Abstracts of papers by M N Vahia on Archaeo Astronomy and related subjects[1]

I. STONE CARVINGS

1) Astronomical interpretation of a Palaeolithic rock carving found at Sopor, Kashmir
M N Vahia, Aijaz A Banday, Mumtaz Ahmad Yatoo, Naseer Iqbal, Tabasum Masood Bhat
To appear in Puratatva, 2006

We analyse a rock carving found in Bomai-Sopor, north of Kashmir, first reported by Banday (2003) and described by Yatoo (2005). The details of the carving and comparison with the geographical features of the region show how several components of it agree with the local geophysical morphology. An interpretation of the carving based on comet shower and astronomy seems a very likely one for which some tests are to be conducted to check this interpretation.

2) Oldest sky-chart with Supernova record
Hrishikesh Joglekar, Kavita Gangal, M N Vahia, Aniket Sule
To appear in Puratatva, 2006

When did the humans begin astronomical observations? The oldest of the human observations are scattered through various Palaeolithic epochs. These observations are seen in the form of the cave paintings at various sites in France and Spain and include the phases of moon leading to ephemeris, bright stars and basic constellations (Rappenglueck, 1999). In India, a stone carving is excavated from a site in the Kashmir region, where permanent settlements are dated to a period around 3000 - 1500 BC (IAR, 1964). The stone slab shows two bright objects in the sky with a hunting scene in the foreground. These have been assumed to be a depiction of a double star system (Kameshwar Rao, 1995). We propose that this is the first record of a supernova. From the manner of drawing of the two objects, they both seem to be brighter than other stars and planets. We show that one of the objects is likely to be near-full moon and other is a probable supernova. We have searched the records of supernovae (Green, 2005; Xu et al., 2005) and suggest that the supernova drawn in the rock painting is HB9 (Xu et al. 2005; Damashek et al., 1978; Laehy and Aschenbach, 1995) which exploded in 5700 BC and had an estimated apparent magnitude of -9.6. We then reinvestigate the entire hunting scene and show that the drawing of the hunter and the stag seem to be correlated to Orion and Taurus in the vicinity of HB9. We scale this picture and find that all the drawings can be correlated to astronomical sky patterns. Hence we suggest that this picture is not only the first record of a supernova, but also a sky-chart from 5500 BC making it by far the oldest such record.

[1] Full papers are available at www.tifr.res.in/~vahia/papers.html

II. NAKSHATRA DESIGNS AND RELATED ISSUES

3) Calculations of *tithi*s: An Extension of *Surya Sidhānta* formulation

Sudha Bhujle and M N Vahia
Indian Journal of History of Science, 2006, **41**, 133

Tithis are the dates of Lunar Calendar. Sewell and Dikshit (1) have given a detailed procedure to calculate the *Tithis* as used in ancient Indian astronomy. The work is based on the principles defined in *Surya Siddhānta* (2) and other seminal ancient works. These calculations rely on tabulated values for some constants. The method of deriving these tables is not clear and no formal process of calculating these constants has been given. In the present paper we evaluate the formulation of the process of calculating the *Tithis*. We show that this formulation uses constants which can be calculated using trigonometric functions. Hence we re-formulate the method of calculating *tithis* and derive a self consistent equation of calculating *tithi*s that still uses the same basic procedure. Using the data of solar eclipses from NASA website (3), we calculate the *tithis* from 2,000 BC till 3,000 AD, we show that this method of calculating the constants from trigonometric formulae gives an accurate prediction around 500 AD when the tables were created. Outside this period, the discrepancies due to the Earth's precession overwhelm the data and by 2,000 BC the discrepancies between calculated *tithis* and occurrence of eclipses can be as much as 7 days. We therefore fit this data with least square method and arrive at the correction factors. We add this empirical linear correction factor to correct for this and derive a method of calculating *tithi*s which is accurate and self consistent from 2,000 BC to 3,000 AD. We propose that the method may be accurate to as much as 10,000 BC to 10,000 AD. We then test this formulation against the predicted *tithis* (full Moon) of lunar eclipses and show that the formulation gives accurate *tithis* from at least 2,000 BC to 3,000 AD.

