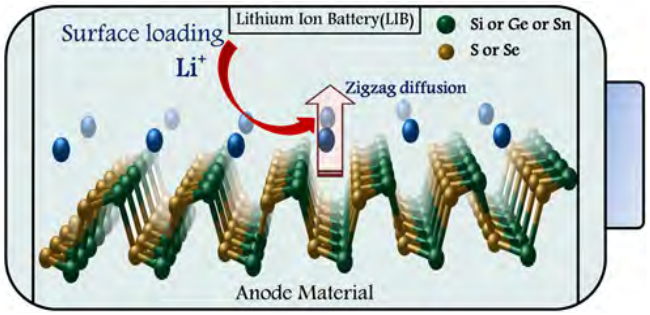


Figure 2: *TPMD distribution for waiting times is shown in grey*

Ayan Datta

Associate Professor, Department of Spectroscopy, Indian Association for the Cultivation of Science, Kolkata

Effect of Quantum Mechanical Tunneling on Reaction Rates of Organic and Organometallic Reactions



Evidence for Quantum Mechanical Tunneling (QMT) by heavy particles like proton at room temperature are very rare. Choice of suitable electrode material is a fundamental step in Li-ion battery (LIB) to achieve enhanced performance. We have explored the feasibility of phosphorene analogs, *i.e.* group IV monochalcogenides (SiS, SiSe, GeS, GeSe,SnS and SnSe) monolayers to serve as anode material in LIB by density functional theory (DFT). Our exploratory study indicates lithium binds weakly to GeS, GeSe, SnS and SnSe monolayer which should restrict their performance as negative electrode in LIB. However, SiS and SiSe show appreciable binding energies that are comparable to phosphorene. Zero point energy corrected minimum energy pathway (MEP) for Li diffusion demonstrates high anisotropy for both SiS and SiSe with a low diffusion barrier of ~0.15eV along the zigzag direction. Inclusion of corrections due to quantum effects like the zero point energy (ZPE) and quantum mechanical tunneling (QMT) increase the diffusion rates by 6-10 % at room temperature and become increasingly significant as temperature is reduced (40-55 % increment at T=100K). The calculated theoretical capacity for SiS and SiSe are 445.7mAh/g and 250.44mAh/g respectively which are well above existing commercially available used anode materials. Both SiS and SiSe preserve their structural integrity upon lithiation justifying their role as host material for lithium. A semiconductor → metallic transition is observed upon full lithiation for both. All these exceptional properties including low diffusion barrier, moderate to high specific capacity, low open circuit voltage (OCV), small volume change and good electrical conductivity, suggest that monolayer SiS and SiSe could serve as a promising electrode material in LIB.

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Influence of Small Molecules on Self Assembly of Type I Collagen to Prevent Cardiovascular Diseases

Background

Collagen is an abundant protein present in the extracellular matrix in mammals. An excessive accumulation of collagen fibrils leads to the narrowing of arteries, which results in cardiac fibrosis thus contributing towards the progression of various cardiovascular diseases. In this present study, potential small molecules to retard or inhibit collagen fibril formation will be explored.

As proposed literature survey on the possible small molecules, which would inhibit the fibril formation of collagen was carried out in this one month. Olive oil from Olea europaea, which forms one of the main components of Mediterranean diet contains a phenolic compound called oleuropein. It is commercially available as food supplement in Mediterranean countries due to its pharmacological activities, which includes antioxidant, anti-atherogenic, anti-inflammatory, antimicrobial, antiviral, anti-cancer properties, hypolipidemic and hypoglycemic effect. It has been shown to be cardioprotective against acute cardiotoxicity and also slow down neurodegenerative and cardiovascular diseases. Hence, oleuropein has been selected to have a detailed study about its interaction with collagen for inhibiting cardiac fibrosis.

SK Ghosh

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Development and Functional Studies of Metal-Organic Polyhedras (MOPs)

Metal-organic polyhedra (MOP) have emerged as a rapidly evolving class of porous material owing to its ease of design, synthesis and potential wide range of applications.[1] The compounds are built via coordination bonds and have well-defined and designable cavities.[2] We have synthesized compounds for gas and vapour separation applications in addition to water and chemical stability.

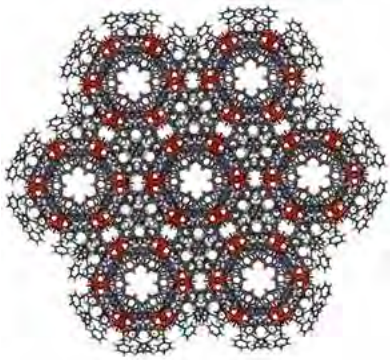

Figure 1: *Packing diagram of MOP-1 showing 1D porous channel along c-axis*

Carbon storage and sequestration (CSS) technology has commanded significant attention in the last few years on account of growing global pollution. Although congener materials like MOFs & COFs have been investigated for sorption by employing various strategies,[3] the corresponding work in MOP-based systems has not been explored much. With this background, we have designed several MOPs which can selectively adsorb CO_2 over gases having similar sizes by using functionalized ligands. As a representative compound among synthesized several similar compounds, we have synthesized MOP-1 having Lewis basic sites decorating the pore surface within the cage. The compound has a symmetric porous channel along-with large voids which can facilitate high uptake of guest molecules in a selective manner (Figure 1). MOP-1 is thermally stable and retains its crystallinity even after the compound has been desolvated by thermal treatment (Figure 2a), which is generally not observed for porous discrete systems.

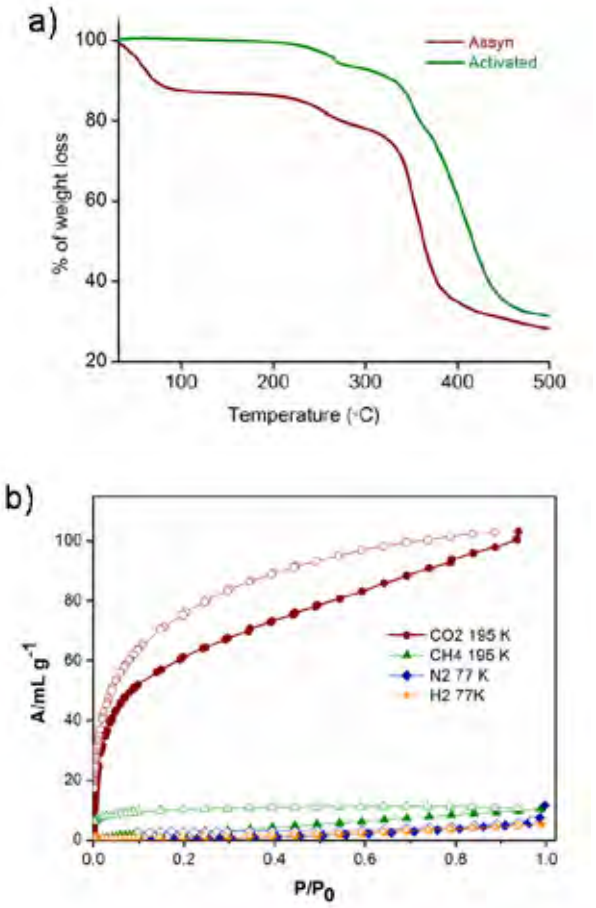

Figure 2: *a) TGA of MOP-1 b) Gas adsorption isotherms of activated MOP-1. Filled shapes = adsorption, unfilled shapes = desorption*

Upon checking the gas adsorption capacity of the compound with adsorptive having similar sizes viz. N_2, CO_2, Ar, He, H_2, the compound was found to show selective uptake for CO_2 only at low temperature owing to the secondary functional units incorporated in the compound (Figure 2b).

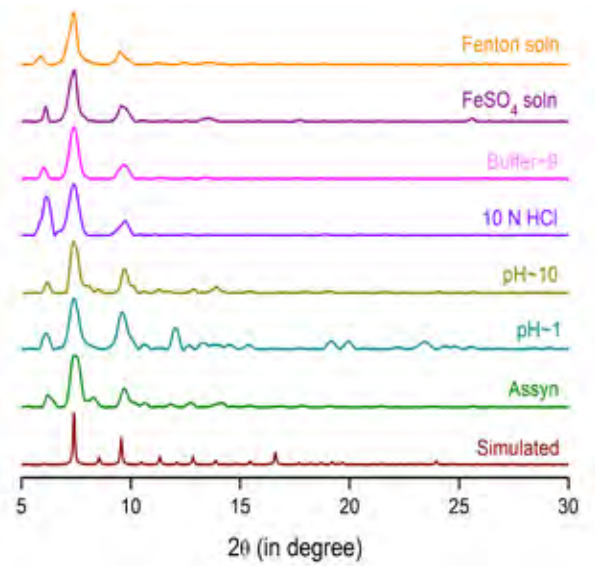

Figure 3: *Bulk phase stability checked in different environment*

Enthused from this result we are working towards development of hydrolytically stable cage systems which can be suited for real-time applicability.[4] By varying the length and the hydrophobic character of the organic linker we have managed to shield the metal-ligand bonds thereby bestowing enhanced stability. This hypothesis was found to hold up even in presence of several strong chemical agents and aqueous solutions with varied pH.

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Construction of a Photoelectron Spectroscopy Experiment for Studying Electronic Structure of Gas-Phase Interstellar Medium Anions

Main objective of the proposal:

We aim at building a complete photoelectron spectroscopy setup which employs a supersonic ion source for producing internally cold interstellar-medium anions and study their photoelectron energy spectra.

Work done in the third year:

We have constructed a velocity map imaging spectrometer

(VMI), in which all photoelectrons with same velocity are focused onto a single point on the position sensitive detector. Thus both energy and angular distribution can be measured. In our VMI we have a repeller, ground and flight tube electrodes.

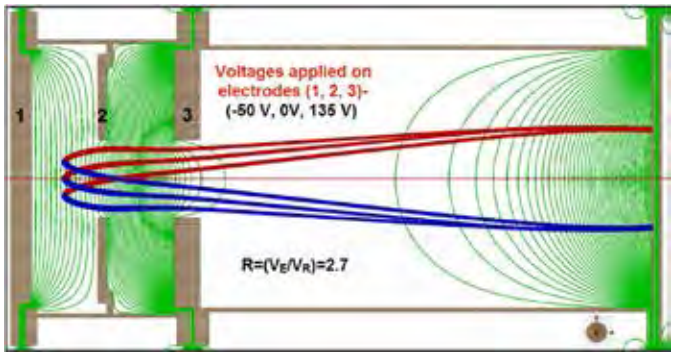

Figure1: *Figure discusses how photoelectrons having same velocity vector originating from different source positions reach the same point on the detector.*

Simulations are performed for photoelectrons having same kinetic energy 1eV originating from various source positions and are presented in the Figure 1. The simulations are performed for three different elevation angles which are -90°, 0° and 90°. To obtain the optimum condition for our VMI spectrometer, we have performed simulations for various repeller-to-flight tube voltage rations, represented by R= V_R/ V_E, where V_R and V_E are repeller-plate and flight-tube voltages, respectively. The results are discussed in the Figure 2. From the simulations, it is found that, for R=2.7, optimum VMI condition is achieved. In this case, the repeller-plate voltage is -50 V and the flight-tube voltage is 135 V.

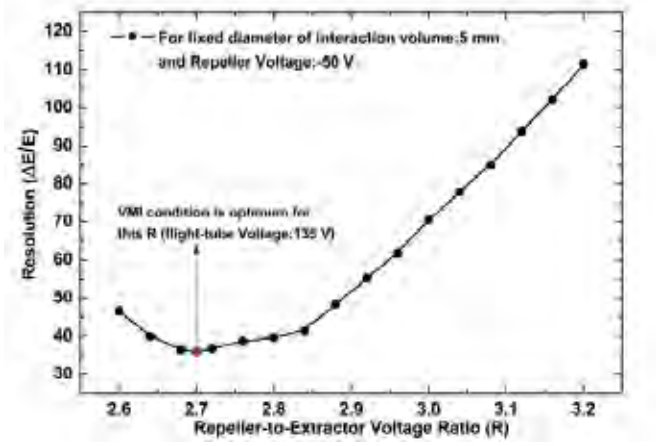

Figure 2: *The VMI simulations are performed for fixed interaction volume diameter (5 mm)*

Simulations shown in the Figure 3, demonstrate the behaviour of photoelectrons traversing with the same kinetic energy 1eV for various R values. Among these simulations, part (b) results are very close to the optimum condition of VMI which is R=2.7, as discussed above. The other two cases show that the focal plane is either at shorter or at farther distance than where the detector is mounted. To show how the photoelectron kinetic energy is related to the square of the radius, the simulations are done and discussed for various photoelectron kinetic energies in the Figure 4. Our results show that our spectrometer can detect photoelectrons having kinetic energy in the range 0-3 eV, for the VMI optimum condition which is fixed for 1 eV kinetic energy photoelectrons.

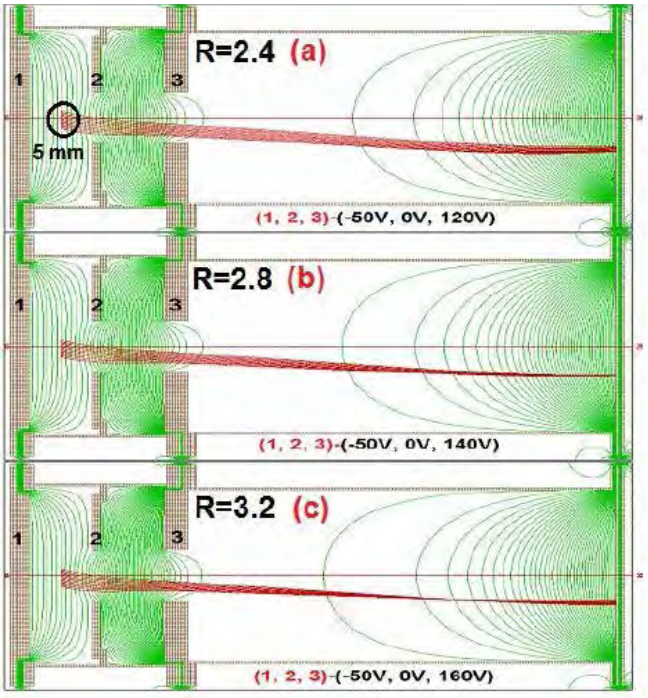

Figure 3: *VMI simulations performed for different 'R' to understand the behaviour of photoelectrons traversing with the same kinetic energy 1eV*

In the Figure 4, part(a) shows photoelectrons whose initial momentum direction has elevation angles -90°, and 90° with fixed azimuthal angle of 90° and the interaction volume diameter considered is 5 mm. In part (b), the velocity vectors are varied by varying elevation angle from -180° to 180° with same azimuthal angle and interaction volume diameter as in part (a).

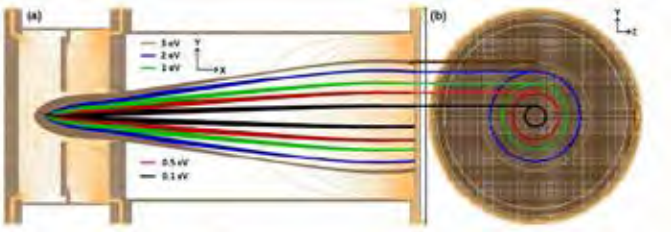

Figure 4: *VMI simulations performed to demonstrate the behaviour of photoelectrons traversing with different kinetic energies*

The radius (r) of the each circle is proportional to electron's energy and the energy resolution is found to be 4.5 meV for 1 eV photoelectron kinetic energy.

