Astronomy in the Indus Valley Civilization

A Survey of the Problems and Possibilities of the Ancient Indian Astronomy and Cosmology in the Light of Indus Script Decipherment by the Finnish Scholars

by

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Introduction

1. The origin of the ancient Indian astronomy has remained one of the most seriously debated questions of oriental studies for about the last two centuries. A well documented history of the disputes and discussions was published by James Burgess[1], who summarised the state of research on the subject from the time of discovery of the Siamese tables in 1687 to the end of the 19th century. The antiquity given to the beginning of the Indian astronomical system has ranged from 4300 B.C. to the 11th century A.D. —dates which may conveniently be termed as Bailly-Bentley extremes after their respective proponents.

Bailly and Bentley were both wrong in placing the origin of the Indian astronomy so early or so late. But a very useful outcome of their lively dispute was a stimulation of interest among other eminent scholars, who contributed brilliant research publications on various aspects of the subject. Specially notable were the works of Colebrooke (1816), Whitney (1858), Weber (1860–1868), and Thaibaut (1877–1899). Their studies, combined with the translations of some of the important classical Indian treatises like the *Surya Siddhanta* (translated by Ebenezer Burgess, 1860), the *Brhat Samhita* (tr. H. Kern, 1865), and the *Panca-Siddhantika* (tr. Thibaut and Dvivedi, 1889), show that the theories and methods of Indian astronomy are not to be considered as one monolithic entity. They are rather to be treated as results of the growth and accretion of ideas—indigenous as well as foreign—through a long process of cultutal diffusion.

2. A tentative division of the Hindu astronomical development into chronological sequence has been made by Kaye[2] according to the esti-

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mates of ages of the ancient literary sources of information. In a general way, his periodic scale may be simplified for the purpose of the present discussion as: *Vedic astronomy* (c. 1200–400 B.C.); *post-Vedic astronomy* (c. 400 B.C. to 400 A.D.); *Classical and Medieval astronomy* (from A.D. 400 onwards).

3. Of these three broad divisions, the last named period has been studied in considerable detail. The Classical astronomy of India is, indeed, heavily indebted to Greek science, specially from the period of Gupta dynasty (320–650 A.D.), as appears from the works of Aryabhata, Varaha Mihira, Brahmagupta, and other astronomers belonging to that age. Both the internal features of the classical astronomy (planetary names of days of the week, twelve-fold solar zodiac, precession or trepidation of the equinoxes, epicyclic and eccentric models of planetary motions, parameters of the solar or lunar variations, etc.), and the external evidence like Al-Beruni's account (Sachau: *Al-Beruni's India*, London, 1910) confirm it to be of Hellenistic derivation. The scientific aspects of the Classical Indian astronomy have been related to the works of some of the Alexandrian astrologers living in the period between Hipparchus and Ptolemy (c. 150 B.C. to A.D. 150).

Early in the present century, Schnabel[3] pointed out certain tangible evidence of the dependence of the Hindu Siddhantas on Seleucid astronomy of Babylon. This line of research has been continued by Prof. Neugebauer[4], who recognizes in the Indian science the characteristically Babylonian procedure of numerical extrapolations (the "step" and "linear zig-zag" function) for determining the variations in planetary velocities, or in calculating the rising times of constellations. He also traces in the late Babylonian ephemerides and the Greek and Demotic documents of the Roman period, some parallels of the rules of approximation, as applied by Tamil astronomers in the "Vakyam Process" for determining the lunar longitude after a long lapse from the fixed epoch of the *Kali Yuga* in the year 3102 B.C.[5]

Problems of the Ancient Indian Astronomy

4. While aspects of the Classical and Medieval Indian astronomy have been well investigated by competent scholars, our ignorance about the earlier phases of the science in India remains in direct proportion to the

remoteness of the post-Vedic, Vedic—and let us say, *pre-Rig-Vedic* ages. We shall turn to the *pre-Rig-Vedic* stage later in this survey. Before that, it would be proper to make a brief assessment of the features of Vedic and post-Vedic astronomy in the light of modern scholarship, so that we may isolate some of the outstanding problems.

