

A COMPARATIVE STUDY ON COMETARY RECORDS FROM THE *BRĤAT SAMĤITĀ* AND *BHADRABĀHU SAMĤITĀ*

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Ancient Indians had a regular tradition of observing comets. Varāhamihira (6th century A.D.) and Bhadrabāhu of probably somewhat earlier period compiled these reports in the samĥita texts, known as *Brĥat Samĥitā* (*BS*) and *Bhadrabāhu Samĥitā* (*BHS*). In this exposition we have tried to compare the cometary reports by these authors.

It has been found that *BS* classifies the comets as sons of planets and deities, on the basis of their similarity with them or their own physical appearance and effects. In addition to this, *BS* gives statistics w.r.t. their apparitions in various directions. On the contrary, *BHS* lists the comets by their names only. This text talks about the period of comets, while the other is silent about it.

It may be remarked that the analyses of the statistical data with respect to directions and sub-directions show that the comets are more abundant in the northern hemisphere, as is only to be expected for an observer in that part of the earth (observational selection feature). This proves that the observations reported by the ancients are real.

#### INTRODUCTION

Man's curiosity to know the mysteries of the universe is as old as human civilization. The movement and the behaviour of the heavenly bodies always fascinated the primitive-man. This led him to correlate the events on the earth with the movements of the comets, meteors, etc. These came to be associated with natural calamities, man-made disasters, social and political upheavals, vicissitudes of dynasties and destinies of potentates. Thus, they came to be associated with good and ban omens. This gave an impetus to the study of the kinematics of the heavenly bodies. In fact, the planetary kinematics has been known to mankind for over two and a half thousand years. It is interesting to note in this connection that the cometary apparition posed problem to rest of the world, till the advent of Newton's laws of gravitation in the 17th century, but ancient Indians seem to have had some knowledge of the time-periods of various comets.

#### PROBLEMS OF THE ANCIENT COMETARY RECORDS

Astronomers observe the natural phenomena, which are not reproducible like the experiments carried out in the laboratories. Many astronomical happenings cannot be

observed more than once in life, as they have very long time periods. Many of them occur once in several hundred to millions of years and some of them are non-periodic events. So their records may have taken very very long time to get finalised in the reported forms. The historical records, howsoever crude they may be, in such cases are our only sources of information about the celestial phenomena. The scientific community has standard observational records of only three to four apparitions of Halley's comet, which however do not provide sufficient data for any conclusive study. In such cases we will have to either wait for centuries, which is neither practicable nor desirable, or depend upon an additional information from the past records. It is in this context that the latter becomes indispensable for the pursuit of cometary studies.

#### SYSTEMATIC STUDIES

Ancient Indian astronomers classified comets into three types, viz. terrestrial (*Bhauma ketu*), atmospheric (*Antariksa ketu*) and celestial comets (*Divya ketu*)<sup>1</sup>. It may be noted however that ancient Indians included even phenomena like lightning, bonfire and aurora among comets. But here we are concerned only with *ketus* or celestial comets.

The breakthrough took place in the 16th century when Tyko Brahe proved that the comets are far removed from the limits of the earth's atmosphere. Observations with telescope were made for the first time in 1618 A.D. and subsequently many detailed studies took place<sup>2</sup>.

T. Kiang from Dunsink Observatory decoded the ancient Chinese records on cometary apparitions and then only was able to draw up a list of the past orbits of Halley's comet from 240 B.C. to 1986 A.D.<sup>3</sup>. J.L. Brady from Lawrence Livermore Laboratory has also calculated past trajectories of Halley's comet from 1986 A.D. to 2647 B.C.<sup>4</sup>; whereas the records on comets in ancient Chinese tradition are very well preserved and have been fully analysed, this is not the case in India. The Indian records on cometary studies of ancient, medieval and post – Halley era have not been properly studied, although some attempts have been made in this direction<sup>5</sup>. For example, even work done by V.B. Ketakara in the early 20th century has not received the due attention it deserves. A paper on his model of solar and cometary motions and relations of cometary concentrations with solar apex, by the authors, is in the process of publication<sup>6</sup>. The present exposition is first of the series of papers on pre-Bhatapala period; other papers will follow soon.