Testing the VMI spectrometer:

Currently we are testing the VMI through multi-photon ionization experiment of argon (Ar) with 355 nm.

Tarun Gupta

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Chemical Characterization of Organic Aerosols under Different Environmental Conditions

During first year, we have collected $PM_{2.5}$ samples (n ≈ 150) onto Tissuquartz filters (20 x 25 sq. cm) using a high-volume air sampler from Kanpur location in the Indo-Gangetic Plain (IGP). These samples were collected during three contrasting seasons: Monsoon (July–September 2015) associated with deeper boundary layer and long-range transport; wintertime (December 2015–February 2016) marked with low dust and high carbonaceous aerosols and, ongoing pre-monsoon campaign (April–May 2016) associated with high dust and low concentration of carbonaceous aerosols. Also, we have initiated a long-year campaign monitoring organic aerosols variability in December 2015 from a downwind location at Allahabad too in IGP with the aid of this project. The sampling at Allahabad may be active at least till end of 2016. So far, we have collected over 30 samples ($PM_{2.5}$) from Allahabad. Besides the offline sampling, we have run a week-long (day and night) campaign during Diwali 2015. The major emphasis was to understand the impact of fire-works on the ambient concentrations of organic aerosols including polycyclic aromatic hydrocarbons (PAHs). In this campaign, we have utilized Sunset Laboratory online EC-OC analyzer for elemental and organic carbon determination, Photoelectric Aerosol Sensor (PAS) for particulate-phase ΣPAHs quantification and Ozone analyzer. The ΣPAHs (particulate-phase) vary from 8–62 ng m^{-3} during the study period (in Diwali). The other data analysis related to this campaign is complete and a manuscript on PAHs is under preparation.

We have also assessed brown carbon (BrC) and water-soluble organic carbon in PM_1 samples collected in a previous year (December 2014–February 2015). This manuscript has been submitted recently for review in Environmental Science and Technology. Proper acknowledgement to the INSA for funding has been made while submission of this manuscript. The chemical analysis (Organic carbon, Elemental Carbon, Water-soluble organic carbon and water-soluble inorganic species (e.g. K^+) measurements and data analysis is going on payment basis utilizing central facility at IIT Kanpur. Another manuscript under preparation is on carbonaceous aerosols and water-soluble ionic species during SW-monsoon period (July–September 2015). This manuscript assesses the impact of long-range transport over IGP during prevailing SW-wind system. Through several offline and online techniques we are observing a distinct seasonal variability in organic aerosols over the IGP. The information from preliminary data set indicates significant variability in the source/strength of biomass burning emissions. We have finalized an analytical protocol for quantification of PAHs. Accordingly, some aerosol samples collected from both the aforementioned locations in IGP will be assessed for individual PAHs using liquid extraction followed by quantification (on a payment basis). We trust that our efforts in understanding various processes related to ambient organic aerosols over the IGP would lead to better insight into the aspects related to physico-chemical characterization.

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1. Project Title:

RutheniumCatalyzed Highly Regio and Stereoselective Oxidative Coupling of π-Components: A Versatile Route to Substituted Alkenes, Dienes and Heterocycles

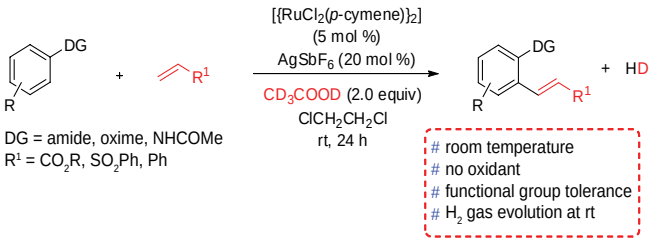
2. Background:

The vinyl arene and allylarene units are present in various natural products and medicinally relevant molecules. In addition, substituted alkene and allylic derivatives are versatile synthetic intermediate which are widely used to synthesize natural products and pharmaceutical molecules. Various routes are available in the literature for synthesizing allylaromatics in organic synthesis. Among them, allyl and alkene arenes are prepared by a metalcatalyzed cross-coupling of aromatic electrophiles or organometallic reagents with allylic electrophiles or organometallic reagents. However, in these reactions, a preactivated halogen or metal species is needed.

3. Salient Research Achievements Summary:

Scheme 3.1: RutheniumCatalyzed Oxidative coupling of Aromatic amides with alkenes at Room Temperature

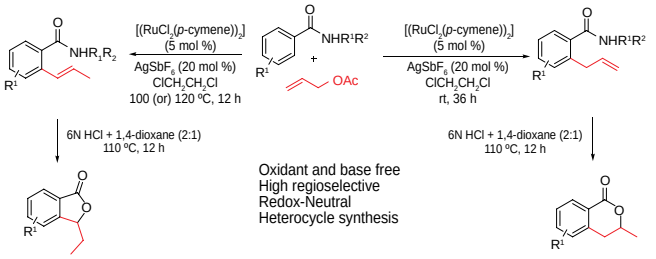
A ruthenium catalyzed oxidant free highly regioselective ortho alkenylation of substituted aromatics such as aromatic amides, aromatic ketoximes and anilides with alkenes in the presence of $AgSbF_6$ and acetic acid in $ClCH_2CH_2Cl$ at room temperature is described. The alkenylation reaction provides *ortho* alkenylated aromatics along with evoluation of H_2 gas. In the reaction, no oxidant was used and the whole catalytic reaction has occurred without changing the oxidation state of metal. The scope of the alkenylation reaction was examined with various substituted aromatic amides. The alkenylation reaction was compatible with various sensitive functional groups such as F, Cl, Br, I, CF_3 and NO_2 substituted aromatic amides.



Scheme 3.3: *ortho* Alkenylation of substituted aromatics (*ACS Catal.*, **6(1)** (2016) 230)

Scheme 3.2: Temperature-Controlled Redox-Neutral Ruthenium(II)Catalyzed Regioselective Allylation of Benzamides with Allylic Acetates

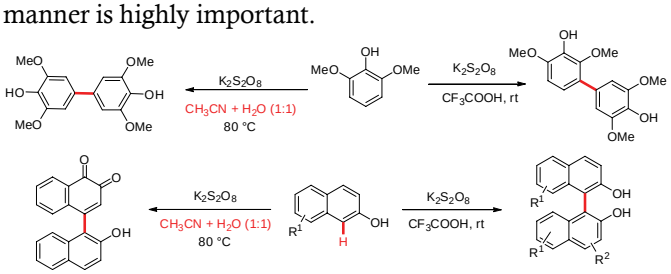
A redox-free ruthenium catalyzed allylation of benzamides with allylic acetates without any oxidant at room temperature is described. The whole catalytic reaction proceeds in a Ru(II) oxidation state. In the reaction, acetate moiety of allylic acetate acts as a base to deprotonate the C H bond. The acetate moiety of allylic acetate intramolecularly transferred into the ruthenium catalyst via β-acetate elimination and maintain the Ru(II) oxidation state. It is important to note that the same reaction provided vinylarenes at a higher temperature. It is important to note that the C H bond activation as well as allylation takes place at room temperature. But, a higher reaction temperature is needed for the double bond migration. The reaction temperature decides the fate of regioselectivity of the product. The double bond migration and mechanism was clearly supported by a deuterium labelling experiment. A possible reaction mechanism of allylation reaction was proposed and supported by the isolation of key metalacycle intermediate and experimental evidences. ortho Allyl and vinylated aromatic amides were converted into biologically useful six- and five membered containing benzolactones in the presence of HCl.



Scheme 3.4: *ortho* Allylation of substituted aromatics (Under submission)

Scheme 3.5: Solvent Controlled Selective Synthesis of Biphenols and Quinones via Oxidative Coupling of Phenols

Biphenol units are present in various natural products, drug molecules and functional materials. In addition, biphenol molecules are efficiently used as ligands in various organic transformations including enantioselective reactions. Generally, nature prefers to synthesize biphenol molecules via an oxidative phenol coupling in the presence of oxidative enzymes such as laccase, peroxidase and cytochrome P450 (CYP) as catalysts. The development of highly efficient, easily accessible and environmentally friendly method for synthesizing biphenol molecules under mild reaction conditions in a highly atom economical manner is highly important.



Scheme 3.3: Oxidative Coupling of Phenols (Under submission)

Herein, we report an efficient route to synthesize symmetrical and unsymmetrical biphenols and binaphthols via oxidative coupling of phenols or naphthols in the presence of $K_2S_2O_8$ in CF_3COOH at ambient temperature. Based on UV-Visible spectroscopic studies, it has been proved that the reaction proceeds via phenoxy cationic radical intermediate. It is also believed that the CF_3COOH solvent stabilizes intermediate cationic radical intermediate via hydrogen bonding and the corresponding intermediate allows the incoming nucleophiles to attack at the various sites of phenols selectively. Thus, in the reaction, *ortho-ortho*, *ortho-meta and meta-para* coupling products were observed. When 1:1 ratio of H_2O and CH_3CN solvent mixtures was used instead of CF_3COOH, *para-para* coupling biphenols, symmetrical and unsymmetrical 1,2-quinones, 1,4-quinones, 1,2-naphthoquinones and 1,4-naphthoquinones were obtained. It is important to note that in the quinone product formation, water acts as a nucleophile. Interestingly, phenolethers reacted with $K_2S_2O_8$ in CF_3SO_3H solvent, giving symmetrical diaryl sulfones. In the reaction, $K_2S_2O_8$ provides SO_2 source.

4. Summary:

In summary, we have described a highly regioselective *ortho* alkenylation and allylation of aromatic amides with alkenes or allylic acetates in the presence of a ruthenium catalyst and $AgSbF_6$ room temperature without an oxidant. Meanwhile, we have also demonstrated an efficient synthesis of biphenols and binaphthols via a $K_2S_2O_8$-mediated oxidative coupling of phenols and naphthols. Further, the preparation of unsymmetrical quinones and diaryl sulfones were also described.

5. List of Publications:

Manikandan R, Padmaja M, Jeganmohan M, RutheniumCatalyzed *ortho* Alkenylation of Aromatics with Alkenes at Room Temperature**.** *ACS Catal.*, **6 (1)** (2016) 230.

Manikandan R, Jeganmohan M, Temperature-Controlled Redox-Neutral Ruthenium(II)Catalyzed Regioselective Allylation of Benzamides with Allylic Acetates (Under Submission).

Yadav More Nagnath and Jeganmohan Masilamani, Solvent Controlled Selective Synthesis of Biphenols and Quinones via Oxidative Coupling of Phenols (Under Submission).

6. Future work:

1. The alkenylation and allylation will be expanded into a weak group substituted aromatics such as aromatic ketone, aldehydes, ester and nitrile. Meanwhile, a proper effort will be devoted to do a similar type of transformation of alkenylation and allylation at the sp3 CH bond of organic molecules.
2. The oxidative cross-coupling reaction of phenols with substituted aromatics will be tried in the presence of $K_2S_2O_8$ at room temperature. In the reaction, the unreactive two CH bond of aromatics cab be coupled efficiently.
3. The developed methodology will be used for the synthesis of biologically active molecules such as alkaloids and potential antioxidant biphenol molecules.

Niti Kumar

Scientist, CSIR-Central Drug Research Institute, Lucknow

Understanding the Auxiliary Roles of HSP110 in *Plasmodium falciparum*

Plasmodium falciparum requires a highly efficient protein folding machinery to keep its metastable-aggregation prone proteome in soluble and functional state. To identify the important components of protein folding machinery involved in maintenance of *P. falciparum* proteome, we performed a proteome-wide phylogenetic profiling across various species. We found that the parasite has lost all other cytosolic nucleotide exchange factors and retained only HSP110 which is essential for regulating HSP70. Evolutionary and structural analysis shows that besides its canonical interaction with HSP70, PfHSP110 has acquired sequence insertions for additional dynamic interactions. Molecular co-evolution profile depicts that the co-evolving proteins of PfHSP110 belong to distinct pathways like genetic variation, DNA repair, fatty acid biosynthesis, protein modification/ trafficking, molecular motions, and apoptosis. This suggests that HSP110 may serve as an important hub to coordinate the protein quality control, survival and immune evasion pathways in the *P. falciparum*. Our data open avenues for experimental validation of auxiliary functions of PfHSP110 and their exploration for design of better antimalarial strategies. (*Proteins*, **83(8)** (2015) 1513).

Figure: *Structural analysis of HSP110 homolog in (A) human and (B) P. falciparum using yeast HSP110 (PDB: 2QXL). Nucleotide binding domain is denoted as NBD and substrate binding domain is denoted as SBD. The insertions in the protein are shown in red.*

GV Pavan Kumar

Assistant Professor, Division of Physics, IISER Pune

Development of Advanced Optical Microscopy System for Surface Enhanced Raman Scattering

In the context of the INSA grant, there are two major aspects of our work:

1. To develop a multi-modal SERS far-field optical microscope workstation capable of probing metallic nano-architectures in spatial, temporal and spectral domains. The proposed workstation will have capabilities to probe electronmagnetic enhancement effects in SERS and nonlinear optical effects such as plasmon-enhanced second harmonic generation and plasmon-coupled two photon luminescence from metallic nanoarchitectures.
2. To integrate the above mentioned microscope workstation with optical spectroscopy methods such as spectral interferometry and plasmon-coupled fluorescence emission, and further utilize them to concomitantly probe linear and non-linear optical properties of plasmonic nanostructures that leads to better understanding of linear and non-linear nanoplasmonic effects.

For the past year or so, we have been focusing our efforts on:

Plasmonics and Excitonics in Fourier space: Conventionally, image of an object is captured in real space, where the intensity of the emitted light is mapped as a function of spatial coordinates (x,y,z). There is another way to capture the image of an object, where the directionality of the emitted light is mapped on to so-called reciprocal space (kx, ky, kz). The image-intensity distribution in such reciprocal space represents the wave-vector distribution, and hence the directionality of the emergent light. Such imaging methods are usually called as Fourier-space imaging techniques, and are vital to understand light-matter interaction especially at nanoscale. For the past few months, we have constructed and optimized this advanced optical imaging/spectroscopy method to study plasmonic and excitonic nanostructures. Specifically, we have been addressing the issue of optical antenna effects in such nanostructures.