4) Possible period of the design of Nakṣtras

Sudha Bhujle and M N Vahia
To appear in the Annals of the Bhandarkar Oriental Research Institute, December 2006

The Nakştras were designed to keep track of the moon's path in the night sky. No literature gives the exact position of these Nakşatras but there are many stories associated with each Nakşatra. They were also probably used for time keeping over days. There are a total of 27 Nakşatras panning the night sky and the Moon spends an average of one day (night) in each Nakşatras. However, as per the present association of stars with these Nakşatras, several of them are as far as 25° away from the ecliptic where as Moon travels only about 5° on either side of the ecliptic. The possibility that in the remote past the ecliptic could have been 25° north to the present is not likely. We are not sure when the Nakşatras were originally identified or when and how many times they were altered. To understand when could be the Nakşatras defined. We studied the sky pattern from 3500 BC to 2005 AD and realized that the Moon path was closest to the maximum number of Nakşatras around 3000 BC. We therefore suggest that the Nakşatras were defined around 3000 BC and that the current association of star like. Mŗgaśīrā with Nakşatras needs to be re-examined

5) **Possible period of the design of Nakshatras and Abhijit**
   Sudha Bhujle and M N Vahia
   Submitted to Indian Journal of History of Science, December 2006

The Nakshatras were designed to keep track of the moon's path in the night sky. The ancient literature does not give the exact position of these Nakshatras but there are many stories associated with each Nakshatrā. There are a total of 27 Nakshatras spanning the night sky and the Moon takes and average of one day to cross each Nakshatra. The earliest mention of Nakshatras is in Vedas. Some of the Vedic literature mentions 28 Nakshatras. The Nakshatra Abhijit gets dropped in the later on documents. However, as per the present association of stars with these Nakshatras, several of them are as far as 25^o away from the ecliptic where as Moon travels only about 5^o on either side of the ecliptic. The possibility that in the remote past the ecliptic could have been 25^o north to the present is not likely. We study the sky pattern from 3500 BC to 2005 AD and show that the Moon's path was closest to the maximum number of Nakshatrās around 3000 BC. To account for 28 Nakshatrās we also looked for the likelihood that a transient star may have existed in the region of Abhijit around the time when the Nakshatrās were defined. We did find a Supernova of apparent magnitude brighter than the brightest star that must have been visible in the region where Abhijit was supposed to be around 3000 BC. We therefore suggest that the Nakshatrās were defined around 3000 BC.

III. ASTRONOMICAL OBSERVATIONS

6) **In search of Indian records of Supernovae**
   Hrishikesh Joglekar, Aniket Sule, M N Vahia
   To appear in the Indian Journal of History of Science, December 2006

One of the unexplained items of ancient Indian astronomical traditions is an apparent absence of records of supernovae, which are the last moments of dying stars when they become several orders of magnitude brighter than usual and may often be visible in daytime sky. In the present paper, we make a list of about 12 supernovae that should have been visible during the periods of prehistory and history.

7) **Saptarşi's visit to different *Nakşatras*: Subtle effect of Earth's precession**
   Aniket Sule, Mayank Vahia, Hrishikesh Joglekar, Sudha Bhujle
   To appear in Annals of the Bhandarkar Oriental Research Institute, 2006

In several ancient Indian texts a mention is made of the movement of the *Saptarşi* constellation (Big Bear or Big Dipper) in the sky, visiting each *Nakşatras* for 100 years. *Saptarşi* is said to visit a *nakşatra* if the *nakşatra* is in the middle of the stars in the first part of *Saptarşi*. Since astronomical objects except planets are more or less stationary in the sky, this is generally considered a fanciful statement devoid of astronomical meaning. We show that this may not be so. We show that the visit of *Saptarşi* to different may be a very significant astronomical observation. The transition is not a constant of time since it depends on the proximity of the *Saptarşi* to the North Pole, which changes due to Earth's precession and relative sizes of different *Nakşatras*. We show that since 8000 BC, *Saptarşi* has visited 5 different *Nakşatras* and for one of them, the transition happening in the span of roughly 100 years. We show that this interpretation allows dating of this belief which is consistent with other evidences of the Harappan civilisation and date different *Saptarşi* Era with calendar dates.