#### PROBLEMS OF IDENTIFICATION

The most difficult problem encountered in the study of the comets from ancient Indian writings is that of their identification. Like other ancient people, Indians took keen interest in observing celestial phenomena and we have a number of references to this effect, in the Vedas, the Puranas, the Epics and various other ancient works. As elsewhere in the world, such phenomena were related to the happenings around them. Unfortunately, there are very few references to particular historical events and what we

get are mostly generalised statements regarding the good and bad effects of various *ketus* (comets).

However, *Mahābhārata* is more specific when it mentions the apparition of a comet believed to be responsible for the great war. Likewise, a comet is said to have appeared at the time of king Kansa's death. Westerners have similarly linked the great events of their history such as death of king Julius Caesar and the Nativity<sup>2</sup> with apparition of comets. With passage of time, the ancient Indians began to understand the kinematics of comets and the fact that these bodies are bound to the earth and thus are members of solar system. They also came to know that they come close to the earth and the sun, but remain most of the time very far away from them. This period had been called their *Paravasa* period. It seems they knew that these revolve around the earth and periodic nature of their motion was also inferred. However, the methods used to find out their time periods remain unknown.

#### WORKS OF VARĀHAMIHIRA AND BHADRABĀHU

The *Br̥hat Sam̥hitā* and *Bhadrabāhu Sam̥hitā* contain valuable information on comets and it is worthwhile to attempt a comparative study of the two texts. The *Br̥hat Sam̥hitā* cites a number of observations from earlier works such as *Br̥ddha Garga Sam̥hitā*, *Parāśara Sam̥hitā*, *Garga Sam̥hitā* and *Nārada Sam̥hitā*. The *Bhadrabāhu Sam̥hitā* has no such references and it seems it is the work of Acarya Bhadrabāhu alone based on his own observations.

#### RISING AND SETTING OF COMETS

Both the texts agree that the rising and setting of comets are not predictable on the basis of mathematics, e.g. the *Br̥hat Sam̥hitā* says:

“It is not possible to calculate the rising and setting of the comets.”<sup>7</sup>.

The Bhadrabāhu goes even further and states:

“Their nakṣatras, etc. are not fixed; the time of rising and setting of the comets is not fixed. The planet (*ketu*) appears suddenly and sometimes”<sup>8</sup>.

It is clear from the above that ancient Indians were familiar with the kinematics of comets and through their observations they confirmed that comets are not fixed but move with respect to stars and their background. Their positions due to their movements are unpredictable, so their rising and setting are not fixed.

#### TIME PERIOD

Although the *Br̥hat Sam̥hitā* does not mention the time period of comets, it appears the astronomers of the time might have been familiar with the idea of their periodicity. For example, about the *Cala ketu* (literally the moving one) the *Br̥hat Sam̥hitā* says:

“The *Cala ketu* appears in the western direction and is possessed of a crest, raised a digit high with its tip turned towards the south. As it moves towards north its length increases, it touches the seven sages, i.e. towards the great Bear as well as the Pole Star and the star *Abhijit* and turns back after travelling only half of the length of the sky and then sets in the south<sup>9</sup>”. It is clear from the above that the trajectory of the *Cala ketu* was known, though the time period could not be calculated. However, sage Nārada seems to have some idea of the periodicity when he says:

“There is only one comet which comes time and again”<sup>10</sup>.

The *Bhadrabāhu Samhitā* says that the time periods of different comets are different. According to this *Samhitā*:

“The maximum time period of comets is 36 years.

The average time period of comets is 24 years, and the minimum time period is 13 years”<sup>11</sup>.

#### TOTAL NUMBER OF COMETS

Regarding the total number of comets the *Bṛhat Samhitā* says:

“Some sages like Parāśara speak of 101 *ketus*, while other like Garga speak of 1000 and according to Nārada there is only one *ketu* which appears in different forms in different places<sup>10</sup>.”

The *Bhadrabāhu Samhitā* on the other hand is of view that there are hundreds of comets<sup>12</sup>.

#### CLASSIFICATION

*Bṛhat Samhitā* mentions that some of the comets are sons of direction, wind and fire, while some of them are sons of different deities (planets). Some are given different names according to their shape and physical characteristics. This clearly indicates that ancient Indians were keen observers, who not only noticed and recognised the comets from their apparitions, colour and shape with different planets, fire, Brahmā, sun and moon. Whereas *Bhadrabāhu Samhitā* has given stress on individual comets and states the individual comets on the basis of their physical characteristics, i.e. colour, shape and size, e.g. *Kabandha*, *Puspaketu*, *Dhūmraketū*, etc.