5. From the little that we know, the Vedic astronomy appears naturally to be of a very primitive level. *Rig-Veda*, the earliest literary source of religious and cultural traditions in India is very much vague on the subject. There is some internal evidence of its composition in the district of Ambala of the Panjab, which combined with other external evidence of the Indo-Aryan literary traditions indicates the time of composition between 1500–1400 B.C.[6]

The traces of primitive astronomical concepts from *Rig-Veda* become more clear in the later religious texts like the *Yajur-Veda* and *Atharva-Veda*, composed between 1200 to 1000 B.C.—and in the still later liturgical manuals like the *Brahmanas*, *Upanishads*, *Samhitas*, *Sutras*, etc., together with the quasi-historical epics of the *Mahabharata* and the *Ramayana*. These sources identify the planets by their characteristic colours, and associate them with the Vedic deities, but have no clear concept of the planetary motions. They recognize a year of 360 days, and seek adjustment of the natural seasons with lunar months by arbitrary intercalations.

6. A most significant feature of the Vedic astronomy is the division of the sky into 27 or 28 *nakshatras*, or asterisms conceived as marking the stages of the apparent daily progress of the moon from west to east in its monthly journey across the sky. The names of the lunar asterisms occur in scattered form in the *Yajur-Veda* and *Atharva-Veda*, but the first complete enumeration is given in the *Taittiriya-Samhita*,[7] composed sometime between 1000 to 700 B.C. as an explication of the *sukla* and *Krsna* orders of *Brahmanas* related to the *Yajur-Veda*.

The system of *nakshatras* or the lunar zodiac is a persistent feature of the Indian astronomy right from 1200 B.C. in Vedic period to fairly late in the Classical astronomy. Over a long stretch of this period the series of the lunar asterisms began from *Krittika* (Pleiades), marking the 3rd degree of the sign of Taurus. At some stage in the Classical astronomy (c. 570 A.D.) the first point was shifted to the asterism known as *Asvini* (β Arietis), as a measure of adjustment of the precession of the Vernal Equinox—

clearly an attempt to reform the Hindu calendar in the light of knowledge gained from Hellenistic astrology.

Many great scholars like Colebrooke, Biot, M. Sedillot, and Weber have tried to trace the origin of the Indian lunar zodiac to the Greek, Chinese, Arab, and Assyrian traditions. But their arguments mutually cancel each other, keeping the place and time of origin of the Indian *nakshatras* still an unsolved mystery. A more noteworthy opinion regarding this feature of the Indian astronomy is that of Prof. Max Muller. In the preface to vol. IV of his edition of the *Rig-Veda* (London 1862) he claims it to be purely of Hindu origin. In agreement with the studies of Archdeacon Pratt of Calcutta, he estimates the point of the Vernal Equinox, marking the beginning of the Vedic calendar, as having been placed in *Krittika* in 1181 B.C.[8]

7. In comparison with the Vedic astronomy, the science in post-Vedic period shows definite signs of progress. The calendar continues to be lunar, but a new element visible in the calendarical computations is a cycle of five-years of 360 days each. This period is approximately equal to 62 synodic lunar months. For the purpose of keeping the traditional 12 lunar months in a natural year, the superfluous period of two synodic months is adjusted by intercalation in two equal instalments—one in the middle and the other at the end of the five-year cycle.

The rules of intercalation in this five-year cycle are far more primitive than in the 19-year (Metonic) cycle evolved in Greece about 430 B.C., and also traced in Babylonian texts 50 years later.[9] In fact the five-year cycle is even a more gross approximation than the 8-year cycle (octaeteris) in ancient Greek parapegmas, later used also by Eudoxus (c. 370 B.C.). It would be safer to assume that the five-year yuga of the luni-solar adjustment is purely an Indian attempt to reconcile the farmer's calendar with the lunar counts. Kautilya[10] explains that the sun carries off 1/60th part of a whole day every day, and makes one complete day in two months or *rtu*. Likewise, the moon falls behind by 1/60th part of a whole day every day, and makes one complete day in two months or a *rtu*. Thus in the middle of every third year (i.e. after the 30th month from start of the yuga), the sun and moon together make a *malamasa* (profane or additional month). In the remaining 30 months of the yuga they again make a second *malamasa*. Thus it may be gathered that an intercalation was made in the summer of the *third* year, and another in the winter of the *fifth* year of the five-year cycle.

8. An important unit of time commonly used in Indian astronomy from post-Vedic times is the *tithi* or lunar day, being equal to 1/30th of the synodic month, and 61/62nd of a *savana* (natural) day. This artificial unit of time was given a primary importance in Indian chronology down to the Classical times. Each of the 30 *tithis* within a lunar month was given its own name, and a *savana* day was named after the particular *tithi* in which it began at the sun-rise. The origin of the Indian *tithi* is generally thought to be due to Babylonian influence transmitted through Hellenistic astrology, but I do not consider it the whole truth. I shall elaborate this point later in this survey.