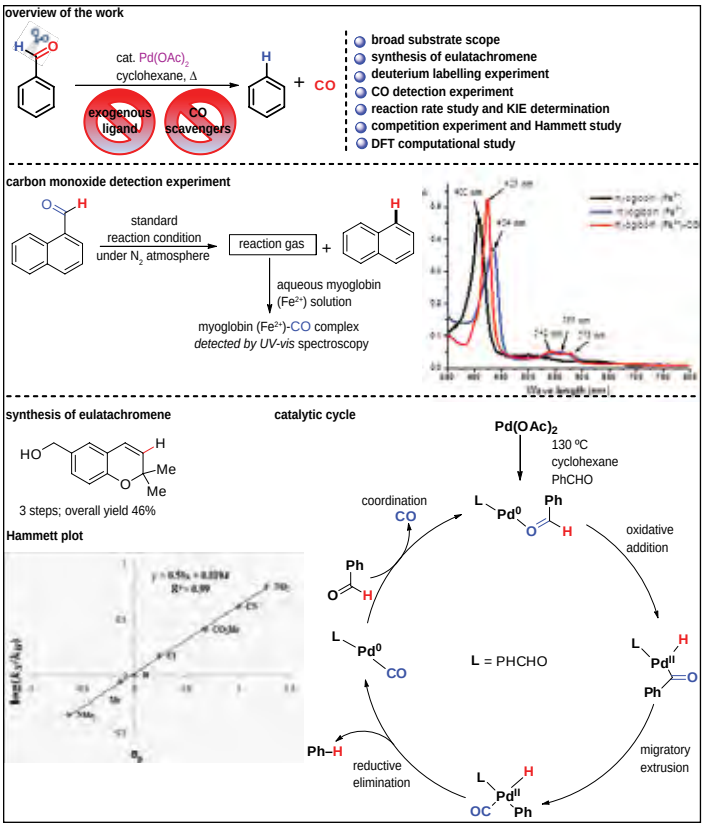
Construction of a femtosecond pump-probe optical microscopy and spectroscopy: A tunable, femtosecond Ti-Sapphire laser, which is now been coupled to our indigenous two-channel microscope system. In the next few months, we will employ this system to perform femtosecond pump-probe micro-spectroscopy. We are interested in using this technique to study picosecond ultrasonics of plasmonic, excitonic and phononic crystal in real and momentum space. Such study give direct insight into energy cascade processes in nanostructures and has relevance in both fundamental physics and applications.

Debabrata Maiti

Associate Professor, Department of Chemistry, Indian Institute of Technology Bombay

Palladium catalyzed deformylation reaction with detailed experimental and *in-silico* mechanistic studies

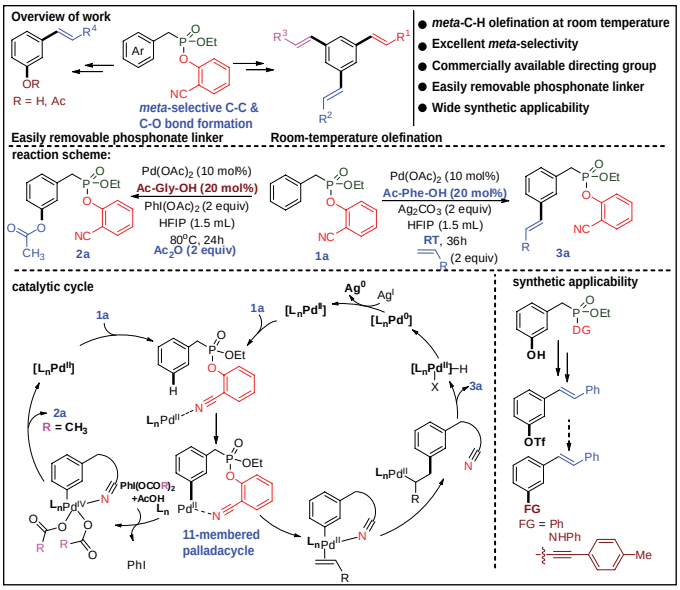
Development of transition metal mediated defunctionalization reaction has immense significance in metal catalysed coupling reactions for their similarity in reaction pathways. Since, a similar type of metal-organic intermediate is responsible for both the reaction, the mechanistic understanding of the defunctionalization reaction can give rise to discovery of new synthetic transformations. In this context, a facile, efficient and general deformylation reaction has been developed using palladium acetate as precatalyst in exogeneous ligand-less condition with a broad substrate scope compatibility. To our delight, the deformylation strategy was successfully applied for the synthesis of chromene (benzopyran) class of natural products such as eulatachromene. Mechanistic details of the palladium catalyzed deformylation reaction have been outlined with the combination of experimental and computational studies. The kinetic studies suggested that the deformylation reaction follows a 1st order kinetics with respect to the aldehyde. The comparative kinetic studies revealed that the deformylation reaction of 4-methylbenzaldehyde-α-d^1 is relatively slower than that of 4-methylbenzaldehyde. A deuterium isotope effect k_H/k_D of 1.63 is observed. The relatively small value of kinetic isotope effect (KIE) indicates that C–H bond breaking may not be involved in the rate determining transition state. The generation of a small negative charge at the transition state (TS) of the rate determining step (RDS) is established from the observed positive slope of +0.59 from the Hammett plot. All these information indeed suggested that an oxidative addition at the C–H bond of aldehyde and the migratory extrusion of CO to the palladium centre were involved in the catalytic cycle as both of these steps can lead the complex with more negative charge. The DFT computational study suggests that the migratory extrusion step is the rate determining step which is reestablished by the experimental findings of Hammett study and the kinetic isotope effect.



Publication:

Modak A, Rana S, Phukan AK, Maiti D, Manuscript submitted.

Room-Temperature meta-Functionalization: Pd(II)-Catalyzed Synthesis of 1,3,5-trialkenyl Arene and meta-Hydroxylated Olefin



Organophosphonates have played important role in bio-organic chemistry and pharmaceuticals. These are important synthons for various synthetic transformations

including the preparation of alkenyl derivatives via Horner-Wadsworth-Emmons reactions. However, transition metal catalyzed *ortho*-C–H functionalization reactions are well explored, related meta-C–H activation poses a significant challenge. Regardless of the functionalization, a successful meta-C–H bond activation relies on the perfect design of the directing group (DG) linkage, coordinating site and the choice of metals. In this context, we have demonstrated the potential of commercially available, simple 2-cyanophenol moiety as the directing scaffold for meta-C–H functionalization reactions at room temperature. Successful implementation of sequential di-*meta*-olefination led to the synthesis of tri-alkenyl arene having applications in organic electronics and optoelectronics. Under robust conditions, C–O bond formation has been discovered for the *meta*-hydroxylation and *meta*-acetoxylation. The utility of meta-C–H hydroxylation was demonstrated by attempting further extension of the hydroxylated product to synthetically useful molecules.

Publication:

Bera M, Sahoo SK, Maiti D, *ACS Catal.*, **6** (2016) 3575–3579.

Sumantra Mandal

Assistant Professor, Department of Metallurgical and Materials Engineering, Indian Institute of Technology Kharagpur

Synergistic Influence of Five Parameter Grain Boundary Character, Grain Size and Grain Boundary Network Connectivity on Intergranular Corrosion Behaviour in 304L Steel

The present work deals with the optimization of grain boundary character distribution (GBCD) through grain boundary engineering (GBE) in an extra low-carbon type 304L austenitic stainless steel. The solution annealed (SA) specimens (of 4 mm thick sheet strips) were subjected to one-step thermo-mechanical processing (OTMP) route to realize GBE microstructure. In OTMP, SA specimen was subjected to cold deformation of 5, 10 and 15 % in a laboratory rolling mill. The cold deformed specimens were subsequently annealed at two different temperatures (1173 and 1273K) for 1 hour followed by water quenching. The SA and thermo-mechanically processed (GBE-treated) specimens were polished employing standard metallographic polishing procedure. The GBCD of SA and GBE-treated specimens were evaluated employing electron back scattered diffraction (EBSD) based orientation imaging microscopy. The triple junction distribution (TJD) was also evaluated in order to assess the random high angle boundaries (HABs) connectivity.

It has been observed that the fraction of low Σ (Σ≤29) coincidence site lattice (CSL) boundaries have significantly increased in all the specimens following GBE treatment. Especially, a deformation of 5% followed by annealing at 1273K for 1h has led to a significant increase in low Σ CSL boundaries (~75%) as compared to SA (~45%) specimen, whereas, Σ3 boundaries have increased to 65% from the 44%. It has also been observed that the proportions of second and third order twins (i.e. Σ9+Σ27) are more than 5% in the GBE-treated specimens (i.e. with 5% and 10% pre-strain and annealed at 1273K). In contrast to SA specimen, it has also been noticed that twins are mostly the part of grain boundary network in the GBE treated specimens. So, the random HAGBs have been substantially replaced by a large number of twins (Σ3) and its variants (i.e. Σ9 and Σ27) in GBE-treated specimens. The ratio of Σ3 to (Σ9+Σ27), which represents the connectivity of random HABs, decreased from 34 in SA specimen to 7 in R5-1273K specimen. This clearly indicates that the connectivity of random HABs has been significantly disrupted in GBE-specimens. The random HABs connectivity was significantly fragmented in GBE-treated specimens due to the presence of large number of percolation resistant J_3-triple junctions (Σ3-Σ3-Σ9 or Σ3-Σ9-Σ27) as revealed by TJD analysis. It has also been observed that the highest proportions (~34%) of J_3-triple junctions have been achieved in R5-1273K specimen as compared to ~5% in AR condition. Therefore, the specimen subjected to 5% deformation followed by annealing at 1273K for 1hour (R5-1273K) has been considered as optimized GBE-specimen on the basis of high fraction of low Σ-CSL boundaries, disruption of random HABs connectivity as well as the maximum number fraction of percolation resistant triple junctions.

Saptarshi Mukherjee

Associate Professor, Department of Chemistry, IISER Bhopal

Spectroscopic Insights into the Interaction of Metal Nanoclusters with Proteins

The project has been focused in the preliminary investigations related to the synthesis of the metal NCs. We have been successful in synthesizing highly luminescent AgNCs using Tyrosine (Tyr) as protecting group as well as reducing agent. The synthesized blue emitting AgNCs exhibited good photo-stability, high QY (~15 %) and luminescent lifetime of ~ 4.3 ns.

Optimized Synthetic Protocol: By mixing $Ag(NO_3)$ (1.5 mM) and Tyr solution (3 mM) under vigorous stirring followed by the addition of NaOH (pH ~10.5) Ag NCs were obtained. The reaction mixture was incubated at 40°C for 4 hours under constant vigorous stirring to obtain a brownish yellow solution. Initially metal-ligand chelate formation takes place where the Ag^+ ions co-ordinate and get electrostatically stabilized by the carboxylate groups of Tyr, strongly resembling the process of biomineralizaion (Scheme 1) and further phenyl group play a major role in the reduction process. Hence, here Tyr plays a dual role of being a stabilizing agent and a reductant. Further addition of NaOH (pH ~10.5) enhances the reducing ability of –OH group (pKa ~9.46).

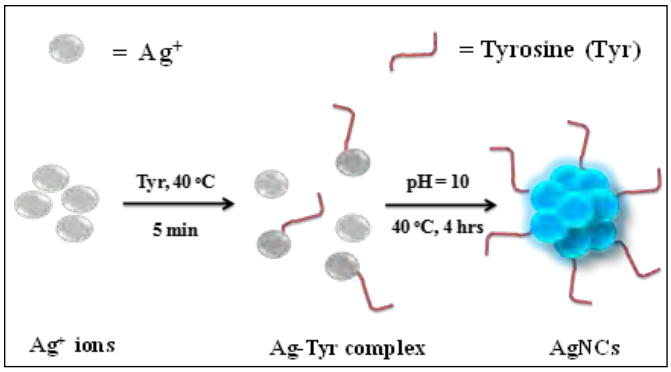


Figure 1: *Schematic representation of formation of the AgNCs using Tyr as a template*

From Figure 1 we can rationally conclude that the optimized conditions for this blue emitting AgNCs are (i) concentration, Ag^+ (1.5 mM) / Tyr (3 mM), (ii) pH = 10.5 and (iii) temperature, 40°C.

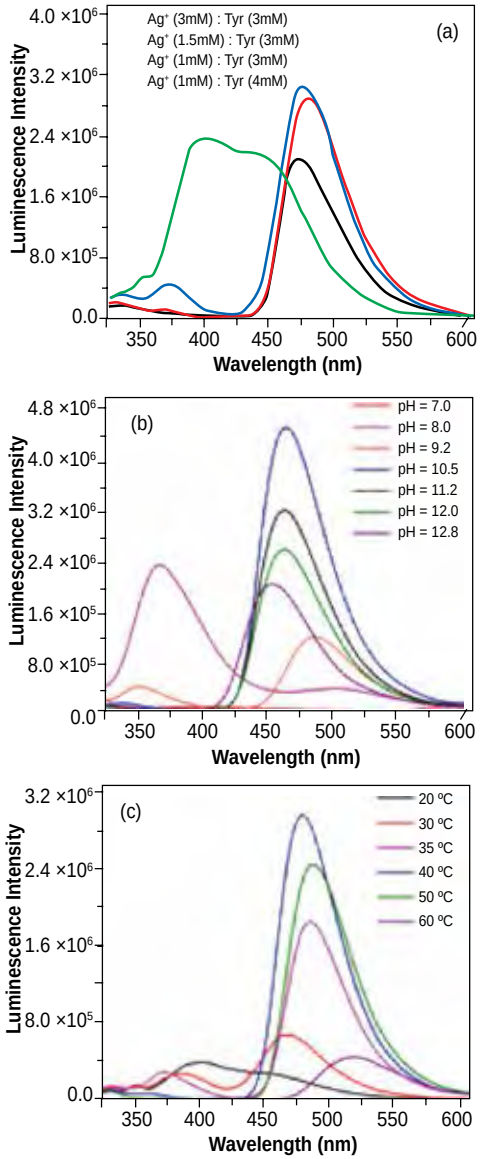
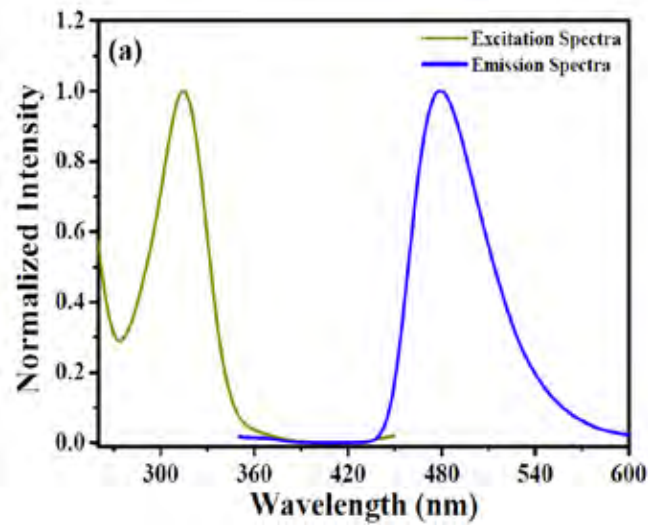


Figure 1: *Synthesis of AgNCs at (a) different concentration ratios, (b) various pH and (c) various temperature*



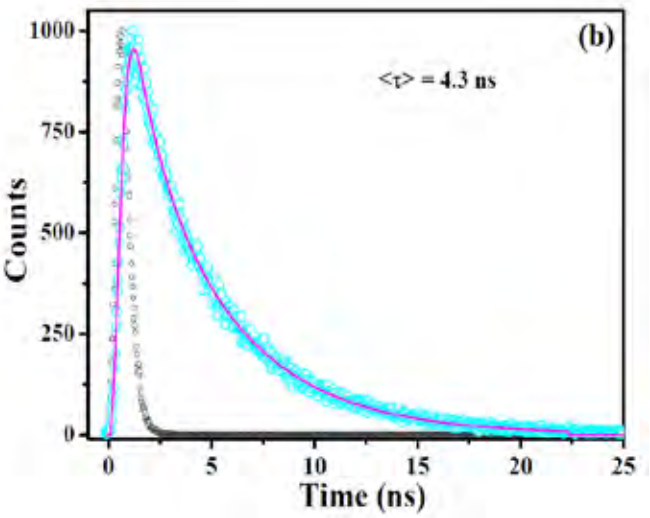


Figure 2: *(a) The normalized excitation and emission spectra of the AgNCs as marked in the figure (b) Representative lifetime decay profile of the AgNCs*

Photo-Physical Properties: The emission spectra (Figure 2a) of AgNCs exhibited intense blue luminescence with peak centered at 480 nm when excited at 315 nm. The QY of the synthesized AgNCs estimated to be ~15% with Coumarin-153 as a reference. The time-resolved luminescence decay transient of the AgNCs exhibited bi-exponential decay with an average value of 4.3 ns [1.27 ns (8.5 %) and 4.56 (91.5 %)] (Figure 2b). Besides having the photo-physical properties as highlighted above, these NCs were stable even for a month retaining almost all its spectroscopic properties.