The lists of the comets mentioned in both the texts are given below:

#### LIST OF COMETS FROM *Bhadrabāhu Samhitā*

*Angāraka*  
*Aruṇa ketu*

*Cikṣaṇa*  
*Kabandha*

<i>Dhūma ketu</i>	<i>Jvalitāṃkura</i>
<i>Vaidūryamani</i>	<i>Tālisā</i>
<i>Nīlasansthāna</i>	<i>Māṃsarohita</i>
<i>Kanakaprabhā</i>	<i>Vaivasvata</i>
<i>Śukla</i>	<i>Dhūmamālī</i>
<i>Samasarpavadankura</i>	<i>Mahārci</i>
<i>Śīśira</i>	<i>Vidhūmīta</i>
<i>Gulma ketu</i>	<i>Dārūna</i>
<i>Vikrānta</i>	<i>Jalada</i>
<i>Udhvamunda</i>	<i>Jalaketu</i>
<i>Visānī</i>	<i>Jalarenu</i>
<i>Kṣīlī ketu</i>	<i>Rūkṣa</i>
<i>Maṃdali</i>	<i>Jalavān</i>
<i>Mayūrapaksī</i>	<i>Śikhī</i>
<i>Dhūmadhvaja</i>	<i>Śikhandī</i>
<i>Dhūmaśikha</i>	<i>Vimala</i>
<i>Dhūmārci</i>	<i>Vināsī</i>
<i>Dhūmatāraka</i>	<i>Dhūmasāsana</i>
<i>Vekeśī</i>	<i>Viśikhāna</i>
<i>Viśikhah</i>	<i>Śatārci</i>
<i>Mayūra</i>	<i>Sālaketu</i>
<i>Viddhamastaka</i>	<i>Alaktaka</i>
<i>Mahāketu</i>	<i>Ghṛta</i>
<i>Sveta</i>	<i>Ghṛtārci</i>
<i>Ketuvāhana</i>	<i>Citrapuṣpa</i>
<i>Ulkāśikha</i>	<i>Vidūšana</i>
<i>Jajvalya</i>	<i>Vilambī</i>
<i>Prajvālī</i>	<i>Viṣama</i>
<i>Vāṃbarīṣeka</i>	<i>Agni</i>
<i>Hendrasvara</i>	<i>Vātakī</i>
<i>Hendraketu</i>	<i>Hasan</i>
<i>Suklavāsa</i>	<i>Kuṭila</i>
<i>Anyadantaka</i>	<i>Kadvakhilamga</i>
<i>Vidyutsama</i>	<i>Kucitruga</i>
<i>Vidyut</i>	<i>Vidyutsphulimgaka</i>
<i>Ketumān</i>	<i>Dīpta</i>

LIST OF COMETS FROM *Br̥hat Samhitā*

<i>Dhūmaketu</i>	<i>Raudraketu</i>
<i>Agnistutāḥ</i>	<i>Calaketu</i>
<i>Mṛtyusutāḥ</i>	<i>Śvetaketu</i>
<i>Dharasutāḥ</i>	<i>Śveta</i>
<i>Śaśisutāḥ</i>	<i>Ka</i>
<i>Vidīksutāḥ</i>	<i>Rāsmiketū</i>
<i>Kirāna</i>	<i>Dhruvaketu</i>

<i>Brahmadanḍa</i>	<i>Kumuda Ketu</i>
<i>Visarpaka</i>	<i>Maniketu</i>
<i>Kanaka</i>	<i>Jalaketu</i>
<i>Vikaca</i>	<i>Bhavaketu</i>
<i>Taskara</i>	<i>Padmaketu</i>
<i>Kaumkuma</i>	<i>Āvarta Ketu</i>
<i>Aruna</i>	<i>Samvarta</i>
<i>Kilaka</i>	<i>Viśvarupa</i>
<i>Ganaka</i>	<i>Kanka</i>
<i>Kabandha</i>	<i>Vasāketu</i>
<i>Kapālaketu</i>	<i>Asthiketu</i>
<i>Śastraketu</i>	