8) Dating of *Rohiṇī-Śakaṭa-Bheda*

Parag Mahajani, M N Vahia, Mohan Apte, A P Jamkhedkar

Annals of the Bhandarkar Oriental Research Institute, 2006

Rohiṇī-Śakaṭa-Bheda (RSB) is referred in Indian literature as an event of great significance. RSB is said to occur when either Saturn or Mars pass through the triangle formed by α, ε and γ stars of the Taurus Constellation (or the *Vṛşabha*). We have searched the literature and found descriptions of RSB recorded by several authors. We have compiled the various references to this event and show that the event has been given considerable importance in the literature, with only minor changes in the description over the millenniums. Based on this, we have derived a common minimal interpretation of the same. In some literature, this event is correlated with a huge disaster.

We have searched the astronomical database using the latest ephemeris for RSB. We found a series of RSB events with Mars. The latest event occurred in 5284 BC but before that, it occurred several times during the 10^{th} millennium BC. However, since 5284 BC, the event has not occurred and is not expected to occur till 10,000 AD.

During 10,000 to 9,000 BC, the end of the last ice age indicates that there was a sudden rise in the sea level by 60 meters over a few hundred years indicating a yearly rise of 22 mm per year. This rise reached a plateau around 9,000 BC when the rate of increase came down to about 2 mm per year until about 5,500 BC when once again it rose significantly by 10 mm/year for about a thousand years to reach the currently observed levels.

We therefore suggest that whoever correlated RSB with huge disasters must have done so around 5284 BC and could have had some idea about the disasters that coincided with the earlier phases of RSB which occurred in 9860BC, 9828 BC, 9371 BC and 9339 BC. This suggests that the tradition of intricate astronomical observations is older than seven thousand years from present.

9) Dating Kāvalaṇ plate inscription of the time of Bhōjadēva

Harshal Bhadkamkar, Sudha Bhujle and M N Vahia

Submitted to the Journal of Indian Epigraphic Society, September 2006

The copper plate inscriptions found near Kavalaṇ in Nasik district of Maharashtra mention about a solar eclipse (Trivedi, Corpus Inscriptionum Indicarum, Vol VII part 2, hereafter referred to as Trivedi p 54 – 60). The inscriptions have no internal noting of date. The *List of Inscrs. of N.I., No 2085* mentions the date of inscriptions as 17th March 1048 AD without assigning a reason for the same (Trivedi, p 55). Based on the contents of the plates it has been proposed by Banerji that it was written in the late period of Raja Bhoja's rule (1000 to 1055 AD, Trivedi, p 60) while Trivedi feels that the inscription is of a much earlier period. The plates mention the donation of a large plot of land to a Jain Tirthaṅkar on the day of a solar Eclipse. We search for an observable Solar eclipse in the list of eclipses. We find that there was no solar eclipse visible in India on the mentioned date. However, four partial solar eclipses were observed at Nashik in Hindu calendar month Chaitra during the reign of Raja Bhoja. Based on this, we suggest that the most likely date of the events discussed in the plates is March 1047.

10) Dating the era of Rāmāyaṇa by astronomical evidences
Sudha Bhujle[1] and M N Vahia[2]
Submitted to *Puratva,* September 2006

We analyse the astronomical events reported in Rāmāyaṇa, which have been used to date Rāmāyaṇa to earlier than fifth millennium BC. We show that none of the astronomical events and other descriptions stand up to scrutiny. Hence using these quotations in Rāmāyaṇa to date it does not give acceptable answers.

IV. INDUS SCRIPT

11) Search for patterns in Indus Script
Nisha Yadav and M N Vahia
Ancient Asia, SOSAA Journal, Dec 2006

We search for writing patterns in the Indus Script based on the concordance of Mahadevan (1977). We do not assume any structure or meaning in the writing. We check if the Indus writing is meaningfully structured with specific rules to code useful information. We create a basic unique data set (BUDS) based on the original concordance. BUDS consists of single line texts from the objects inscribed only on one side and containing only single line text. We show that the ordering of the signs in the writing is far more significant than random association. The unit length of information is 2, 3 or 4 signs at a time. We find that most common two-sign combinations are also parts of most common three-sign combinations, which in turn also appear in four-sign combination. However, in texts with just 2, 3 or 4 signs we do not find these frequent two, three or four sign combinations. We conclude that while the information is given in units of two or three signs, these are more like phrases where an additional sign is required to complete the grammatical structure.