Determination of Atomic Composition Using Jellium Model: The Jellium model is a conventional theoretical approach for estimating atomic composition of the metal NCs according to the following equation:

$$E_{em} = E_{Fermi} / N^{0.33} \quad \ldots (1)$$

where, E_{em} = emission energy of the nanoclusters (2.583 eV) at 480 nm

E_{Fermi} = Fermi energy of the Ag (5.49 eV)
N = number of metal atoms = 9.6

Hence, from the Jellium model we confirm the presence of ~10 Ag atoms in the each NCs.

Conclusion: So far we have been successful in establishing that the amino acid (Tyr) templated luminescent AgNCs, which besides being rarely explored, are bio-compatible in nature. In the future we will further characterize these synthesized NCs and show practical applications.

Dhananjay Nandi

Associate Professor, Indian Institute of Science Education and Research, Kolkata

Development of Novel Velocity Map Imaging Technique for the Study of Molecular Dynamics

The main aim of our group is to study molecular dynamics using low-energy electron collisions with gas phase molecules. Under this project we have developed the velocity map imaging spectrometer at IISER Kolkata using the major support from the parent institute. Recently, we moved from our transit campus to our permanent campus and reestablished the spectrometer. The spectrometer has been successfully applied in various simple molecules. In the last one year the spectrometer has been probed to study some molecules of our interest.

The following key steps have been implemented over last one year

- The veto electronics has been implemented in our experimental technique to avoid unwanted noise observed.
- The spectrometer has been successfully used to study the dissociative electron attachment (DEA) process to chlorine molecule and some interesting new results have been obtained. The details have already been published in Physical Review A journal and a preprint is at arXiv 4506.02524, (2015).
- DEA to ethanol has also been studied and the analysis is under process.
- Angular distribution of the negative ion fragments produced due to polar dissociation from oxygen and has also been studied using the spectrometer.
- Detailed analysis on dipolar dissociation dynamics in electron collisions with carbon monoxide has been performed and submitted in Physical Review A.

Publications:

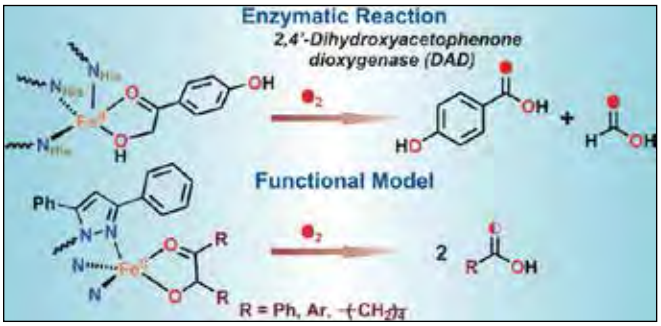
Nag Pamir and Nandi Dhananjay, Identification of overlapping resonances in dissociative electron attachment to chlorine molecules. *Phys. Rev. A*, **93** (2016) 012701.

Chakraborty Dipayan, Nag Pamir and Nandi Dhananjay, Dipolar dissociation dynamics in electron collisions with carbon monoxide. *Phys. Rev. A,* (2016) (under review).

TK Paine

Professor & Head, Department of Inorganic Chemistry, Indian Association for the Cultivation of Science, Kolkata

Biomimetic Functional Models for C–C Bond Cleaving Dioxygenases: Reactivity and Mechanistic Studies



Objectives and achievements: The objective of this project was to probe the mechanism of the reaction catalyzed by C-C bond cleaving iron oxygenases using biomimetic iron complexes. In that direction, a series of biomimetic iron(II)-α-hydroxy ketone complexes supported by a facial N_3 ligand and a tripodal N_4 ligand have been isolated and characterized. The iron(II) complexes react with dioxygen to oxidatively cleave the aliphatic C–C bond of α-hydroxy ketones, yielding 2 equiv of carboxylic acid. In the C–C bond cleavage reaction, an oxygen atom from dioxygen is incorporated into each carboxylate unit. An iron(III)-superoxo intermediate is implicated to initiate the oxidative transformation reaction, and the C–C bond cleavage reaction follows the mechanism of an intradiol cleavage pathway. The iron complexes of the tridentate ligand afford a higher amount of C–C cleavage products in comparison to those of the tetradentate ligand, supporting the natural selection of a "3-His facial motif" in the active site of the bacterial enzyme, 2,4'-dihydroxyacetophenone dioxygenase (DAD). The C–C bond cleavage of α-hydroxy ketones by the iron complexes provides useful insights into the mechanism of oxygen-dependent aerobic degradation of toxic pollutants catalyzed by DAD.

Publication:

Rahaman R, Paria S, Paine TK, Aliphatic C–C Bond Cleavage of α-Hydroxy Ketones by Non-Heme Iron(II) Complexes: Mechanistic Insight into the Reaction Catalyzed by 2,4'-Dihydroxyacetophenone Dioxygenase. *Inorg. Chem.*, **54** (2015) 10576-10586.

Abdur Rub

Assistant Professor, Department of Biotechnology, Jamia Millia Islamia, New Delhi

Role of Small G-Protein in *Leishmania donovani* Infection

Leishmania down regulates K-ras and H-ras in infected human macrophages while upregulates N-ras. This shows

that N-ras might play an important role in growth and survival of *Leishmania* inside the macrophages. RhoA and Ran were slightly down regulated while RhoB was upregulated in infected macrophages. Arf1 and Arf3 were unchanged during the infection. We have also studied the effect of ras inhibition (Farnesyl thiosalicylic acid) on parasite load. Parasite load is decreased with increasing concentration of ras inhibitor. This suggests protective role of ras inhibition during *Leishmania* infection. IL-12 plays protective role during *Leishmania* infection, while IL-10s helps in growth and survival of *Leishmania* inside the macrophages. Hence, for our next objective we checked the expression of IL-10 and IL-12 in presence of ras inhibitor at different doses (2μM, 4μM and 8μM). We found that IL-10 expression decreases with increasing concentration of inhibitor. On the other hand IL-12 production has increased on increasing ras inhibition. These results suggest that overall ras inhibition may provide protection against *Leishmania* infection *in vitro*. Further we moving ahead to see the activity of the ras in infected macrophages. Any way more studies are needed in this direction to validate our findings.

Amit Roy

Assistant Professor, Department of Biotechnology, National Institute of Pharmaceutical Education and Research, Bihar

Role of HIV-1 Protease Inhibitors on Catalytic Activity of *Leishmania donovani* Topoisomerase I for the Treatment of HIV-VL Co-Infection

Among four clinical forms of leishmaniasis, visceral leishmaniasis (VL) is most severe life-threatening global infectious disease, which is caused by protozoan parasite *Leishmania donovani*. *L.donovani* DNA topoisomerase I (LdTOPILS) has emerged as an important therapeutic target with a group of targeting agents having a broad spectrum of anti-parasitic activity. According to WHO, HIV-VL co-infection is an emerging problem. HIV infection weakens natural resistance mechanism of human body leading to more susceptibility of further infection. Therefore, further investigation of newer drugs for treatment of HIV-VL co-infection is therapeutically justified. In case of HIV-VL co-infection, treatment can be attempted to target the necessary leishmanial enzyme, like DNA Topoisomerase I.

It was reported previously that HIV-1 protease inhibitors (PIs) have direct effect on opportunistic parasites including *Leishmania*. But there are not evaluated in detailed for anti-leishmanial potency as well as for inhibitory effect on *Leishmania* Topoisomerase I. There is not a single report of effect of PIs on catalytic inhibition of LdTOPILS. Therefore, among all anti-viral drugs, HIV-1 protease inhibitors can be a novel drug target against visceral leishmaniasis as well as HIV-VL co-infection.

The proposed work will be the first report of HIV-1 protease inhibitors on catalytic activity of LdTOPILS, which might be highlighted a new strategy in treatment of VL in near future. Thus, the proposed study might be exploited for therapeutic development against HIV-VL co-infection. Some of the targets of the project have been fulfilled within the time limit, like - (i) to develop the suitable expression system and to over express the enzyme DNA topoisomerase I (LdTOPILS), (ii) to purify the recombinant enzyme DNA topoisomerase I of *L.donovani* from suitable expression system in large scale, and (iii) to study the effect of HIV-1 protease inhibitors on catalytic activity of LdTOPILS.

After purification of the enzyme, it has been checked in 1.2% agarose gel whether the drugs (HIV-1 PIs) inhibit the catalytic activity of the enzyme. The DMSO solubilized drugs Nelfinavir, Saquinavir are simultaneously incubated with the enzyme and substrate DNA. The topoisomerase poison CPT was taken as the positive control for this inhibition experiment. With the increasing drug concentrations (50,100, 200μM) of Nelfinavir and Saquinavir, the enzymatic activity is assayed. The appearance of topoisomers ladder and the relative position of supercoiled monomer are studied. It is revealed from the assay that Nelfinavir and Saquinavir inhibit the enzyme activity to relax the supercoiled monomer of plasmid. But there was not observed 100% enzyme inhibition even with the CPT control. This may be the result of un-optimized enzyme and DNA concentration for which dilution assay is needed. To optimize the DNA-enzyme concentration for the appearance of distinct LdTOPILS activity, enzyme dilution assay is performed in 1.2% agarose gel.

The present work will be the first report of the effect of HIV-1 protease inhibitors on catalytic activity of LdTOPILS, which might be highlighted a new strategy in treatment of VL in near future. Thus, the proposed study might be exploited for therapeutic development against HIV-VL co-infection.

KC Sahu

Associate Professor, Department of Chemical Engineering, Indian Institute of Technology Hyderabad

The Fluid Dynamics of Bubble and Drop: Motion, Deformation and Breakup

As a part of this project, the hydrodynamics of rising bubble/falling drop in isothermal and non-isothermal systems has been investigated. We developed a computational fluid dynamics (CFD) three-dimensional solver based on finite-volume approach. The solver has been used to understand the dynamics of an initially spherical bubble rising in quiescent liquid inside a tube or in an open domain in isothermal and non-isothermal configurations. Recently, we have started some preliminary experiment to validate the results obtained in our numerical simulations.

Publications:

Konda H, Tripathi MK and Sahu KC, Bubble motion in a converging-diverging channel. *J Fluid Eng - T Asme*, **138 (6)** (2016) 064501.

Tripathi MK, Sahu KC and Govindarajan R, Dynamics of an initially spherical bubble rising in quiescent liquid. *Nature Communications*, **6** (2015) 6268.

Tripathi MK, Sahu KC, Karapetsas G and Sefiane K, Matar OK, Non-isothermal bubble rise: Non-monotonic dependence of surface tension on temperature. *J. Fluid Mech.*, **735** (2015) 82-108.

Tripathi MK, Sahu KC, Karapetsas G and Matar OK, Bubble rise dynamics in a viscoplastic material. *J. Non-Newt Fluid Mech.*, **222** (2015) 217-226.

Premlata R, Tripathi MK and Sahu KC, Dynamics of rising bubble inside a viscosity-stratified medium. *Phys. Fluids*, **27** (2015) 072105.

Rahul Vaze

Reader, School of Technology and Computer Science, Tata Institute of Fundamental Research, Mumbai

Design of Efficient Spatial Wireless Networks Using Stochastic Geometric Tools

We are happy to report that two journal papers have been accepted with regards to work done in last one year that fall in the area of WP1 and 2 (connectivity and PHY technology) and WP6 (Connections with emerging technologies) of the original proposal, whose details are as follows.

1. Iyer SK, Vaze R and Narasimha D, Autoregressive Cascades on Random Networks, *Physica A: Statistical Mechanics and its Applications*, **447** (2016) 345-354.
2. Iyer S, Vaze R, Achieving Non-Zero Information Velocity in Wireless Networks, to appear *Annals of Applied Probability*, accepted March 2016.

Current work is on the area of delay tolerant networks and connectivity in large wireless networks under the effect of random fading. Details are as follows.

- Delay Tolerant Networks: In delay tolerant networks, the objective is to make packets reach their destination (eventually) in a very sparse network via multiple hops, where the applications are not delay sensitive and there is no guarantee on the end-to-end delay. Several theoretical results are available for various models, however, there is no crisp formulation for this problem for which rigorous results are available. We are taking the approach of directed percolation to study critical local connectivity required for packets to reach their destination eventually with high probability.
- Wireless Networks with random fading. In previous works, connectivity in wireless networks has been well studied but all those works preclude the small scale fading (random fluctuations) in received signals, which is a significant limitation. In our work, we are taking a different approach and are trying to prove a basic result on connectivity in random connection model of random graphs to establish critical threshold results for wireless networks while taking fading into account to make the results more directly applicable to the real-world problems.

Gaurav Verma

School of Biotechnology, Jawaharlal Nehru University, New Delhi

Understanding the Role of Ca^{2+} in Prohibitin-Mediated Mitochondrial Dysfunction Leading to Pancreatic B-Cell Death

Background, Concept and Objectives:

Mitochondria play a central role in pancreatic ß-cell physiology by coupling glucose recognition to insulin exocytosis**.** However, regarding the pathophysiology of ß-cells in the context of diabetes, mitochondria have emerged to be a critical player in Ca^{2+} induced β-cell death**.** Numerous reports suggest that Ca^{2+} has a permissive role in apoptosis but the detailed mechanism is not yet understood. Prohibitins (PHB) are mitochondrial chaperone proteins recently highlighted for their function in mitochondrial integrity. Located in inner mitochondrial membrane, phb1 and phb2 interact to form heterodimers maintaining the structure and regulating the function of mitochondria. The absence of phb2 in ß-cells (β-*phb2*$^{-/-}$ mice) leads to mitochondrial dysfunction, β-cell death, and diabetes. Thus, alteration in PHBs promotes mitochondrial dysfunction and fragmentation followed by cell death. It is still unknown whether this event is mediated by Ca^{2+} and thus it's very attracting to study the possible role of Ca^{2+} signaling in this event which is central to both normal and pathological cell processes. All these phenomena will be tested in the presence and absence of a recombinant protein rADMc1 which is a purified protein taken from the plants. Preliminary results show the anti-diabetic effect of the rADMc1 in diabetic phenotype. We, therefore, aimed following objectives:

a. To identify the molecular mechanism of recombinant protein rADMC1 in diabetic phenotype
b. Role of Ca^{2+} and PHB in stress-induced ß-cell dysfunction and death

a. ***Specific Aim and Outcome:*** **To identify the molecular mechanism of recombinant protein rADMC1 in diabetic phenotype**

The invention of rADMc1 from our laboratory relates to a novel hypoglycemic/antihyperglycemic protein named ADMcl purified from the seeds of *Momordica charantia* for control of hyperglycemia. The process for the purification of novel hypoglycemic/antihyperglycemic protein named ADMcl.

