

Understanding astronomy through verses, prose and phrases

Venketeswara Pai R

Indian Institute of Science Education and Research Pune

INSA-AGM

IISER Pune

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Research Focus

Field of Specialization and mode of Research

- History and Development of Astronomy and Mathematics in India from 12th to 17th century AD.



- Deciphering the manuscripts pertaining to Astronomy/Mathematics
- Editing, and Translating/decoding the contents
- Critical study of the text
- Preparing the detailed mathematical notes in terms of modern mathematical parameters/notation
- Comparing the algorithms and results with modern ones and with other Indian astronomical works

Indian Astronomical literature

Evolution from *Siddhāntik* to *Karaṇa* School

- The huge corpus of astronomical literature that has been produced in India from the time of Āryabhaṭa (c. 499 CE) is generally divided into *Siddhāntas*, *Tantras*, *Karaṇas* and *Vākyaas*, in decreasing order of the theoretical contents.
- Astronomical parameters given in Siddhāntik texts are very large
- Complex and lengthy computational algorithms are employed in finding the planetary longitudes and other astronomical quantities
- Hence evolved a new school of astronomy which is known as *Karaṇa* school
- The epoch is chosen to a closer date and observed planetary longitudes documented
- Astronomical parameters are made smaller in magnitude
- *Karaṇa* texts describes the simplified algorithms and the mathematical equations are modified for computational ease

Instantaneous velocity in *Siddhāntaśiromaṇi*

दिनान्तरस्पर्शगान्तरं स्याद् गतिः स्फुटा तत्समयान्तराले ॥ ३६ ॥

कोटीफलप्री मृदुकेन्द्रभुक्तिस्त्रिज्योद्धृता कर्किमृगादिकेन्द्रे ।

तया युतोना ग्रहमध्यभुक्तिस्तात्कालिकी मन्दपरिस्फुटा स्यात् ॥ ३७ ॥

समीपतिथ्यन्तसमीपचालनं विधोस्तु तत्कालजयैव युज्यते ।

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$$\frac{d\theta}{dt} \approx \frac{d\theta_0}{dt} - \frac{r_0}{R} \times R \cos(M) \frac{dM}{dt}$$

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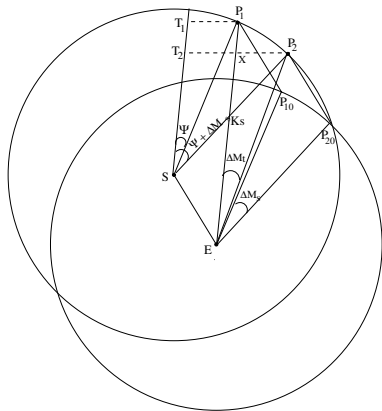
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अद्यतनश्चस्तनस्फुटग्रहयोरौदयिकयोर्दिनार्धजयोर्वाऽस्तकलिकयोर्वा यदन्तरं कलादिकं सा स्फुटा गतिः।

अद्यतनाच्छ्वस्तने न्यूने वक्रा गतिर्ज्ञेया। तत्समयान्तराल इति। तस्य कालस्य मध्येऽनया गत्या ग्रहाश्चालयितुं युज्यन्त इति। इयं किल स्थूला गतिः। अथ सूक्ष्मा तात्कालिकी कथ्यते। तुङ्गगत्यूना चन्द्रगतिः केन्द्रगतिः। अन्येषां ग्रहाणां ग्रहगतिरेव केन्द्रगतिः। मृदुकेन्द्रकोटिफलं कृत्वा तेन केन्द्रगतिर्गुण्या त्रिज्यया भाज्या लब्धेन कर्कादिकेन्द्रे ग्रहगतिर्युक्ता कार्या। मृगादौ तु रहिता कार्य। एवं तात्कालिकी मन्दपरिस्फुटा स्यात्। तात्कालिक्या भुक्त्या चन्द्रस्य विशिष्टं प्रयोजनम्। तदाह— समीपतिथ्यन्तसमीपचालनमिति। यत्कालिकश्चन्द्रस्तस्मात् कालाद्गतो वा गम्यो वा यदाऽऽसन्नतिथ्यन्तस्तदा तात्कालिक्या गत्या तिथिसाधनं कर्तुं युज्यते। तथा समीपचालनं च। यदा तु दूरतस्तिथ्यन्तो दूरचालनं वा चन्द्रस्य तदाऽऽद्या स्थूलया कर्तुं युज्यते। स्थूलकालत्वात्। यतश्चन्द्रगतिर्महत्वात् प्रतिक्षणं समा न भवति। अतस्तदर्थमयं विशेषोऽभिहितः।