12) A statistical approach for pattern search in Indus writing[2]

[2] Also available on www.harappa.com

Nisha Yadav, M N Vahia, Iravatham Mahadevan, H Joglekar
International Journal of Dravidian Linguistics, Jan 2008

We search for potentially grammatical patterns in the Indus writing based on the concordance of Mahadevan (1977). We make no assumptions about its structure or meaning. We *only* attempt to check if the Indus writing is meaningfully structured with specific rules to code useful information. In order to avoid possible errors in interpretation due to incompletely read or multiple copies of a piece of writing, and other possible sources of error, we create an Extended Basic Unique Data Set (EBUDS) based on the original electronic concordance. EBUDS consists of completely read single line texts on any side of the writing material. We exclude multi-line text or partially read text. This gives us a set of 1548 lines of data consisting of 7000 signs. We show that the ordering of the signs in the writing is much more significant than random association. The unit length of information is 2, 3 or 4 signs at a time. We then study the most frequently occurring two, three and four sign combinations in EBUDS. We find that in many cases, most common two-sign combinations are also parts of most common three-sign combinations, which in turn also appear in four-sign combination. However, in texts with just 2, 3 or 4 signs we do not find these frequent two, three or four sign combinations. We therefore conclude that while the information is given in units of two or three signs, these are more like phrases where an additional sign is required to complete the grammatical structure.

13) Segmentation of Indus Texts[3]
Nisha Yadav, M N Vahia, Iravatham Mahadevan, Hrishikesh Joglekar
International Journal of Dravidian Linguistics, Jan 2008

We adopt a comprehensive approach to segment the Indus texts using statistically significant signs and their combinations in addition to all the texts of length 2, 3 and 4 signs. We find that we can segment 88% of Indus texts (of length 5 and above) by this method and hence it can be suggested that the texts of 5 or more signs can actually be seen as permutations of other frequent sign-combinations or smaller texts (of length 2, 3 or 4 signs). The results of the segmentation process are in agreement with our earlier results (Yadav et. al, 2008, henceforth referred to as Paper 1) where we show the importance of 2, 3 and 4 sign combinations as important units of information. We do not assume anything regarding the content of the script and the work is purely based on the structural analysis of Indus Texts.

V. GENERAL:

14) Archaeo-Astronomy
Mayank N Vahia
Proceedings of the Conference at Asiatic Society, 2006

Archaeology is the study of ancient civilizations and their developments while astronomy, apart from being the study of skies – a study of location of Sun, Moon,

[3] Also available on www.harappa.com

planets and stars, is one the oldest sciences. Hence the imprint of astronomy can be found in ancient cave tools onwards. Astronomy is expressed in a variety of ways in different literature. However, it has never been exploited to create a separate window into the past. In the present paper, we discuss the possibility of using astronomy as an effective tool for archaeology and the ability and limits of such studies.

15) Possible error in historical dates: Error in correction from Julian to Gregorian Calendars

Mohan Apte, Parag Mahajani, M N Vahia

Current Science, **84**, 21, 2003

We have studied five major historical events reported between 1630 AD and 1680 AD where detailed references to the stars in the night sky are available. We show that the descriptions of the star patterns at that time are off by exactly 10 days. For example, the solar eclipse reported in one example to occur on March 20, 1680 in fact occurred on March 30, 1680 according to the current (Gragorian) calendar. This is checked using a computer simulation package (SkyMap Pro 8). We attribute this error in dating ancient event(s) due to switch over from Julian to Gregorian calendars in later half of 18th Century.