Progress: I have successfully purified the rADMC1 protein from the M charantia and concentrated it to be used in cell culture system. I have also calculated the toxicity of the rADMC1 protein in pancreatic cells and found no toxicity till 200nM concentration which

can be safely administered to observe its effect.

b. ***Specific Aim and Outcome:*** **To decipher the role of Ca^{2+} and prohibitin interdependency in ß- cell dysfunction and death induced by cytokines and glucolipotxicity**

Professor Dixit laboratory in JNU, Delhi is focused on understanding the role of PHBs in β-cell death, which could possibly be mediated by Ca^{2+} changes. They observed β-cells from phb2$^{-/-}$ mice exhibit mitochondrial dysfunction followed by cell death. Changes in Ca^{2+} oscillations during cytokines/ glucolipotoxicity challenge increase the Ca^{2+}influx/ leakage through the specific ER Ca^{2+} channels and reduces ER Ca^{2+} storage. Defects in the ER storage lead to increased cytosolic Ca^{2+} that result in possible mitochondrial dysfunction possibly by contributed by prohibitin.

Progress: We have standardized pancreatic β-cells in the cultured system and stimulated the same with the high glucose concentration (25mM) and checked the expression of prohibitin (PHB1 and PHB 2) in these cells. We found differential expression pattern of PHB in β-cells induced by the rADMc1 protein.

ANNEXURE-XX

RESEARCH PROJECTS UNDER HISTORY OF SCIENCE

PROJECTS ACCOMPLISHED DURING 2015-16

Niladri Sarkar

Birla Institute of Technology & Science, Pilani

Study of the Indus Valley Scripts through Linguistic and Markov Chain Methods

The work on "Indus Valley Scripts" remains unfinished and enigmatic as well. However, few attempts were made to understand the structure of the forgotten scripts. The application of the Shannon's information theory is used on the scripts. Besides this, a new method based on Metropolis algorithm was proposed for the scientific deciphering of the Indus Scripts. The whole work has been complied into four chapters viz. Traces of the lost civilization and its scripts; Scientific & Linguistic Approaches Towards understanding of the Indus Scripts; Scientific Evidence of a Script and a Language by Markov Chain Model followed by Conclusion. Monte-Carlo Metropolis Algorithm for deciphering an unknown script by replacing the unknown signs with signs of a known language which may be closely related to the unknown language was tried in the study.

A Sripada Bhat

RS Vidyapeetha, Tirupati

Edition with English Translation of Part II of *Śiddhānta Śekhara* of Śṛipati (11th Century)

The part II of *Śiddhānta Śekhara* consists of eight chapters. In *Vyaktagaṇitādhyāya*, having fifty-five verses, the arithmetical formulae are explained. In *Avyaktagaṇitādhyāya*, the formulae of Algebra are explained in thirty seven verses. In *Golādhyāya*, Śṛipati presents the opinions of Purānas, Jains and Baudhas regarding the shape and the position of the earth. In the chapter *Golāvarṇaṇādhyāya*, epicyclic theory, use of the hypotenuse in the computation of the equation of the centre and formulae to get the values of the H sines of 60°, 45°, 36°, 30°, and 18° are explained. In *Rāhunirākaraṇādhyāya*, Śṛipati negates the role of Rāhu in eclipses of the Sun and the Moon. The chapter *Grahopapativarṇaṇādhyāya* elucidates the reason for the parallax in longitude and latitude in the eclipses of the Sun and also explains the necessity of *Dṛkkarma* correction to the planets at the time of their risings and settings. The chapter *Yantrādhyāya* gives description of several astronomical instruments. In the chapter *Prasnādhyāya*, Śṛipati raises some intelligent problems to test the skills of the readers.

The study of *Śiddhānta Śekhara* reveals that Śṛipati closely followed Lalla and Bramhagupta to compose his text.

Somenath Chatterjee

Sanskrit Sahitya Parisat, Hoogly

Somasiddhānta – Text for Critical Edition, English Translation, Commentary and Studies

Somasiddhānta is an important astronomical treatise containing ten chapters (three hundred thirty five verses) described by Candra to sage Saunaka. Analysing these verses and comparing with the other texts it can be concluded that *Somasiddhānta* existed before the time of Brahmagupta. In Brahmagupta's monumental work *Brāhmasphutasiddhānta* (XXIV), we get the reference '*sūryendu – pulisa – romaka – vasisthyavanādhyaih*'; which explains all the existing systems.

The first chapter starts with the dialogue between Candra and Sage Saunaka. Candra introduces mean positions of the planets, time of revolutions, time divisions, concepts of intercalary months, the omitted lunar days, the sidereal, lunar and civil days, the number

of revolutions in a *kalpa* etc. Chapter two, deals with the method of computing true places of the planets from their mean positions. Chapter three deals with the application of gnomon, shadow, *karaṇi* (surds) and conceptual basis of *agrjyā*. Chapter four discusses the cause of lunar eclipse in 29 verses giving details of the time of eclipse, percentage of darkness over the moon, time of first contact and last contact, etc. Chapter five, deals with the projection of eclipses. '*Parilekha'* means the projection map of the eclipse. Chapter six, deals with the conjunction of planets and stars. Chapter seven explains the knowledge of risings and settings of the heavenly bodies especially of planets of inferior brilliancy. It deals with rise and set of Svāti, Agastya, Mṛgavāadha, Citrā, Jyesthā, Punarvasu, Abhijit, Brahmahṛdaya etc. Chapter eight is named as *sṛgnnoatyadhikārah*, consisting of only eight verses, deals with moon's rising and setting and of the elevation of its cusps. Chapter nine deals with *pāta* (fault); when the moon and the sun are opposite sides of either solstice and their minutes of declination are the same, it is *vyātipāta*. Chapter ten, the longest among all, discusses different contemporary knowledge like geography, cosmogony etc. *Golādhyāya* consists of previous knowledge as *Āryabhaṭīyam*, *Laghu Bhāskariya*, *Mahā Bhāskariya* etc.

After thorough study of *Somasiddhānta*, it can be concluded that this text belongs to the school of *Sūryasiddhānta* composed before 7th Century AD. No writer's name is found in any manuscript.

S Sunadara Rajan
Jain University, Bengaluru

***Amarakośa*– A Biological Assessment**

Amarakośa, technically known as *Namaliṅgānuśāsana*, composed by Amarasimha around 5th or 6th century AD is the most popular Sanskrit Lexicon available today. *Namaliṅgānuśāsana* literally means names, genders and rules pertaining to them. It is encompassed within its three parts (*kāṇḍas*) and distributed in several chapters (*vargās*). *Vanauṣadhivarga* deals with mostly wild (non-cultivated) plants. It gives an account of plant biodiversity and lists nearly 280-300 plants. *Śudravarga* deals with agriculture and allied aspects – crops, agricultural implements etc. Animals have been dealt with in *Bhogīvarga* (seven types of serpents), *Vārivarga* (aquatic features such as river, fish, alligator, etc.) and *Simhādivarga* (lion, wild and domesticated animals). *Kṣatriyavarga* mentions horse and elephant and *Vaiśyavaraga* mentions about cows. *Manuṣyavarga* dealing with human beings mentions cosmetics made out of plants besides several other relevant facts.

Amarakośa even though primarily meant as a linguistic study containing meaning of terms, words with several meanings (*Nānārthapāda*) and several words with same meaning (*Paryāyapāda*), provides sufficient material for a comprehensive analysis of an ancient Indian Society particularly with reference to their social, economic and other activities.

Saumitra Basu
The Asiatic Society, Kolkata

History of Neurodegenerative Diseases and its Impact on Aged Population in India: An Assessment

The present research project is an effort to understand the history of neurodegenerative diseases and its impact on aged population in India. The ancient Indians had clear and deep understanding of human neurology as shown by the large volume of Vedic and post Vedic literatures more specifically the *Atharvaveda*. In Ayurveda, the term *neurodegeneration* was not available but equivalent terminology like *dhatukshay, dhatusaithilyo, Smriti- Buddhi bhramsa, Vatik Unmada, Vikritovat* were mentioned. From Ayurvedic perspective either *siro or hridaya* has been identified as the major cause of all kinds of neurological problems. The Ayurvedic concept of *siro or hriday* was completely different from the Western medical concept of *head or heart.*

During colonial period there was no sharp distinction between neurological and psychiatric diseases and specific concept of neurology was started at the mid 20th century. Western perspective gave more emphasis to generalization, clinical researches and technological advancement whereas it was individualistic and preventive in India. Since 19th century onwards the concept of *Smr'itibhramsha* and other neurological diseases mentioned by different Ayurvedic specialists took a different connotation. After clinical identification of neurodegenerative diseases, like dementia, systematic research on this disease gradually increased in India. The concept of neurodegenerative diseases developed as an interaction among biological, clinical, historical and social views. Historical research and epistemological reflection can make a constructive contribution towards progression and current theoretical understanding.

Rakim Ranjan Saikia and Nurul Amin
JB College, Jorhat, Assam

A Study on River Channel Modification of Jorhat District of Assam

The objective of the study is to identify the signatures of the paleochannels of Jorhat District from different sources and establish relationship among identified paleochannels and to construct a palaeo river map of the study area with the help of data generated through the study.

The Jorhat District is situated in the East Central part of Brahmaputra valley of Assam. An ethnic group known as Kachāri or Dimāsā (means offspring of river) are known to live in the southern part of the district since 2000 BC. In 9th century, the Dimāsā group of people had established their kingdom in the Central and eastern part of Assam. In 1086 AD, about 142 years before the Ahoms entered

Assam, the Dimāsā capital was shifted from Jorhat to Dimapur of Naga Hills, not due to political, but most likely natural cause. When Ahoms had shifted their capital to Jorhat in 1794, there was a scarcity of water in Jorhat. As a result Ahoms King Kamaleswar Sinha (1795-1810) made arrangements to change the course of the pre-existing rive Disoi to the Jorhat town to solve the problems of water.

The field observation and sedimentological studies indicates about at least two paleochannels in the area. AMS radiocarbon dating indicates that the age of landform is around 1425 AD. The phytolith analysis of paleochannels sediments indicates cultivation of rice during the period under study, which is an indication of a stable farmer society and presence of flora like bamboos are also indicated. There was also indication of dry-wet-dry phase of climate of the period. Burial of numbers of big trees indicate some natural disaster like big flood or earthquake around 1425 AD, by AMS radiocarbon dating. This indicates that the majority of population of the area shifted from the area might be due to some natural disaster.

Meera Nanda

Indian Institute of Science Education and Research, Mohali

Tryst with Destiny: A Social and Intellectual History of Scientific Temper in Modern India

The project essentially looks at the cultural meaning of modern science in India. It proposes that there are two historical models at work in India: one, the Renaissance mode in which modern science is assimilated into an Indic-Vedic worldview whose validity and authority is thereby enhanced; two, the Enlightenment mode in which modern science is sought to challenge and correct the inherited Indic-Vedic worldview.

The project investigator examines recent claims regarding India's priority in mathematics and medicine. These assertions have been placed in a comparative historical perspective and four new essays on these issues have been written.

Jayanta Sthanapati

Centre for Interdisciplinary Research & Education, Kolkata

History of Science Museums and Planetariums in India

While Indian Museum in Kolkata was the first museum of the country, established in British India in 1814, all the modern science & technology museums, natural history museums, science centres, science cities and planetariums were established in independent India (see Table below). There are now 113 such institutions, established in the country during the last sixty years or so.

Table 1

	1950-1959	1960-1969	1970-1979	1980-1989	1990-1999	2000-2009	2010-2014	Total
Science Museums	3	1	2	-	-	3	-	9
Science Centres	-	1	1	8	15	12	10	47
Science Cities	-	-	-	-	1	1	1	3
Natural History Museums	-	-	1	-	2	1	1	5
Planetariums	3	2	5	11	11	8	10	50

Detailed information (42 points) has been collected on history, operation, activities, exhibits and relevant photographs in respect of all the institutions mentioned in the Table, through correspondence, questionnaire and visits. Further, descriptive studies have been completed in respect of all 50 planetariums, 5 natural history museums and 60 mobile science exhibition units. So far 5 articles have been published on this study.

SC Roy

Indian Science News Association, Kolkata

History of X-ray Research in British India

Discovery of X-rays was credited to Wilhelm Roentgen (1845-1923) when he noticed a barium platinocyanide screen placed at some distance away in his laboratory fluoresced every time he produced cathode rays in the Crooke's tube. Research on discharge of gases was fashionable at that time. It is interesting to note that at a time when vigorous research activities on discharge of gases using Crooke's tube was going on in Europe (1870-1880), Father Lafont (1837-1908) of St. Xavier's College, Calcutta brought a Crooke's tube from Europe. Father Lafont delivered a lecture in 1880 titled "Crookes on Radiant Energy' in the Science Association. That was the beginning of interest in research in discharge of gases and which finally led to X-ray research in India.

X-ray was discovered in 1895 by Wilhelm C Roentgen using Crookes tube. While investigating X-ray research work in India immediately after the discovery of X-rays, some new information has been uncovered in connection with the X-ray apparatus built by Acharya Jagadis Chandra Bose (1858-1937) in 1897 while he was in Presidency College, Calcutta with the help of his assistant in Presidency College. It was found that his X-ray machine was used for clinical diagnostics in patients with broken bones by a physician no less than Sir Nilratan Sircar. However, because of unavailability of his apparatus in Bose Institute or in any museum or any authentic document, it raised some doubts in a section of people about the photographs he had taken using his machine. A press report published in the Calcutta based English daily The Amrita Bazar Patrika in its 5th May edition of 1898 which gives us some idea about his apparatus and the experiment he performed. Using the description available in this document a schematic diagram of the apparatus he had used has been drawn. This report also contradicts the comments made by some authors that JCB had not taken

X-ray photograph using Barium Platinocyanide before 1901.