In the Indian chronological computations the *tithis* are to be distinguished as *mean* and *true* depending on whether they represent 30 equal parts of a mean synodic month, or of a true synodic month.[11] The *mean tithis* are of constant duration, but the *true tithis* fluctuate in length, according to the number of days involved in a given lunar month. The quantitative irreconciliation between the *savana* days and *tithis* is further complicated by the *suppressed tithi* as name giver to a *savana* day in the mean lunar calendar, and by the *repeated tithi* in the same context in true calendar.

9. Resuming our general review of the post-Vedic astronomy of India we find that the apparent diurnal motion of heavens is postulated as a kind of vortex with uniform angular speed. Around 300 B.C. the twelvefold solar zodiac of Babylonian origin is also introduced, and its constellations are termed as *Rashis*,[12] but the calendarical computations are based on the 27 equal or 28 unequal *nakshatras* of the Vedic period.

Presumably, some kind of crude observations with gnomons are also made at Ujjain to determine the difference of its shortest and longest days in the year. The difference quoted by Varaha Mihira is just in the ratio of 2:3, which does not fit the latitude of Ujjain, and has been shown possibly to be a Babylonian parameter by Thibaut[13] and supported by Neugebauer.[14]

In the post-Vedic period also, we hear of Parasara and Garga, the earliest Indian astronomers known by name, who lived within a couple of centuries following Alexander's conquest of the Panjab.[15] It is a pity that their several works like *Parasara Tantra*, and *Gargi Samhita*, and *Nakshatra Kalpa* are lost; but some extracts have been preserved by Varaha Mihira living in the Classical period. The main literary sources

representative of the period are *Jyotisha-Vedanga* (original source traced to some 36 stanzas of the *Rig-Veda* and 43 stanzas of the *Yajur-Veda*), *Paithamaha-Siddhanta*, named after one of the stars in the Great Bear (dated to 80 A.D. from the use of the second year of the Saka Era), and the Jaina books *Suryaprajnapti* and *Jambudvipa prajnapti*. These works in their modern form are mostly corrupt versions of the originals, and as such, are not of much historical value. Some astronomical and cosmological information of the period is also contained in the *Vishnu-Purana* and other Puranic accounts.

10. An interesting aspect of the post-Vedic astronomy is the body of speculations on cosmological models as represented by the Jaina books and the Puranic works. The earth in these primitive models is essentially the hub of the universe. It has a flat circular shape of a diameter of 100,000 yojanas, its centre being occupied by the golden Mount Meru—abode of angels and of excessive height, standing right beneath the pole-star. Around the base of Meru is situated the great landmass of Jambudvipa, split into four lobes like petals of a lotus, and the southern lobe of it makes the Bharat Versha or India. The Jambudvipa is surrounded by seven concentric bands of oceans and continents, and the land farthest away from Meru is the Vadavamukha island.

The *Suryaprajnapti* states the heavenly bodies to be at the same level above the earth. They revolve in their various orbits imagined as concentric circles around Mt. Meru from east to west. They become invisible at night when they go behind Meru; only the Pole-star remains visible in all seasons, because it is situated right above the sacred peak. Some of the celestial phenomena are explained by a complicated scheme of two suns, two moons, etc.;[16] and the day and night on Meru itself last six months each. The *Vishnu Purana* gives considerable details of the heavenly bodies revolving round Mt. Meru, and states their distances in round numbers of yojanas. In order of increasing distance the first orbit is that of the sun, followed by the orbit of the moon and then by the five visible planets, Saturn being the farthest of these. After the orbit of Saturn is the sphere of the *Saptarshiyas* or the seven Rishis of the Great Bear. Farther still is the *dhruva*, or the pivot axis of the whole planetary system, marked by the Pole-star. All the heavenly bodies are tied to the Pole-star by aerial cords ..., etc.[17]

In the planetary arrangement of this dynamic cosmic model, some of

the Puranic accounts also include the names Rahu and Ketu, interpreted by scholars as representing the ascending and descending nodes of the lunar orbit. According to the fable, the demon Rahu stole some *amrita* at the "churning of the oceans". The god Vishnu was very angry at this outrage, and vanquished the demon. But as the demon had already tasted of the divine libation, his head and tail had become immortal, and survive as the ascending and descending nodes of the moon. Indian astronomers of the medieval period did not believe in this myth, and some of them explicitly rejected it.[18] But within living memory, the occasion of an eclipse always caused great consternation, particularly among the Doms, or the untouchable caste of India. They used to beat drums and brass pots, and chanted spells to drive away the primeval demon Rahu.