## COMETS WHICH FIND MENTION IN BOTH THE TEXTS

<i>Dhūmaketu</i>	<i>Kabandha</i>
<i>Aruṇa ketu</i>	<i>Jalaketu</i>
<i>Kiraṇa ketu</i>	<i>Śveta</i>
<i>Kanaka ketu</i>	

In fact, these lists include all types of *ketus*. It is evident that Bhadrabāhu has given more names of the *ketus* and has stressed on individual comets, while *Brhat Samhitā* gives lesser number of names of the *ketus*. Sometimes this text also includes different *ketus* under the same heading.

The diagram (Fig. 1) shows directions and subdirections as used in ancient Indian literature. The subdirections are inclined at an angle of 45° to the directions. In fact, comets are coming from all the directions, so in order to take into account their apparitions in various directions and subdirections, it is logical to define their angular spans of 45°, each equally distributed about the direction and subdirection symmetrically as is shown in the figure. This way angular span of east is 22½°, similarly angular span of *Īśāna* is 22½°. Therefore, the number of comets coming from a particular direction are comets, which are seen in the respective angular span of the direction and are known as sons of that particular direction. For example, in *Īśāna* region the number given is 115; this means that there are 115 *ketus* which appear in this region.

It is evident from the figure depicting the statistical distribution of comets from *Brhat Samhitā* that there are more comets observed in northern hemisphere, which is expected too. It confirms the observational selection for an observer in northern hemisphere. It is to be noted that the *ketus* which have the same probability of coming from all the directions are not given in the daigram.

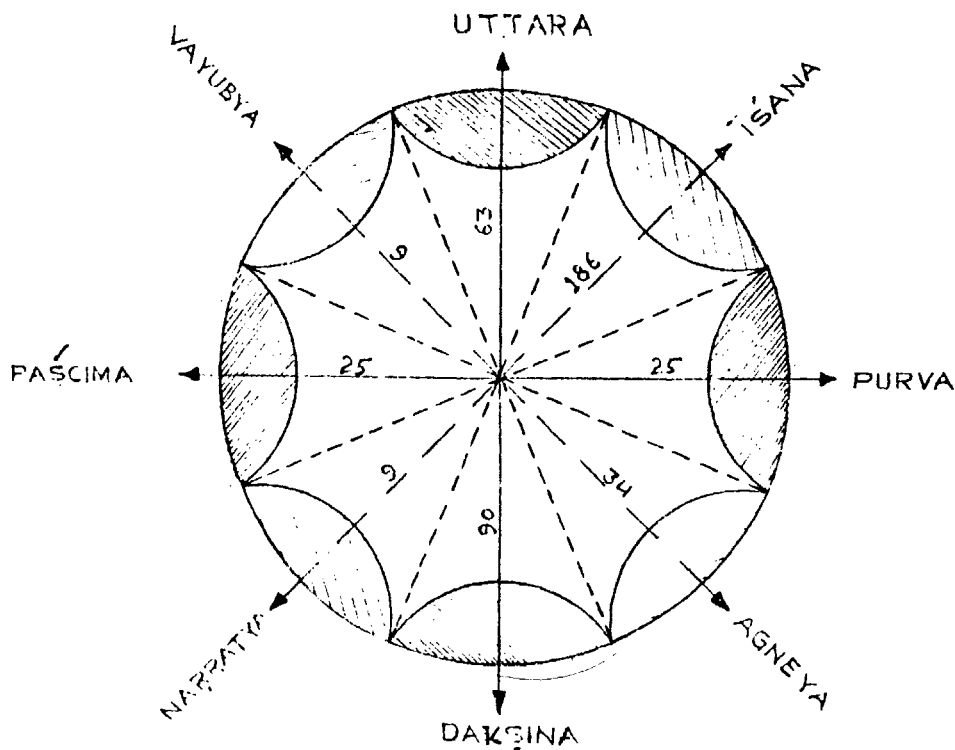


Fig. 1. The diagram showing 8 Directions/Subdirections and the number of observed comets as reported in *Brhat Samhitā* of Varāhamihira (6th century A.D.). The figure given in the respective regions shows the number of comets observed in that region. Evidently, the number of comets is much more in Northern Region justifying the observational selection features.