अथ गतिफलवासना। अद्यतनश्वस्तनग्रहयोरन्तरं गतिः। अत एव ग्रहफलयोरन्तरं गतिफलं भवितुमर्हति। अथ तत्साधनम्। अद्यतनश्वस्तनकेन्द्रयोरन्तरं केन्द्रगतिः। भुजज्याकरणे यद्भोग्यखण्डं तेन सा गुण्या शरद्विदस्रैर्भाज्या। तत्र तावत् तात्कालिकभोग्यखण्डकरणायानुपातः। यदि त्रिज्यातुल्यया कोटिज्ययाऽऽद्यं भोग्यखण्डं शरद्विदस्रतुल्यं लभ्यते तदेष्टया किमित्यत्र कोटिज्यायाः शरद्विदस्रा २२५ गुणस्त्रिज्या हरः। फलं तात्कालिकं स्फुटभोग्यखण्डं तेन केन्द्रगतिर्गुणनीया शरद्विदस्रैर्भाज्या। अत्र शरद्विदस्रमितयोर्गुणकभाजकयोस्तुल्यत्वान्नाशे कृते केन्द्रगतेः कोटिज्या गुणस्त्रिज्या हरः स्यात्। फलमद्यतनश्वस्तनकेन्द्रदोर्ज्ययोरन्तरं भवति। तत्फलकरणार्थं स्वपरिधिना गुण्यं भांशे ३६० भाज्यम्। पूर्वं किल गुणकः कोटिज्या सा यावत् परिधिना गुण्यते भांशे ३६० ह्रियते तावत्कोटिफलं जायत इत्युपपन्नं कोटिफलघ्नी मृद्वुकेन्द्रभुक्तिरित्यादि। एवमद्यतनश्वस्तनग्रहफलयोरन्तरं तद्गतेः फलं कर्कादिकेन्द्रे ग्रहणफलस्यापचीयमानत्वात् तुलादौ धनफलस्योपचीयमानत्वाद्भुनम्। मकरादौ तु धनफलस्यापचीयमानत्वान्मेषादावृणफलस्योपचीयमानत्वादृणमित्युपपन्नम्।

Geometrical construction from the Commentary



- The term *Vākya* literally means a sentence consisting of one or more words.
- In the context of astronomy, it refers to a phrase or a string of letters in which numerical values associated with various astronomical parameters are encoded.
- The *vākyas* are composed using the *kaṭapayādi* system of numerations.
- The strings used in composing *vākyas* are chosen so that they not only represent numerical values, but are also in the form of beautiful meaningful phrases and sentences that convey worldly wisdom and moral values.

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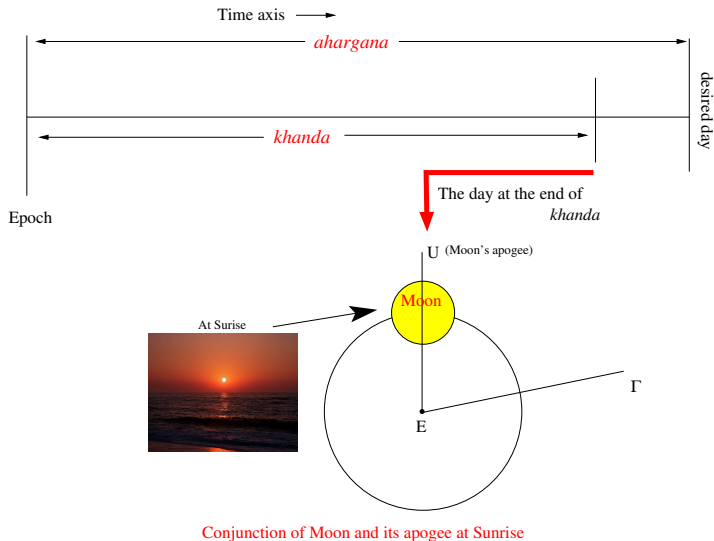
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No.	The Vākya	The Numerical Value		
1	<i>gīrnaḥ śreyah</i>	00	12	03
2	<i>dhenavaḥ śrīḥ</i>	00	24	09
3	<i>rudrastu namyaḥ</i>	01	06	22
⋮	⋮		⋮	
124	<i>rāmā gīyate</i>	06	13	52
125	<i>atyāhārastu</i>	06	28	10
⋮	⋮		⋮	
247	<i>kaveḥ śakyam</i>	00	15	41
248	<i>bhavet sukham</i>	00	27	44

- The desired numerical value is coded in these *vākyas* using *Kaṭapayādi* system.

Period of Moon's anomaly

Significance of the *khanda*



Conjunction of Moon and its apogee at Sunrise

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Rate of anomaly of Moon

- Application of *Vallyupasamhāra* or **Continued fraction**

<i>alpa-hāra</i> (H_i)	<i>alpa-guṇakāras</i> (G_i)
27	1
28	1
55	2
248	9
3031	110
12372	449
188611	6845
1332649	48364
1521260	55209
21109029	766081
43739318	1587371
414762891	15052420
.	.
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.	.
.	.
130798262479	4746881712
599082677500	21741684881
126040405436547500	4574211340428709

THANK YOU

for your patience