11. So far as post-Vedic astronomy is concerned, we cannot claim it to be entirely of Indian origin. The main portion of its period is post-Alexandrian in date. Parasara and Garga, the most ancient astronomers noted in India, refer in their passages to the presence of Greeks or Yavanas in western India, and praise them for their cultivation of the knowledge of heaven. Even centuries before Alexander, the Indians possessed a degree of acquaintance with the Greeks in the time of the Achaemenian Empire of Persia.

Though definite evidence is lacking, the nature of the cosmic model in the Jaina books and Brahmanic Puranas betrays a good deal of Greek and Persian ideas, with some possible traces of the older myths and superstitions of purely Indian origin. Taking hints from Al-Beruni, Kaye[19] has made a strong case of the resemblance between Hindu concept of Mount Meru and the Zoroastrian belief of Girnagar as centres of the world. In his opinion, the variants of Meru as Neru, Sineru and Sumeru indicate a foreign origin, and the geographical distribution of the seven oceans and continents recalls to mind the seven districts of the Avestan scheme. We may note in passing that while the Hindus place the Meru at the North Pole, Ptolemy mentions a "Meroe" somewhere in Ethiopia, a little north of the Equator, marking the second zone of "climate" (*Almagest*, ii).

The arrangement of the heavenly bodies, and their circular motion, at uniform angular speed around the sacred peak of Meru, apparently presents a unique structure of the cosmic model, of which we do not find a prototype in the development of Greek astronomy. Perhaps it would

be more correct to consider it as an accretion and synthesis of ideas coming from the west through centuries. It is not difficult to discern in the Indian cosmic model the vestiges of some garbled ideas of the pre-Socratic philosophers—Milesian, Pythagoreans, Eleatics, Empedocleans, all combined and filtering to India as travellers' tales. The ideas, some fossilized others metamorphosed, were necessarily touched by Zoroastrian views in the process of transmission through western Asia, perhaps mainly as oral traditions.

12. In spite of these vague similarities, which may never be confirmed, it would be importunate to assign every feature in the ancient Indian cosmic model to foreign ideas. For instance, in the early Greek cosmology a support to the flat Earth is normally envisaged (except in Anaximander's model) as water, a cushion of air, or an equilibrium between the upper and lower voids of the cosmic sphere—but for suspension of the heavenly bodies in space, no support is felt necessary! In contrast to this, the Indian cosmic model presents the Pole-star as *dhruva* of the universe, supporting the heavenly bodies by invisible aerial cords. This may truly reflect a Vedic tradition, whose origin may even go back to *pre-Rig-Vedic* times. To the same remote period may also be assigned the origin of the fable of the primeval demon Rahu, whose surviving head and tail were later set beautifully in the cosmic scheme in the era of the Puranic accounts, perhaps soon after the advents of the classical astronomy in India.

From the foregoing stock-taking of the ancient Indian astronomy and cosmology, after a cleaning of the later fungal growth, we can single out the features of problematic nature and origin as follows:

a) Recognition of the visible planets by their characteristic colours, and their identity with the Vedic deities.
b) Origin of the *nakshatra* asterisms.
c) Concept of the Pole-star forming *dhruva* of the universe, and supporting the heavenly bodies by invisible aerial cords.
d) Concept of the primeval demon Rahu, and his misdemeanor at the "churning of the oceans".
e) Concept of the Mount Meru as centre of the celestial motions.
f) Significance of the Indian *tithi*.

Archaeological "Red-shift" in the Indian Astronomy

13. In examining the historical evolution of the above noted residual features of the ancient Indian astronomy and cosmology, most of the modern investigators have fought shy of the idea of assigning them a native Indian origin. In the 18th and 19th centuries their reserve and caution appear basically to have proceeded from the absence of any tangible evidence of high antiquity of the Indian civilization. The earliest written documents recognized in those days were the inscriptions of Asoka, set up about the middle of the third century B.C.