PROGRESS OF ON-GOING RESEARCH PROJECTS DURING 2015-16

Srabani Sen

The Asiatic Society, Kolkata

The State of Ayurveda in Colonial Bengal

The objective of the project is to highlight the revival movement of Ayurveda during late nineteenth and early twentieth centuries in Bengal. European attached greater importance to western medicine introduced in this country during the British rule. Though the Europeans neglected this indigenous medical system as unscientific, Ayurveda remained firmly entrenched in the countryside and rivaled western medicine in urban areas as well. The nationalists' fervor of the late nineteenth century raised the demand for the revival of this ancient indigenous system, their study and research. Many well-known ayurvedic practitioners and private organizations had started taking a keen interest in ayurvedic medicine, treatment and cure. Ayurvedic dispensaries were started in different districts of Bengal free of cost treatment to the poor. Ayurveda revival movement was initiated by well-known *kavirajes* of Bengal like Ganga Prasad Sen, Jamini Bhushan Roy, Gananath Sen and others who worked for synthesis of medical systems and institutionalization of Ayurveda. A number of books and periodicals in Bengali on indigenous medical systems appeared from late nineteenth century to impart ayurvedic knowledge to the layman. Some of the most important periodicals were *Bhisak Darpan, Chikitsak, Chikitsa-Sammilani, Swasthya* and *Ayurved Sanjibani.* From early twentieth century Bengal witnessed the founding of Ayurveda colleges established by well known ayurvedic practitioners. Ayurvedic revival movement was not a simple, linear isolated process of reviving a pristine, pre-colonial indigenous system but a complex one emphasizing tradition while at the same time attending to the changed and changing conditions under colonialism.

Jayanta Bhattacharya

Pachim Bangia Vijnan Manch, Kolkata

Calcutta Medical College and the Rise of Hospital Medicine in India: Locating its Evolution and Epistemological Consequences

Calcutta Medical College, laying the cornerstone of "hospital medicine", did not automatically lead to it in India. It had to pass through vicissitudes and temporally different phases. First, the victory of the Anglicists out of Anglicist-Orientalist debate made English mandatory for higher learning and the transition from *zootomy* at the NMI to dissection proper at the CMC. Second, how to provide clinical instructions to the pupils of CMC. They became medical graduates but not proper physicians to attend independently the sick population. J. R Martin first drew attention to this hiatus and proposed for establishing a hospital attached to CMC in April 1835. Third, whether to assimilate extant dispensaries for this purpose or to establish an altogether new hospital. The Committee appointed by government looked into the issue of location, its necessity for clinical teaching, its clear demarcation with the College, and dispelling the fear of dissection among the "natives" if a person dies in hospital. Fourth, concerns about how to overcome the prejudices of the "native population" to get them admitted into hospital for treatment. Case records became mandatory for proper history taking with clinical methods, use for future statistical accounts, and induction of hospital medicine in India. Fifth, four CMC boys' educational sojourn in England showed that Indians could master science and medicine on a level with Europeans. Not only they served role models for future Indian scientists but also set the stage for a veritable flood of Indian students to England for study in all fields.

Santhosh Abraham

Indian Institute of Technology Madras, Chennai

Medicine and British Empire in South India: A Study of Psychiatry and Mental Asylums in Colonial Kerala

This research aims to comprehensively deal with a full range of institutional data of the mental asylums in Calicut and Travancore to understand the case of Colonial Governmentality and Medical Scribal Practices, Socio-demographic characteristics of the patients admitted in the lunatic asylums; caste and religious configurations of the patients; diagnostic development and disease categories; and finally the outcomes of institutional confinement and treatments as revealed in death, illness and cure statistics.

Based on the collected archival records from Administration of Travancore State (Health) and Reports on the Lunatic Asylums of Madras Presidency the researcher is currently working on three important aspects such as Therapeutic Work in the Asylums, Moral and Occupational Therapies and Asylum Work and Colonial Finance. During the colonial period, work tended to be firmly embedded in the rhetoric of moral therapy. Work and occupation among the patients were developed as an institutional medical attempt to prevent idleness among the patients and was largely promoted as beneficial to patients if not curative. In the western view, this was conceived as occupational therapy and introduced in India as a better way to treat the insane since 1920s. However this study is an attempt to understand the questions like asylum labour and colonial economic concerns and how the concept of selective occupation and work among the patients were developed particularly in India. In South

Indian context Asylum work was employed as a moral therapy to empower patient to remove idleness and at the same time 'work therapy' was designed in such a way to create institutional profit and also as a forced labour.

Senu Kurien George
College of Engineering, Thiruvalla, Kerala

English Translation of *Yōgāṃrtaṃ*

The purpose of the Project is to translate *Yōgāṃrtaṃ* straightforward into English. *Yōgāṃrtaṃ* is a text prescribing medicines for a wide variety of different kinds of diseases. The available text consists of the following sections (the number of verses in the section is given in brackets): *prāraṃbhaṃ* (4); *jvara cikitsa* (93); *raktapitta cikitsa* (11); *asṛgdara cikitsa* (19); *kāsa cikitsa* (28); *rājayakṣma cikitsa* (8); *śvāsa cikitsa* (27); *hidhmā cikitsa* (11); *svarasāda cikitsa* (2); *charddi cikitsa* (14); *arōcaka cikitsa* (9); *hṛdrōga cikitsa* (6); *tṛṣṇa cikitsa* (8); *bhaktarōdha cikitsa* (15); *arśōrōga cikitsa* (40); *atisāra cikitsa* (31); *viṣūci cikitsa* (8); *agnimāndya cikitsa* (8); *atyagni cikitsa* (7); *mūtrakṛcchrāśmari cikitsa* (20); *śuklasrāva cikitsa* (7); *asthisrāva cikitsa* (6); *pramēha cikitsa* (38); *pramēha piṭakā cikitsa* (19); *vidradhi cikitsa* (14); *āntravṛddhi cikitsa* (17); *gulmarōga cikitsa* (25); *mahōdara cikitsa* (26); *pāṇdhurōga cikitsa* (13); *kāmilarōga cikitsa* (28); *śōpha cikitsa* (16); *visarppa cikitsa* (24); *masūrikā cikitsa* (10); *visphōṭa cikitsa* (6); *śītapitta cikitsa* (7); *kuṣṭharōga cikitsa* (93); *vātavyādhi cikitsa* (70); *vātaśōṇita cikitsa* (18); *vāyukṣōbha cikitsa* (37); *śūla cikitsa* (37); *madamūrcchāya cikitsa* (4); *mūtrātisāra cikitsa* (7); *sōmarōga cikitsa* (8); *garbha cikitsa* (29); *bāla cikitsa* (59); *sthūla cikitsa* (3); *kṛśa cikitsa* (4); *nētrarōga cikitsa* (93); *karṇṇarōga cikitsa* (16); *nāsārōga cikitsa* (7); *ōṣṭharōga cikitsa* (7); *dantarōga cikitsa* (13); *mūkhapāka cikitsa* (5); *kapōlārbuda cikitsa* (2); *dantanāḷi cikitsa* (2); *adhijihvādi cikitsa* (5); *śirōrōga cikitsa* (29); *vṛṇa cikitsa* (18); *bhaṃgakṣatādi cikitsa* (22); *bhagandara cikitsa* (11); *ślīpāda cikitsa* (2); *apacī cikitsa* (4); *kṣudrarōga cikitsa* (20); *liṃgavyādhi cikitsa* (18); *guhyarōga cikitsa* (8); *vājikaraṇa cikitsa* (6); *kaiviṣa cikitsa* (5); *viṣa cikitsa* (12). The final compilation of the report after discussion with expert is being carried out.

Mala Bhattacharjee and Purabi Mukherji
Gokhale Memorial Girls' College, Kolkata

Compilation of Classified Bibliographies and Assessment of Research Work Done in Different Branches of Mathematics in the Eastern Zone of India during the 19th and 20th Century

The Project aims to provide classification and documentation along with genealogical account of the development of mathematical research in the Eastern Zone of India focussing Odisha, Assam and Bengal (which includes the erstwhile East Bengal of the pre-partition days, which is now known as Bangladesh). In third and final year of the project documentation in algebra, number theory, analysis of real and complex variables, ordinary and partial differential equations including difference equations, special functions, algebraic and general topology, mechanics of deformable solids, fluid mechanics, heat transfer and bio-mathematics have been completed.

This year, we are documenting the bibliographies in Combinatorics, Probability Theory and Stochastic Processes (including Statistics). Apart from classification and documentation, this year too, like last year, we have focused on the genealogical account of professor PC Mahalanobis in Probability and Statistics (Stochastic Processes) and RC Bose, SN Roy, CR Rao who have been fountain head of inspiration not only to the mathematicians of the Eastern Zone but to the whole of India. It was found out that four of India's notable mathematicians, KR Parthasarathy, VS Varadarajan, SRS Varadhan and R Ranga Rao were all students of the ISI, Calcutta and started their research career there under the guidance of Professor CR Rao. In Combinatorics, Professor RC Bose inspired students in the Eastern Zone of India and elsewhere. Professor RC Gupta is internationally acclaimed for his contributions in the history of mathematics has inspired generations of researchers in the field. Two papers related to the project were published.

Venketeswara Pai R
SASTRA University, Thanjavur

Vākyakaraṇa and its Commentary *Laghuprakāśika* by Sundararājā

Vākyakaraṇa is an Indian text (c. 1282 CE) which describes the method of expressing the true longitude of the Sun, the Moon, and the planets using *vākyas.* The word means a *karaṇa* or manual, in which *vākyas* or phrases are used to encode the numbers. It has also a commentary called *Laghuprakāśika.* Objective of the work is to translate the text and the commentary with detailed mathematical notes in three years. Translation and detailed mathematical notes for all the verses and the corresponding commentary of the first two chapters have been prepared. The first chapter *ravicandrarahusphuṭaha* deals with obtaining true longitudes of Sun, Moon and Moon's node (*Rahu*) and procedure for finding *ahargana* and the commentary explains this algorithm in details with Rationale. The *Vākyas* such *as gunamitradi* and *bhupajnadi* for the transit and obtaining true longitude of the Sun, and the commentary presents Rationale for these *Vākyas*. Algorithm for obtaining the true longitude of Moon, corrections to be applied to it such as *carardhadi-samskara* and *desantara-samskara* and algorithm for finding the longitude of Moon's node or *Rahu* are also explained.

The second chapter *tārāgrasphuṭaha*, deals with means the true longitudes of star-planets. Concepts such as *mandala*, *Dhruva* and *Sodhyadina*, computations of true

longitudes of all the five planets, true daily motions of planets and time corresponding to the desired planet are dealt in detail.

V Madhukar Mallayya
Mohandas College of Engineering and Technology, Trivandrum

The Kriyākramakarī of Śaṅkara and Nārāyaṇa – Translation with Expository Notes: A Critical Study in Modern Perspectives

The contents of the commentary taken up for translation and study during the current period includes the sections on *vargaparikarma* (square operation), *vargamūlam* (square root), *ghanaparikarma* (cube operation), *ghanamūlam* (cube root), *bhinna-parikarmāṣṭakam* (eight operations on fractions), *bhāgajāti* (assimilation of fractions), *prabhāgajāti* (assimilation of sub-fractions, or fraction of fraction), *bhāgānubandha* (assimilation of fractional increase), *bhāgāpavāha* (assimilation of fractional decrease), *bhinna-saṅkalita* (addition of fractions), *bhinna-vyavakalita* (subtraction of fractions), *bhinna-guṇana* (multiplication of fractions), *bhinna-bhāgahāra* (division of fractions), *bhinna-varga-ghanādi* (square, cube and so forth of fractions), *bhāgānubandha-mūlīkaraṇam* (extraction of roots of augmented fractions), *Śūnyaparikarmāṣṭakam* (eight operations on zero), *vyastavidhi* (method of inversion) and *iṣṭakarma* (method with assumed quantity). Relevant books, necessary reference materials and related works are being collected from various sources. A research paper on extension of some of the special geometrical proofs from the chapters on *śreḍhīvyavahāra* and *vṛttavyavahāra* presented last year at the international conference at Hangzhou, China has been completed for publication.

Anirban Mukherjee
University of Kolkata, Kolkata

History of Technological adoption and development: The case of silk industry in colonial India

This project seeks to understand the institutional and socio-cultural barriers to successful adoption of foreign technology in silk industry. In particular, the project looks at the issue of filature technology adoption in colonial India. Filature was the machine for reeling silk which the East India Company tried to introduce in the eighteenth century Bengal for producing export quality silk. However, the project did not give them the desired result and was finally abandoned in the mid nineteenth century. While the existing explanations for this failure range from market volatility to changing production relation, it brings in the lack of micro innovation as an explanation for this failure. But innovation activity is costly and unless the innovator is compensated with some kind of economic pay off, he/she does not have the incentive to undertake the innovation. However, in the case of filature technology in the eighteenth century India, no such provision was available. The only compensation the resident commissioners could get—for investing in micro innovation—was the revenue from selling the silk to Europe on their own account. But silk trade was the monopoly of the East India Company and therefore for getting the private trade permit, the resident officers were at the mercy of the Board of Directors of the Company. After analysing the organizational structure of the East India Company it showed how the Board of Directors failed to credibly commit to the policy of allowing private trade of silk that could incentivize micro innovation. Archival documents show that the Company actively discouraged any kind of new innovation upon the Italian design of the filature.

Sukta Das
Cancer Foundation of India, Kolkata

Perception of Food and Nutrition in Health and Disease - A Critical Exposition with Focus on some Classical Indian Medical Texts

The project aims to study critically the concept of food and nutrition mentioned in the classical Indian medical texts. A study of the *Aṣṭanga Hṛdayam* of Vāgbhata and *Bhāvaprakāśa* of Bhāvamiśra was taken up to focus on the perception and recommendation on food and nutrition embodied in these two texts in reference to health and disease. The medical concepts in this text can be traced to *Caraka Samhita* and *Suśruta Saṃhitā* which were mostly followed by Vāgbhaṭa but primarily focusing on internal medicine or *kāyācikitsā*. The chapter *Sūtrasthāna* deals with the teachings of Ayurveda, which forms a means of achieving *dharma* (righteousness), *artha* (wealth) and *sukha* (happiness) that are essential for attaining a good health and long life. Health has been defined as a condition where the *doṣas*, which are basic and permanent components of the body, are in equilibrium. Food has been considered as one of the important components of *dinacarya* (daily regimen).

Bhāvaprakāśa defines *roga* (disease) as a disturbance of equilibrium among *doṣas* and *svavāvika* (disease free state) is when the *doṣas* are in equilibrium; disease is the cause of grief and fever. Total health was believed to be acquired only by following a proper daily and seasonal routine (*dinacarya, nisacarya and ṛtucarya*) failing of which leads to illness. The scrutiny of the texts also give an impression that there was a profound understanding of the basic nature of food components, concept of nourishment, process of digestion, assimilation and metabolism within the body as well as the role of food and nutrients for normal growth and function and in diseased conditions. Therefore, use of compatible and balanced food combinations was advocated and incompatible food combinations were discouraged.

Rajat Sanyal
University of Kolkata, Kolkata

Environmental and Ecological Change as inferred from the Copperplate Inscriptions of Early Bengal

The project aims to study the copper plate inscription in order to infer environmental and ecological changes in early Bengal. The second year work focused on two aspects of collection of database from the inscriptions of eastern and southeastern Bengal and fieldwork in western and northern Bengal (within the present administrative orbit of West Bengal).

The principal inscriptional corpus of southeatern Bengal comprises a set of copperplates of the Rata, Khaḍga and Deva dynasties who ruled the Comilla-Noakhali tract of the trans-Meghna region of southeastern Bengal. A second set of plates issued by the Candra and Varman rulers are found mostly along the delta of the present course of the Padma river in the Dhaka-Mushiganj districts of Bangladesh. Chronologically this set belongs to the tenth-eleventh century horizon.Tthe earliest of the copperplate inscriptions of Vainyagupta is dated to the sixth century, found from Gunaighar in the Comilla district.