#### CONCLUSION

From the above discussion it is evident that Indians could infer some important aspects. The outcomes of their studies can be summarised as follows:

- I Cometary kinematics or at least ideas about the kinematics were already there to ancient Indians.
- II Through their observations they confirmed that there are different types of comets and classified them into groups accordingly. The *Brhat Samhitā* classifies the comets on the basis of their resemblance with various planets, deities or with fire. Some of them have been related to directions/subdirection and have been called their sons. However, *Bhadrabāhu Samhitā* gives the classification based entirely upon the physical characteristics of individual comets.
- III Numbers of comets mentioned in both texts are different. But on the basis of statements regarding directions of comets is *Brhat Samhitā*, the observational selection is confirmed for observers in the northern hemisphere.

IV Bhadrabāhu had some idea about the periodicity of the comets, whereas Varāhamihira either did not have any such notion or has not mentioned it. But the later commentator Bhaṭṭapala mentions periods of some of the comets. On the basis of number of comets given in it, the *Bhadrabāhu Samhitā* seems to be earlier than *Brhat Samhitā*. The critical analysis of these reports will be presented in our later expositions.

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#### NOTES AND REFERENCES

- <sup>1</sup>Varāhamihira's "*Brhat Samhitā*" commentary by M.Ramakrishana Bhat, Moti Lal Banarasi Dass, New Delhi, 1981 ketucaradhya 11/2.  
"*Darśanamastamayo vā na gaṇitavidhināsyā śakyate Jñatum.*  
*Divyāntarikṣabhaumāstrivīdhāḥ Syuḥ ketavo Yasmāt*"
- <sup>2</sup>William Thynne Lynn, *Remarkable comets*, a brief survey of the most interesting facts in history of cometary astronomy, London: Edward Stanford, 26&27, Coackspur Street, Charing Cross, S.W., 1896, page-7.
- <sup>3</sup>T.Kiang "Contributions from the Dunsink Observatory, No. 10, The Past orbits of the Halley's comet" reprint from *Mem.R.Ast. Sock* 76-27-66, 1971.
- <sup>4</sup>Joseph L Brady, "*Halley's Comet 1986 A.D. to 2647 B.C.*". Preprint Lawrence Livermore Laboratory, Dec 1, 1976 Preprint Number UCRL 74776 Rev. 2.
- <sup>5</sup>Sharma S.D., "*Periodic nature of cometary motions as known to Indian Astronomers before 11th century A.D.*" IAU Colloquim 1986 published from Oxford Press in "*Oriental Astronomy*" (p-109-112)
- <sup>6</sup>Sharma S.D., "*Ketakara's model of cometary orbits*" in process of publication with the journal *Histroia Mathematica*, Toronto. (Canada).
- <sup>7</sup>*Brhat Samhitā* 11/2.
- <sup>8</sup>Bhadrabāhu, *Bhadrabāhu Samhitā* commentary by Nemichandra Shastry published by Bharatiya Jnanapitha, Kashi, 1959, Chapter 21/41.  
"*Na kāle niyataḥ ketuḥ na naksatrādikastathā*  
*Ākasmiko bhavatyeva kadācidudito grahaḥ*"
- <sup>9</sup>*Brhat Samhitā* 11/36.  
"*Anyānapi ca sa deśān kvacitkvacidhanti rogaḍurbhiksaiḥ*  
*Daśa māsānphalāpako'sya kaiścidaṣṭādaśa proktaḥ*"
- <sup>10</sup>*Brhat Samhitā* 11/5.  
"*Śatamekadhikāmeke Sahastramapare Vadanti Ketūnām,*  
*Bahurūpamekamekeva prāha munirnāradaḥ ketum*".
- <sup>11</sup>*Bhadrabāhu Samhitā* 21/42.  
"*Śaṭ trīṃśat tasya varsāni pravāsaḥ paramuḥ smṛtaḥ*  
*Mādhyamaḥ Saptaviṃśam tu Jaghanyaṃ tu travodaśa*".
- <sup>12</sup>*Bhadrabāhu Samhitā* 21/4.  
"*Śatāni Caiva ketūnām pravakṣyāmi pṛthak pṛthak*  
*Upātā yādṛśā uktā grahāstamanānyapi*".