A conviction of the antiquity of the "Aryan" civilization in India as dating back to the middle of the second millennium B.C., was the result of a slow and laborious growth achieved through linguistic studies of the *Rig-Veda* and other religious and liturgical texts. These studies were first started by Coeurdoux and Sir William Jones in the second half of the 18th century. The occurrence of the names of some of the Vedic gods[20] in Mitanni documents of the 14th century B.C., excavated at Bogazkoy in 1907, and in records found at other Hittite ruins in Asia Minor, lent strong support to the view that the *Rig-Veda* was composed between 1500–1400 B.C. Recent studies tend to place the irruption of the Indo-Aryans into the Indus Valley area in 1800 B.C. or a little later.[21]

Though the *Rig-Veda* is not very explicit on astronomical questions, as we have noted earlier, yet the date given by Kaye to the beginning of the ancient Indian astronomy in 1200 B.C. is an underestimate. This date shows at best some consolidation of the celestial knowledge acquired by the "Aryan", and as represented in the *Yajur-Veda*, *Atharva-Veda*, and the *Mahabharata*. Professor Max Muller's estimate of fixation of the first point of the Indian *nakshatra* in Krittika in the twelfth century B.C. also points in the same direction.

It looks very much possible that after their immigration into the South Asian Subcontinent, the Aryans were acquainted with a primitive and crude astronomical system which had already existed in the pre-historic Indian culture. Their initiation into this *pre-Rig-Vedic* astronomy was at first slow and imperfect, as apparent from the *Rig-Veda*, but their knowledge increased with the passage of centuries and the process of indianization.

The Vedic astronomy of the *Atharva-Veda* and *Mahabharata*, then, is a true heir to the primitive astronomical tradition of the *pre-Rig-Vedic* India,

or more specifically to that of the Indus Valley Civilization. I regard this receding antiquity of the possible origin of the Vedic astronomy as an archaeological "red-shift" in the present discussions.

14. An opening into the vast pre-history of the Indian culture was first recognized by General Cunningham on his visit to Harappa in 1856. Seventy years later, it led to a series of large scale excavations at Harappa and Moenjodaro. Though the earliest limit of the Harappan culture is by no means settled with certainty, yet the beginning of its mature phase corresponds with the Classical Sumerian period (2500–2400 B.C.). In brief, the excavations have revealed a civilization based on agricultural economy susceptible to seasonal rains, floods, and draughts; possessing a marvellous sophistication in town planning; and tendency for orderly regulations in trade and commerce, and in other aspects of civic life.

It is indeed difficult to conceive that this civilization, spread over an extensive area of the western parts of the South Asian subcontinent, would have flourished for about a thousand years without some forms of calendar derived from the primary—or what Prof. Asger Aaboe terms as the "farmer's and shepherd's astronomy".[22] Astronomical observations of a crude nature have been pointed out in prehistoric communities in England and Brittany and in ancient civilizations of the Maya and Olmec people for determining dates of rituals and civil harvest festivals. All the great ancient civilizations in Egypt, Mesopotamia, and China have their claims to *archaeo-astronomical* and *ethno-astronomical* traditions, and I see no reason to doubt the existence of the same traits in the agrarian communities of the nameless empire of the Indus Valley, centred on the twin capitals of Harappa and Moenjodaro.

Unfortunately, at this stage of our pursuit of the ancient Indian astronomy, we enter into a cultural milieu whose intellectual standards still remain to be fully evaluated from the debris raked by the archaeologists. In our study of the inscrutable features of Indian astronomy, mentioned on the preceding pages, it would be preposterous to look for a complete solution of their origins in the *pre-Rig-Vedic* lores of an extinct people. We can only suggest some possibilities, and wait for the final verdict of the future investigators, better equipped for probing the past of the Indus Valley Civilization.

15. The main obstacle in evaluating the finer elements in the extinct

civilization is the problematic Indus script, which unlike the Mesopotamian cuneiform and Egyptian hieroglyphic, remains as yet undecipered. The symbolic ideograms appear to convey messages in short texts on small bronze tablets, terracotta pottery, and steatite seals found from Harappa and Moenjodaro, very often in association with pictures of real and mythological animals and legendary heroes or deities in human form.

Attempts at decipherment of the Indus script are as old as the archaeological discovery of the civilization. Among the few useful outcomes of these studies are the recognition of some 350 different signs, and the fact that the script is generally written from right to left. Frequent repetitions of the pictorial shorthands with slight variations suggest an easy structural analysis, while some symbols such as the vertical strokes ranging in number from 1 to 12 may be taken to indicate numerical values. Despite all these alluring features, the script has defied all amateurish claims of extracting the meanings and phonetic qualities of the symbols with certitude, in the absence of any bilingual texts. The attempts are not given up in despair. To the contrary, they have been intensified with the aid of computers in Soviet, Czechoslovakian, Scandinavian, and other prestigious academies of the world.