Starting from the Gunaighar inscription to those of the tenth-eleventh century, the inscriptions of these ruling lineages supply crucial details of the riverine geography of the region throwing, in turn, light on the local environmental set up of the southeastern coast and the southern delta. The major elements that find frequent references in the boundary clauses of the inscriptions are bewildering varieties of waterbodies like tank (*puskariṇi*), ditch (*jola*), dried river (*gangini*) and stream (*gamga*); different types of land (*kṣetra*) like lowland (*tālabhumi*), homestead land (*vāstubhūmi*) and fallow land (*khilakṣetra*). Reference to maritime activities are found in the Gunaighar plate referring to a *nauyoga* or 'landing place of boats'.

NEW PROJECTS 2015-16

P Ram Manohar
AVP Research Foundation, Coimbatore

English Translation with Critical Notes and Indexing of "*Siddhamantra*" – A 13th Century Text on Ayurvedic Pharmacology

The *Siddhamantra* is a short treatise on pharmacology in Ayurveda that was composed by Keśava, a renowned physician scholar who lived in the 13th century AD. This work is historically important for theoretical innovations that have been put forth by the author to explain drug action with greater clarity and precision. The *Siddhamantra* is a strikingly terse piece of literary work in which drugs and food articles are classified into 57 categories indicating their impact on the humours (*dośa*). According to Vopadeva, the commentator, these nine verses are together known in Sanskrit as the *navaślokī*. The enumeration of these substances in these 57 categories is achieved in 169 verses.

The present work is an attempt to provide a structured translation of the text and commentary in English with classified indices of technical terms, scientific names of herbs, animals and minerals mentioned in the book. In the first four months 49 verses have been translated along with the commentary. In the ancient texts dealing with pharmacology of drugs, the properties of substances are described on the basis of the *rasa*, *virya* and *vipaka*. However, *Siddhamantra* directly identifies the action of substances on the *dośas*. The work is unique because of the precision in deciphering the action of *dośas*. For instance, the text explains not only whether a substance increases a particular *dośas* but also which other *dośas* it will decrease and which *dośas* it will neither increase nor decrease (*udāsina*).

Naveena K
Jeevanthi Rejuvenating Rural Livelihood, Sringeri, Karnataka

English Translation of Āyurveda Prakāśa with Critical Notes

Āyurveda Prakāśa is an exclusive text on *Rasaśāstra* the pharmaceutical wing of Ayurveda that concentrates on preparation of herbo-mineral medicaments, written in 17th Century AD by Mādhava Upādhyaya, a resident of *Sourāstra* (Gujarat). The book is considered to be one of the practical and authoritative books of *Rasaśāstra*.

The text contains six chapters with total of 1693 verses. The first chapter alone contains 597 verses. The first 200 verses of first chapter relating to the importance of the text, importance of mercury, it's various methods of purification and special processes called *saṁskaras* to make it therapeutically efficacious have been translated. To mention uniqueness in the translated verses, the text has introduced a new set of *pañcakarma* for *Rasaśāstra* which include digestion (*pācana*), oleation (*snehana*), sudation (*swaedana*), emesis (*vamana*) and purgation (*virecana*). For tempering of mercury, nineteen *saṁskāras* have been told and a *saṁskāra* called *anuvāsana samskāra* is the original contribution of this text. Along with translation, indexing is also being done under different headings like herbal drugs, drugs of animal origin, scientific and English names of the drugs etc.

SK Uma
Sir M Visvesvaraya Institute of Technology, Bangalore

Makarandsāṛṇi — English Exposition and a Critical Analysis

Makarandsāṛṇi (MKS) is the most popular text among the Indian astronomical tables. These tables with explanatory *ślokās* are composed by Makaranda in 1478 AD. This *sāriṇi*

belongs to Saurapakṣa. The various Astronomical tables of M.K.S are being analysed one by one and their algorithms are worked out. During the period of 4 months the tables on *Tithyādi* for śaka years and *Varṣa tithyādi patram* are analysed.

Table on provides *tithikandas* of *vardi* and *valli* in *ghatis* and *palas* for *śaka* years upto 1994. [1622 AD 2022 AD]. Table on *Varṣa tithyādi patram* gives *tithikandas* for *varadi* and *valli* for *sakavasesa* which means the remainder when the difference between given year and *śaka* year in the table is divided by 16. From the above tables discussed we conclude that for the determination of *tithi* endings on any given day, the true rates of motion of Sun and the Moon are used. For this, the mean daily motions are corrected for the equations of the centre of both the Sun and the Moon.

Sharada Srinivasan
National Institute of Advance Studies, Bangalore

Art of Making Kerala Mirror

The metal mirrors Kerala represent a distinctive and unique metallurgical tradition as one of the rare surviving mirror making artisanal technologies that survives in the world. This study proposes to explore the dimensions related to history of science and technology of this intriguing craft tradition which represents one of the few crafts survivals left anywhere in the world of making metallic mirrors. It aims to work towards a comprehensive book monograph over three years, encompassing literature survey also related to understand the historical context of mirrors, literary references and field and laboratory investigations related to the Aranmula mirror making process. In the initial phase in the past 3 months, preliminary literature survey has been undertaken, with special emphasis certain aspects a) exploring the historical background of the finds of mirrors in Indian antiquity and exploring museum collections including photos related to mirrors including sculptures etc b) on taking further and establishing contact with existent craftspeople in Aranmula, and networking with them, c) collection of samples relevant for analysis etc. and programme of study for analysis. In an article published in INSA (2016), the author has pointed to certain insights related to methodological aspects that can be construed from the ethnoarchaeological studies such as on the achari community of mirror makers.

S Rama Krishna Pisipaty
SCSVMV University, Kanchipuram

Documentation and Study of the Archaeo-Metallurgical and Ethno-Metallurgical Evidences in North & Western Tamil Nadu with Special Reference to Iron

The project aims to study and document Archaeo and Ethno-metallurgical evidences of iron working in the in North & Western Tamil Nadu. It tools for the study involves, Surface exploration and trial diggings, utilization of GPS & Remote Sensing data for identifying the site and recording. Exploration of ethnological evidence and living tradition of Iron metallurgy in the tribal belt area is also one of the object of project. Sangam literature, regional literature of the area is providing information about the iron usage and technologies of pre-industrial iron working sites early Tamil Nadu. It may be noted that rapid industrial growth and other developmental activities in the area, is damaging evidences of the early Iron Age settlements. It is high time to document the traditional iron smelting and workshop areas and collect archaeological material from these sites for analysis and in-depth study. We have to analysis the antiquities and iron objects to understand the composition and early technologies. Some localities are inhabited by the ethnic communities who had been engaged in iron working for generations. Gradually those communities are also changing their profession and disappearing. Documenting the traditional iron working and collecting ethno-archaeological material from these sites for analysis and in-depth study will help us get real insight into the metallurgical heritage of India in general and the study of area in particular.

Satarupa Dattamajumdar Saha
Kolkata Society for Asian Studies, Kolkata

History of the Scientific Study of the Languages of North-East India with Special Reference to the Bodo Group of Languages: Retrospect and Prospect

The present research program traces the history of the scientific studies of the Tibeto-Burman languages along with the languages of other language family, spoken in North-East region of India. Retrospective literature survey has been carried out by visiting the relevant libraries/organization/institutes. An account of the chronological development of the major contributions to the scientific studies of the Austroasiatic languages, Indo-Aryan languages, and to some extent Tibeto-Burman languages spoken in North-East India will be carried out. The grammars by colonial administrators and Christian missionaries in the nineteenth and early twentieth century were developed in the traditional Latinate model. Tone which is a major phonemic characteristic of these languages did not find its reflection in these scientific studies. This fetched a serious gap in the scientific enquiry of these languages. As the scientific enquiry of the languages was restricted to the vocabulary level in the early part of the nineteenth century, the influence of the super-strate language/s hindered the identification and proper characterization of the languages. Due to lack of proper identification of the cognates, classification of the speech variety (as to whether it is a separate language or a variation (dialect) of a language) suffered from limitation.

Co-relation between the geographical location and the linguistic identification could not be established. Due to ever volatile socio-political situation of the region co-ordination between ethnic affiliation and linguistic characterization suffered from limitation. By the end of the nineteenth century, the scientific enquiry of the languages at a relatively subtle level with study of the speech sounds became a desideratum for linguistic characterization and classification. Therefore, the history of the scientific study of the Tibeto-Burman languages of North-East India along with its changed perspective is an ongoing work. Data needs to be collected by field investigation.

ANNEXURE-XXI

LECTURES DELIVERED IN REMOTE AREAS (1.4.2015 – 31.3.2016)

S. No.	Name	Place and Date		Title
1.	Professor Amitava Datta, FNA	i)	Chhatna Chandidas Vidyapith, Chhatna, Dist Bankura,West Bengal	The quest for Elementary Particles from Atoms to the Higgs Boson
		ii)	Bankura Banga Vidyalay, Machantola, Bankura, West Bengal	
		iii)	Garhbeta College PO Garhbeta Y Dist. Paschim Medinipur, West Bengal, October 15 & 16, 2015	
2	Professor NM Bujurke, FNA	i)	Jawahar Navodaya Vidyalaya, Kyarkoppa Rd, Dharwad, October 17, 2015	Glimpse of Ramanujam–His Life and His work
		ii)	Women's University, Bijapur, November 29, 2015	–do–
		iii)	Central University, Gulbarga, December 15-16, 2015	Glimpse of Ramanujam–His Life and His work
				Mathematics in Science and Engineering
		iv)	Harugeri Pre University College; Taluk Gokak, Belgaum, December 16, 2015	Glimpse of Ramanujam–His Life and His work
		v)	Gulbarga University, Gulbarga, December 29, 2015	–do–
3	Professor Premashish Kar, FNA	Midnapur Medical College, West Bengal, March 14, 2016		Treatment of Chronic Hepatitis B–When and What?
4	Professor NR Jagannathan, FNA	NCL Boys Higher Secondary School, Neyveli, January 27, 2016		Magnetic Resonance Imaging: A tool for the Doctor given by Physicists, Chemists, Engineers and others
5	Professor Kalluri Subba Rao, FNA	Smt. Kondapalli Sarojini Devi Mahila Kalasala, Tanuku, Andhra Pradesh, February 8-9, 2016		Origin of Life–I
				Origin of Life–II
6	Professor H Pathak, FNA	Maharshi Dayanand Sr. Secondary School, Mumtajpur, Pataudi, Haryana, December 5, 2015		Climate Change and Food Security

S. No.	Name	Place and Date		Title
7	Professor RR Rao, FNA	i)	Yogi Vemana University, Kadapa, A.P., September 14, 2015	Floristic diversity in India with special reference to bio energy plants
		ii)	Indira Gandhi National Tribal University, Amarkantak, M.P., March 7, 2016	Role of Ethno Botany in search of newer drug plants & in conservation of biological diversity: Some concerns & Issues
8	Professor T Subramoniam, FNA	Holy Cross College, Nagercoil, Near Kanyakumari (Tamil Nadu), October 1, 2015		Climate Change, Ocean Acidification and Impact on Biomineralization of Marine invertebrate exoskeleton
9	Professor MRN Murthy, FNA	i)	Mahavir College, Moodabidri, Karnataka State, October 29, 2015	Biochemical and biophysical principles of life
		ii)	IISER, Trivandrum, November 1, 2015	Why is Darwin's theory of evolution so controversial
		iii)	Doddaballapur, Karnataka State, November 3, 2015	Our wonderful world
		iv)	Siddaganga Womens' College, Tumkur, December 26, 2015	Why learn science
		v)	SASTRA, Tanjore, December 27, 2015	Scientific temper in 12th century Vachana poetry
		vi)	NES Engineering College, Shimoga, December 29, 2015	Importance of science to society
		vii)	JNU, New Delhi, March 2, 2016	–do–
		viii)	Kumaun University, Bhimtal, Uttaranchal, March 4, 2016	X-ray crystallography, Part 1. X-ray crystallography, Part 2.
10	Professor Samir Bhattacharya, FNA	Pathabhanana, Shantiniketan, December 13–14, 2015		i) Yantrashaktir Utsa Sondhane-Shilpo Biplaber Suchana (Delivered in local language) ii) Prtnajyotirvigyan-Mahabharato Puraner kall nirupan (Delivered in local language) iii) Conceptual Evolution of Dynamics and the Little Known Story of F=ma iv) Measuring the Universe
11	Professor Sushanta Dattagupta, FNA	Pathabhavana, Shantiniketan, December 13–14, 2015		How We Enjoy Science
12	Professor Amitabha Ghosh, FNA	Pathabhanana, Shantiniketan, December 13–14, 2015		i) Jagadish Chandra Basu o Rabindranath ii) Diffusion iii) Rabindranath Ganne-Vigyane (Delivered in local language)

S. No.	Name	Place and Date		Title
13	Dr Sushama D Joag, (Teachers Awardee)	i)	Disha Jr. College, Varora (Dist. Chandrapur), February 16, 2016	Bonding in Organic Molecules
		ii)	Loya High School, Varora (Dist. Chandrapur), February 16, 2016	Crossword Puzzle of Periodic Table
		iii)	Anand Niketan College, Varora (Dist Chandrapur), February 17, 2016	Perpetual Dance of Organic Molecules
		iv)	Yogeshwari Mahavidyalay, Ambajogai (Dist. Beed), February 24, 2016	Introduction to Spectroscopy (UV, IR, 1H-NMR)
		v)	Yashwant College, Nanded, February 25, 2016	Introduction to Spectroscopy (UV, IR, 1H-NMR) & Problem Solving
		vi)	Science College, Nanded, February 25, 2016	Perpetual Dance of Organic Molecules
		vii)	Netaji Subhashchandra Bose College, Nanded, February 25, 2016	Perpetual Dance of Organic Molecules
		viii)	School of Physical Sciences, SRTMU, Nanded, February 26, 2016	Introduction to Spectroscopy (UV, IR, 1H-NMR)
		ix)	Nagarjun Public School, Nanded, February 26, 2016	Periodic Table on Crossword Puzzle
		x)	Dnyanopasak College, Parbhani, February 27, 2016	Perpetual Dance of Organic Molecules
		xi)	Z.P. High School, Hingoli, At & Post Hatta, Tal Vasmat, February 27, 2016	Periodic Table on Crossword Puzzle; Discussion with Teachers of the District.
14	Dr Sulabha Kulkarni, FNA	i)	Palod Public School, Jalgaon, October 12, 2015	Scientists and Opportunities in Science for Young Students
		ii)	North Maharashtra University, Jalgaon, October 12, 2015	Nanotechnology
		iii)	Dr. MJ College, Jalgaon, October 13, 2015	Scientists and Their Life
		iv)	Dr. Annasaheb GD Bendale Mahila Mahavidyalaya Jalgaon, October 13, 2015	–do–
		v)	RK Mishra School, Bahadurpur, Jalgaon, January 7, 2016	–do–
		vi)	Devchand College, Kolhapur, January 22, 2016	Nanotechnology
		vii)	GL Bagewadi Arts, Science and Commerce College, Nipani, January 22, 2016	–do–
		viii)	SJG High School, Kagal, January 23, 2016	Delivered in Local Language

S. No.	Name	Place and Date		Title
15	Professor Avinash Khare, FNA	i)	Shri Gulabrao Deokar College of Engineering, Jalgaon, January 7, 2016	Recent Research on God Particle
		ii)	GL Bagewadi Arts, Science and Commerce College, Nipani, January 22, 2016	Constituents of Universe
		iii)	Devchand College, Kolhapur, January 22, 2016	–do–
		iv)	Dr. Annasaheb GD Bendale Mahila Mahavidyalaya Jalgaon, January 23, 2016	Recent Research on God Particle
		v)	SJG High School, Kagal, January 23, 2016	Delivered in Local Language
16	Dr Suryasathi Bose (INSA Young Scientist Awardee)		Amal Jyothi College of Engg (AJCE), Kanjirapally, Kerala, March 10-11, 2016	Wonders From Polymers–I Wonders From Polymers–II

ANNEXURE-XXII

AWARD LECTURES DELIVERED – UNDER LOCAL CHAPTERS

Professor Shyam Bahadur Saksena Memorial Medal Lecture (2011) entitled *Decoding Cyanobacterial Survival under Arsenic Stress through Proteomic, Genomic and Bioinformatics Approaches* by Professor LC Rai, FNA on August 22, 2015 at Allahabad University, Allahabad.