16) The Harappan Question

Mayank Vahia

Annals of the Bhandarkar Oriental Research Institute, 2006

One of the major problems of interpretation of early Indian history has been the inconsistencies between the Harappan (Indus Valley) civilisation and the Rigvedic literature. Problems arise from the fact that the Harappan Civilisation was at its peak around second millennium BC (Allchin and Allchin, 1989 page 131). The period of creation of the Rigveda has also been put around 4000 to 2000 BC, though the writing down of the text has been dated to a much later period around 2000 BC or later. The Rigvedic literature and its subsequent developments have also been in the Indian subcontinent. There has therefore been a strong temptation to connect the Harappans to the Vedic Civilisation. However, there are several problems with this association, most graphically portrayed in the ‘horse problem’ (Thapar, 2003). Horses are integral to most Rigvedic ritualistic customs while they are absent in the Harappan sites. There are several other problems also. We re-visit this controversy in the light of some recent developments and suggest that the Harappans belonged to the ancient Homo sapiens who separated from the humans migrating from Africa as early as sixty thousand years ago and travelled along the coast of the Arabian Sea (Wells, 2003). This group lost touch with the group that migrated to the Mediterranean and evolved independently of them. We suggest that it was this group that set up the Harappan civilisation. We suggest that the group that went to the Mediterranean eventually moved east at the end of the Ice ages and passing through northern Iraq, Iran and Afghanistan entered India (the Indo – Iranians) where they met the earlier migrants who had come along the seas. They met at the Harappan sites sometime around two and a half thousand years BC. We base this suggestion on new data on the genetic make up of aboriginal Indian tribes (Thangaraj et al., 2002) and other studies of human migration, dating of separation of languages (Gray and Atkinson, 2003) and broad based studies of prehistoric human evolution (Mithen, 2003) as well as other evidence about the appearance of horses in Asia, etc. We propose that the Vedas were composed by the Indo Iranian but they included upon the learning of the Harappans and this mix of knowledge is also visible in the Vedic literature, especially in the astronomical information in the literature.

17) **History by the victors: Thoughts on Mahābhārat**
M N Vahia
Preprint

We examine the general aspects of the story of Mahābhārata as a record of history by the victors of Mahābhārata war. We discuss various inclusions and exclusions from the story and investigate the inconsistencies in the contents of the Mahābhārat. We then compare the contents of the Bhagavad Gita and the Şānti Parva with the prevalent religious practices of the period and discuss their contradictions. We then try to speculate on its original contents and their later modifications.

18) **India's prehistory: Assimilation of archaeological, archaeo astronomical, genealogical, genetic and linguistic data**
M N Vahia
Ancient Asia, SOSAA, December 2006

Indian prehistory has largely been studied through archaeology and by interpretation of various texts. These methods have been successful to a great extent in deciphering Indian prehistory. However, new analyses of genetic, genealogical, linguistic data and archaeo astronomy have provided completely new insights into the prehistory of the Indian Subcontinent. While archaeological and genetic data suggest that the Indian population separated from the other population groups about 40,000 to 60,000 years before present (YBP), recent results on genealogical studies suggest that all living humans today, had an *identical set* of common ancestors around 7,000 years ago. Analysis of world languages also suggests that Indian languages separated from the European languages around the same time. Archaeo-astronomical data suggest robust intellectual growth in the Indian subcontinent from time scales earlier than 10,000 YBP. We discuss these results together and attempt to reconcile them. We suggest that they provide some interesting insights into the human population groups in the prehistoric period and allows a study of interaction and migration patterns during the period of 7,000 to 3,000 YBP.

19) **Harappan Geometry and symmetry: A study of geometrical patterns on Indus Objects**
M N Vahia and Nisha Yadav
Submitted to Indian Journal of Historical Studies, November 2007

We study the geometrical patterns on various Indus objects catalogued by Joshi and Parpola (1987) and Shah and Parpola (1991). We show that some of the patterns seen on these objects are geometrically very complex and technologically difficult to make. It suggests that the Indus culture had a deep understanding of complex geometry as well as manufacturing capabilities far ahead of its times. We also show that these objects have 4, 7, 8, 12, 20 and 24 fold symmetries. We suggest that they have astronomical and other significance beyond what is normally assumed. We discuss both, successful and failed attempts to create geometrical patterns to show that these creations are not random scribbles to create a pattern but involves a certain understanding of geometry. We show that there are examples of failed attempts to comprehend complex geometrical patterns as well as one magnificent inscription with extremely well proportioned geometric work that must be considered a piece of art of exceptional quality that demonstrates understanding of complex geometrical ideas with high technical precision.

20) **Harappan Weights**
M N Vahia and Nisha Yadav
Submitted to Man and Environment, December 2007

We show that the data of Marshall (1934) about Harappan weights shows that they were standardised with an uncertainty of 6%. This fluctuation within each weight class may be a result of weathering and the original weights may well be more accurate. Within this pattern of uncertainty, they follow the octal system for small weights and decimal for larger weights.