A beginning towards interpreting some of the pictographic symbols of the Indus script in terms of celestial bodies has been made in recent years by Dr. Asko Parpola and his associates of the Scandinavian Institute of Asian Studies in Copenhagen.[23] Assuming it to be the script of a proto-Dravidian language of India, the Epigraphic experts have tried to decipher the symbols through statistical analysis on computer, by a process obviously involving complex semantics of the phonetic, philological and other variables, formulated from the linguistic and mythological considerations from extant Tamil, Telgu, and Sanskrit sources.

16. Their small but germinal monograph referred above, is not an easy reading for non-linguists of the Dravidian and Sanskrit languages. But some of their interpretations of the symbols as signifying celestial entities are of capital advantage to a serious study of the history of the primitive astronomical systems.

As I happened to be engaged precisely in that kind of study at the University of Thessaloniki during 1974–76, I perceived a chance of making a break-through in the old deadlocks of the ancient Indian astronomy, just as a side-issue of the main theme of my research. I felt urged to look

closely at the question whether the Harrapan seals offered any possibility of a bilingual, or at least a bilateral expression of the calendarical convention based on the crude astronomy of the remote age. So far the Indian *nakshatra* asterisms are concerned, I felt that the square pictorial stamp seals from Harappa and Moenjodaro did hold that potential.

The present concensus of opinion about the purpose of the stamp seals is that they served probably as tokens of clearance through custom or taxation formalities for goods exported or imported through the various trade routes of the Indus Valley. Harappan seals have been discovered even as far afield as Mesopotamian sites in deposits of Akkadian times from about 2300 to 2000 B.C. or a little later.[24] To the hypothesis of their being the labels of ownership of the merchandize for bureaucratic protocols, I would add the suggestion of their being also indicative of the seasons of the year, and even of particular months and dates on which the various goods (mostly perishable agricultural produce) were meant to be released for shipment, in order to facilitate the state records.

Viewed in this light, the various figures of real and mythological animals (bulls, elephants, rams, rhinoceroses, crocodiles, tigers, unicorns, animals with composite heads, etc.) and deities in human form may be presumed to signify some kind of a crude system of division of the sky by asterisms, roughly marked along the apparent path of the moon as a frame of reference for calendarical reckoning. In this character, the pictographic seals of the Indus Valley share the calendarical function of the so-called Assyrian astrolabe[25]—the earliest astronomical document from Mesopotamia. The term "astrolabe" applied to this clay tablet is a misnomer, only because it has a circular arrangement of the twelve lunar months—each enclosing three constellations, more or less from the zodiacal limits. Seasonal reckoning from 36 asterisms or "decans" marked along the southern side of the ecliptic is also evident from the Egyptian "diagonal calendars".

17. With this rough sketch of a working hypothesis in mind, I started exploring details of mechanism of the supposed astronomical calendar of the Indus Valley. In order to extract these details it was necessary not only to ponder over the interpretations of the symbols given by the Finnish scholars, but also to find out what further progress had been made in their project during the intervening period of five years, and whether the subsequent studies by computer decoding had introduced any major changes in the previous meanings of the symbols.

These considerations induced me to open correspondence in October 1975 with Dr. Asko Parpola living in Helsinki. After some pause, I was delighted to receive not only a very warm response to my letter from him but also xerox copies of two of his latest research papers. The first is only a one-page abstract of a detailed paper read by him at the 29th International Congress of Orientalists in Paris, 1973, and entitled "Harappan Roots of Ancient Indian Astronomy and Cosmic Speculations". The second is "Interpreting the Indus Script" written in June 1974 for publication in *Fifty Years of Harappan Studies* (Sir Mortimer Wheeler Felicitation Volume: editors B.B. Lal and S.P. Gupta) to appear from New Delhi. These papers will be referred to in following discussions as *Parpola*, i and *Parpola*, ii for the sake of brevity.

It was somewhat surprising to find that what had cropped up as a diffused and incidental issue in the linguistic studies of the Indus Civilization by the Finnish scholars five years ago, was now a focal image being resolved by Dr. Asko Parpola. The obvious success of certain astronomical interpretations of the symbols had directed his researches towards "the study of the origins of the Indian astronomy and the reconstruction of the Harappan religion".[26]

I was happy to see that what I had erstwhile imagined to be an abandoned venue of speculations, into which I had strayed, was not lonely at all. It was already being explored by people equipped with vast linguistic resources and computers, whereas I was handicapped by a total absence of all first rate means and material. But, I felt an infinitely greater joy to discover that my idea of the existence of some link between the Vedic *nakshatras* and the pictorial stamp seals of the Indus Civilization was not entirely absurd.