The Syed Husain Zaheer Medal Lecture (2014) entitled *The Problem in Signal Processing –Need to relook at the time frequency analysis of speech signals* by Professor B Yegnanarayana, FNA on September 22, 2015 at University of Hyderabad, Hyderabad.

Professor Krishna Sahai Bilgrami Memorial Medal (2015) lecture entitled *Managing Crop Residues for Nutrient Cycling, Improving Crop Productivity and Reducing Air Pollution* by Dr Yadvinder Singh, FNA on October 28, 2015 at IARI, New Delhi.

Professor GN Ramachandran 60th Birthday Commemoration Medal (2015) lecture entitled *Lessons from GPCR-Cholesterol Crosstalk: Implications for Health and Disease* by Dr Amitabha Chattopadhyay, FNA on November 6, 2015 at Guha Centre for Genetic Engineering and Biotechnology (GCGEB), Kolkata.

Professor Vishwa Nath Memorial Lecture (2009) entitled *Defining the Pathway of Transcription Initiation* by Professor Siddhartha Roy, FNA on November 6, 2015 at Guha Centre for Genetic Engineering and Biotechnology (GCGEB), Kolkata.

Dr Yadvinder Singh delivering Professor Krishna Sahai Bilgrami Memorial Medal Lecture (2015) at IARI, New Delhi

The Satyendranath Bose Medal (2015) lecture entitled *String Theory* by Professor J Maharana, FNA on November 17, 2015 at Indian Institute of Technology Madras, Chennai.

Professor Vishnu Vasudeva Narlikar Memorial Lecture (2015) entitled *Irreducible Polynomials* by Professor SK Khanduja, FNA on November 18, 2015 at IISER, Mohali.

Professor SK Khanduja receiving the citation of the award lecture from Professor N Sathyamurthy, FNA. Professor RC Mahajan, FNA was also present on the occasion

The Vishwakarma Medal Lecture (2015) entitled *Chemical Engineering Foray into Rural India* by Professor AB Pandit, FNA on December 15, 2015 at ICT, Mumbai.

Professor AB Pandit delivering the Vishwakarma Medal Lecture

INSA Medal for Promotion & Service to Science Lecture (2014) entitled *Evolving Approach of Biology to Ayurveda* by Professor MVS Valiathan, FNA on December 29, 2015 at IISER, Bhopal.

Professor Valiathan receiving the citation from Professor Gadagkar, Professor Mittal is on left

The Aryabhata Medal Lecture (2015) entitled *Exotic Organisms and Novel Biology: World of Parasites* by Professor Alok Bhattacharya, FNA on December 29, 2015 at IISER, Bhopal.

Professor Alok Bhattacharya delivering the medal lecture during AGM

Dr Nitya Anand Endowment Lecture (2015) entitled *Epigenetic Regulation of Chromatin Dynamics and Gene Expression: Implications in Differentiation, Disease and Therapeutics* by Professor TK Kundu, FNA on December 29, 2015 at IISER, Bhopal.

Professor TK Kundu receiving the award from President INSA

The Sunder Lal Hora Medal Lecture (2008) entitled *Genome Editing and Tissue Fabrication: Emerging Approaches to Designing Life Forms* by Dr Rakesh Tuli, FNA on December 29, 2015 at IISER, Bhopal.

Dr Rakesh Tuli delivering the SL Hora Medal Lecture at AGM

Professor Vishwa Nath Memorial Lecture (2015) entitled *Molecular Markers and Tumour Behavior in Glioma – The Tumours of the Supporting Cells of the Brain* by Professor Subrata Sinha, FNA on March 19, 2016 at Delhi University, South Delhi Campus, New Delhi.

Professor Subrata Sinha delivering Professor Vishwa Nath Memorial Lecture

ANNEXURE-XXIII

SUMMER RESEARCH FELLOWSHIP PROGRAMME
MAY-JULY 2015

S. No.	Subjects	No. of applications received		No. of fellowships offered		No. of fellowships availed	
		S	**T**	**S**	**T**	**S**	**T**
1.	Life Sciences (including Agricultural Sciences)	4326	172	529	61	458	46
2.	Engineering Sciences & Technology	12928	172	374	56	294	45
3.	Chemistry	2221	117	246	26	223	17
4.	Physics	2517	88	191	33	159	24
5.	Earth & Planetary Sciences	933	11	131	00	114	00
6.	Mathematics	998	33	94	05	73	04
	TOTAL	**23923**	**593**	**1565**	**181**	**1321**	**136**
	GRAND TOTAL	**24516**		**1746**		**1457**	

ANNEXURE-XXIV

REFRESHER COURSES HELD FROM APRIL 2015–MARCH 2016

S.No.	Topic	Venue	Date
1	Experimental Physics-69	Indian Academy of Sciences, Bengaluru	Apr 14-29, 2015
2	Thin Films and Nanoscience	Tripura University, Suryamaninagar	May 04-18, 2015
3	Experimental Physics-70	NIT Mizoram, Aizawl	May 07-22, 2015
4	Quantum Mechanics	Loyola College, Chennai	May 11-23, 2015
5	Experimental Physics-71	Goa University, Goa	May 13-28, 2015
6	Experimental Physics-72	Panjab University, Chandigarh	Jun 16-Jul 01, 2015
7	Experimental Physics - 73	Kurukshetra University, Kurukshetra	Sep 13-28, 2015
8	Developmental Biology	Sophia College, Mumbai	Nov 16-28, 2015
9	Water	Field Marshal K M Cariappa College, Madikeri	Nov 16-29, 2015
10	Crystallography, Mineralogy, Igneous Petrology and Thermodynamics, Sedimentology and Economic Geology	Indian Academy of Sciences, Bengaluru	Dec 11-24, 2015
11	Refresher Course in Recent Advances in Chemistry	A.S. College, Deoghar	Dec 14-26, 2015
12	Physics Training and Talent Search	Kuvempu University, Shankarghatta	Dec 17-30, 2015
13	Applications of quantum mechanics: molecules and radiation	University of Mumbai, Mumbai	Dec 21, 2015-Jan 04, 2016
14	Environmental Biology	University of Punjab, Bathinda	Feb 01-15, 2016
15	Quantum Mechanics	Govt. Arts College, Melur	Feb 08-20, 2016
16	Material Science and Measurement of Properties	Indian Academy of Sciences, Bengaluru	Feb 09-24, 2016
17	Advanced molecular techniques in cell and molecular biology	Manipal University, Manipal	Feb 29- Mar 12, 2016
18	Experimental Physics – 74	Tripura University, Tripura	Mar 08-23, 2016
19	Mountain hydrology and climate change	GB Pant University of Agriculture and Technology, Pantnagar	Mar 28-Apr 08, 2016

ANNEXURE-XXV

LECTURES / WORKSHOPS HELD FROM APRIL 2015 - MARCH 2016

S.No.	Topic	Venue	Date
1	Advances in Wireless Communications and Networking	Amal Jyothi College of Engineering, Kanjirapally	July 23-24, 2015
2	Advances in Chemistry Education and Research	University of Gour Banga, Malda	July 23-24, 2015
3	Analysis and Topology	MS University of Baroda, Baroda	Aug 01-08, 2015
4	Integrated Research Approaches in Biology	Nirmala College for Women, Coimbatore	Aug 07-08, 2015
5	Future Perspective and emerging technologies for sustainable energy resources	Tumkur University, Tumkur	Aug 18-19, 2015
6	Supramolecular Assemblies: Synthesis and Application	Guru Ghasidas Vishwavidyalaya, Bilaspur	Aug 20-21, 2015
7	Green Revolution to Gene Revolution	Telangana University, Nizamabad	Aug 20-22, 2015
8	Spectroscopy and Perspectives	Sacred Heart College, Tirupattur	Sep 10-12, 2015
9	Recent Trends in Physics	Guru Nanak Dev University, Amritsar	Sep 18-19, 2015
10	Recent developments on the theoretical and experimental aspects of advanced materials	North Bengal University, Darjeeling	Sep 18-19, 2015
11	Emerging trends in chemical sciences	VHNSN College, Virudhunagar	Oct 09-11, 2015
12	Recent Advances in Electrochemistry	NMKRV College for Women, Bengaluru	Oct 28-29, 2015
13	Spectroscopic techniques and applications	Bishop Moore College, Mavelikara	Nov 11-13, 2015
14	Taxonomy and Evolution	Mangalore University, Mangalore	Nov 23-24, 2015
15	Statistical Mechanics and Thermodynamics	JSS College of Arts, Commerce and Science, Mysore	Nov 25-27, 2015
16	Functional materials and their applications in devices	SSSIHL, Puttaparthi	Nov 26-28, 2015
17	Advances in molecular techniques	GITAM University, Vishakhapatnam	Nov 27-28, 2015
18	Emerging trends in Chemistry	St. Josephs College, Tiruchirappalli	Dec 18-20, 2015
19	Special functions and their applications	PSGR Krishnammal College for Women, Coimbatore	Dec 22-23, 2015
20	Biological Sciences	RMVC College, Kolkata	Jan 05-06, 2016
21	Advances in Biology	Goodwill Christian College for Women, Bengaluru	Jan 07-08, 2016
22	Recent Developments in chemistry	Madurai Kamaraj University, Madurai	Jan 08-09, 2016

S.No.	Topic	Venue	Date
23	Time and again: Challenging Science	Sophia College, Mumbai	Jan 08-09, 2016
24	Electronic structure and spectroscopy of atoms and molecules	Fakir Chand College, Diamond Harbour	Jan 20-22, 2016
25	Scope of Medical Biotechnology	Dr Hari Singh Central University, Sagar	Jan 21-22, 2016
26	Recent trends in biological sciences	The American College, Madurai	Jan 21-22, 2016
27	Trends in Plant Taxonomy	Yogi Vemana University, Kadapa	Jan 21-22, 2016
28	Frontiers in material sciences	Ravenshaw University, Cuttack	Jan 22-23, 2016
29	Recent trends in Nanobiotechnology	K.S. Rangasamy College of Technology, Tiruchengode	Jan 25-27, 2016
30	Biotechnology - Present and Future	Vijaya College, Bengaluru	Jan 29-30, 2016
31	Emerging trends in environmental biology	D.Y. Patil University, Navi Mumbai	Jan 29-30, 2016
32	Environmental Biotechnology	Auxillium College, Vellore	Feb 04-05, 2016
33	Recent developments in chemistry	Seethalakshmi Ramaswami College, Tiruchirappalli	Feb 05-06, 2016
34	Bioinformatics	IWSA and KBP College, Mumbai	Feb 06-07, 2016
35	Recent trends in machine learning	PSGR Krishnammal College for Women, Coimbatore	Feb 09-11, 2016
36	Bioprospecting and bioresources	St. Josephs College, Tiruchirappalli	Feb 10-12, 2016
37	Frontiers on corrosion Engineering and Technology	Bannari Amman Institute of Technology, Sathyamangalam	Feb 12-13, 2016
38	Recent trends on cellular mechanisms and gene expression	St. Josephs College, Bengaluru	Feb 12-13, 2016
39	Biotechnology tools and techniques in solving environmental problems	K.S. Rangasamy College of Technology, Tiruchengode	Feb 16-17, 2016
40	Spectroscopic Techniques and applications in material characterization	S.V. University, Tirupati	Feb 16-17, 2016
41	Frontiers in Nanoscience and Technology	St. Xaviers College, Aluva	Feb 18-19, 2016
42	Recent advances in chemistry	V.O. Chidambaram College, Tuticorin	Feb 19-20, 2016
43	Exploring developments in chemical sciences	Sant Gadge Baba Amaravati University, Amaravati	Feb 19-21, 2016
44	Innovations in bioscience	Bharathiar University, Coimbatore	Feb 21-22, 2016
45	Modern aspects of chemical research	Christ University, Bengaluru	Feb 22-23, 2016
46	Recent breakthrough in plant sciences	Central University of Punjab, Bathinda	Feb 22-24, 2016
47	Synergy between computational and experimental chemistry	Uday Pratap College, Varanasi	Feb 26-27, 2016
48	Fourier series, fotier transforms in applications	Indian Academy Degree College, Bengaluru	Feb 26-27, 2016

S.No.	Topic	Venue	Date
49	Recent developments in chemistry	Central University of Tamil Nadu, Thiruvarur	Mar 02-03, 2016
50	Chemistry at the interface if biology	Central University of Rajasthan, Ajmer	Mar 02-04, 2016
51	Genetically Modified Organism - Pros & Cons	The Oxford College of Science, Bengaluru	Mar 03-04, 2016
52	Advances in biosciences	Lady Doak College, Madurai	Mar 03-04, 2016
53	Modern chemistry and its applications	Guru Nanak Dev University, Amritsar	Mar 03-05, 2016
54	New frontiers in plant sciences and biotechnology	Nehru Memorial College, Tiruchirappalli	Mar 03-05, 2016
55	Plant Ecology and systematics	Telangana University, Nizamabad	Mar 10-11, 2016
56	Advances in plant and biomedical sciences	Bishop Cottons Women's Christian College, Bengaluru	Mar 10-11, 2016
57	Nano Science and nano technology	Alvas Institute of Engineering and Technology, Moodbidri	Mar 10-12, 2016
58	Recent developments in chemistry	PSGR Krishnammal College for Women, Coimbatore	Mar 11-12, 2016
59	DNA Repair and Diseases	Christ University, Bengaluru	Mar 11-12, 2016
60	Excitements in chemistry and physics	Dinabandhu Mahavidyalaya, Bongaon	Mar 16-17, 2016
61	Current trends and directions in cryptography and cyber security	CIET, Coimbatore	Mar 18-19, 2016
62	Theoretical and Computational Fluid Dynamics	S.V. University, Tirupati	Mar 21-22, 2016
63	Frontier lectures in biology	Jayaraj Annapackiam College for Women, Periyakulam	Mar 21-22, 2016
64	Applications of biotechnology	Telangana University, Nizamabad	Mar 21-22, 2016
65	Emerging trends in applied physics	Devanga Arts College, Aruppukottai	Mar 25-26, 2016