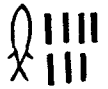
At this point, I am reminded to express my sincere gratitude to Dr. Asko Parpola for his words of encouragement and interest in my work, and implicit consent to use his published results in my discussions. In the following few sections, therefore, I take the liberty of summarising the views and astronomical interpretations of some characters of the Indus script according to the Finnish scholars, specially with reference to the two recent papers of Dr. Asko Parpola.

Astronomy from the Indus Script—the Finnish Approach

18. A starting point towards exposition of the ancient Indian astronomy

in the study of the Indus script is the upright figure of fish  . The Dravidian word *min* for fish was first associated by Henry Heras with the homophone *min* for star. The sign with various combinations makes about 20% of the entire material of the Indus script.[27]

The elaborate arguments drawn by Dr. Parpola from Vedic and Epic mythology in support of this interpretation are very weighty. In brief, they suggest that the ancient Dravidian religion of the Indus Valley was a dual system of star-worship and fish cult, which linked the heavenly spirits with the earthly ones. Perhaps, the ancient Dravidians believed the sky to be circumvented by an ocean or a broad river in which, allegorically, the stars were considered to be swimming fishes. That explains the convention of denoting stars with fish signs in the Indus script, which is quite different from the astral sign *DINGIR in Sumerian pictograms, as determinative of a god's proper name.[28]

The basic fish symbol in the Indus script indicates the constellations or asterisms by putting vertical strokes beside it, numerically equal to the number of stars in the particular case. Thus, according to the Soviet scholars, the word  is "three-star" or *mu-m-min*, the Old Tamil name of the asterism *Mrigasirsha* in the Vedic *nakshatra*. Similarly  indicates "six-star" or *aru-min*, the Old Tamil name of the asterism *Krittika* (Pleiades) in the Vedic *nakshatra*; and  is "seven-star" or *elu-min*, the name of Ursa Major.[29]

19. In the study of the Finnish scholars, the basic fish symbol assumes further flexibility to indicate the five visible planets by the addition of strokes of another kind. Dr. Parpola suggests that such a stroke combined with the fish sign appears to be a rebus for a particular colour, and the fact that the words for these very colours in Old Tamil and Telgu also signify the names of the different planets gives support to his views. The identities of some of the Vedic gods with different planets and their attributes of the relevant colours, are probably due to legends rooted in the astral faith of the Indus Valley Civilization.[30] Thus, the Finnish scholars interpret  as *paccai* (Ganesa = Mercury = the green star);  as

val-min, velli-min or *ven-min* (Balarama = Venus = the white star);  or simply  as *cem-min* (Siva = Mars = the red star);  as *por-kol* (Brahma = Jupiter = the golden star); and  as *mai-m-min* (Krsna = Saturn = the black star).

While the above noted fish signs indicate the specific planets, Dr. Parpola interprets the crab sign in the Indus script as denoting planets in general, or the planetary quality of tight hold or seizure of the human fate in the primitive astral superstition. The crabs in a variety of shapes such as  , or  , or  , or simply as  occur in most cases immediately before or after the various fish signs. The emphasis on claws rather than on feet of the crabs conveys the idea of grip, which is strengthened by the fact that the Tamil word *kol* for planet verily means "to seize" or "seizure". The Sanskrit word *graha* for planet has also exactly the same meaning, indicating once again the possibility that the Aryans acquired the astral superstitions regarding human fate from the *pre-Rig-Vedic* tradition of the Indus civilization.[31]

20. An interesting aspect of the crab sign is its depiction within a tree sign to form a composite pictograph or ligature as  . Some copper tablets from Moenjodaro, bearing identical inscriptions on the obverse sides, use either this ligature or its seemingly equivalent—a goat-faced male figure, as index on reverse sides. Dr. Parpola points to the identity of the goat-faced hero as the hunter god, from evidence of the Indus terracottas and dance masks.[32]

The association of the ligature  (or its variant  in an unpublished seal from Harappa) with the hunter god has far-reaching consequences. The hunter god of the celestial pantheon of the *pre-Rig-Vedic* times is pointed out by Dr. Parpola as the proto-type of the *Rig-Vedic* god Rudra—the cruel, malicious, fire-brand and blood-sucking deity. This dreaded planetary god (Mars) has many aliases or mixed identities in Sanskrit and Tamil as *Hara, Agni, Vishnu, Siva, Skanda, Murukan*, etc. The animal form of the Vedic *Agni* is the red-haired goat, which seems to

have got its image from the goat-faced hunter god of the Indus civilization. In Old Tamil legends the handsome, ever-young war-god *Skanda* or *Murukan* was born in *alar-kutam* (fire-pond) marked by *aru-min* or "six-star" (Krittika, Pleiades). Skanda's heavenly counterpart is another goat-faced hero *Vishakha*, whose abode is the asterism of the same name in the *nakshatra* system, lying opposite to *Krittika*.[33]

21. The tree sign itself, in the above mentioned ligature, assumes a wide cosmological significance in the interpretations of the Finnish scholars. The sign has other variants in the Indus script such as  or  , interpreted as the "banyan tree" (Sanskrit *vata*, northern dialect *nyagrodha*) or *ficus indica*. Dr. Parpola associates it also with the pipal (*asvattha*, *ficus religiosa*) motif  seen on pre-Harappan pottery of Mundigak.

It is not clear whether the pipal and banyan connote a difference of meaning. Both these trees are native to the Sub-continent, and seem to be represented on the Harappan seals in cosmological, planetary or theistic contexts. Dr. Parpola suggests that the Sanskrit word *vata* for the banyan tree seems to be etymologically connected with the Dravidian *vata*, meaning "rope, string, cable, cord" and its homophone *vata*, meaning "north".

In Dravidian language, the word *vata* seems to express the attributes of the banyan tree, known best for its profusion of long aerial roots and its ecological limits to more or less in the subtropical parts of the Sub-continent, *north* of the peninsular India. A ligature in the Indus script  finds its remarkable equivalent in the Old Tamil as *vata-min* "north-star". Going a step farther, Dr. Parpola hints at the origin of the Vedic notion of the Pole-star as *dhruva* of the universe—supporting the planets, asterisms and other stars by invisible *cords*—in association with the *pre-Rig-Vedic* cult of the banyan tree and its probable place in the cosmic scheme of prehistoric India.[34]

22. A more abstract form of the tree sign in Indus script is the character  , which makes about 10% of the entire material. The Soviet

scholars interpret this pictograph as meaning the pipal tree (holy fig tree, *ficus glomerata* or *ficus religiosa* as mentioned earlier). By virtue of its occurrence at the ends of the inscriptions, as a general rule, the sign  , has been regarded as a grammatical ending as a suffix of the genetive case. Dr. Parpola strongly supports this Soviet view, and points out the sign  as a variant noted on an unpublished potsherd from Kalibangan, and the sign  on a copper tablet from Moenjodaro, signifying the same motif in the sense of grasping roots of the epiphytic plant. He draws attention to the astronomical significance of the pipal tree, which is considered as the tree of the god Brahma, represented as  in the planetary sequence. In Vedic religion, this tree of Brahma is the abode of the spirits of the dead, and the place where the moon god temporarily retires at the end of every month before his rebirth.[35]

23. Another important character of the Indus script taken in cosmic sense is the sign  , which appears nothing but the pipal tree symbol shorn of the pairs of horizontal strokes. This sign has been interpreted variously as to mean a sacrificial pot, or a pitcher of water to protect the fishes. From the sense of receptacle or abode, it has been equated with the Dravidian words *kutam* or *kuntam*, meaning "pot, pool, pond, pit".[36] An extension of these meanings qualifies it to denote the ponds of the heavenly river Sarasvati. These ponds in Vedic accounts are also referred to as *apsaras* or asterisms of the *nakshatra*. The asterisms are spoken of as heavenly damsels with whom the Moon, as the heavenly playboy (*gandharva*) dances and unites every night.[37]

The myth of this enviable privilege of the Moon mentioned in later Vedic texts, appears to have been derived from the astral tradition of the *pre-Rig-Vedic* religion. The idea essentially incorporates the primitive calendarical convention of keeping track of time by marking the positions of the Moon in its daily eastward shift against the starry background—a scheme reflected by the so-called Vedic *nakshatras*. During the full phase

of the Moon, of course, it would not have been easy to see the fainter stars in the immediate vicinity. But a prominent star or a group of fainter stars lying at some distance towards north or south, away from the glare of the moonlight, might well have served as the indicator of the pot-hole  for the position of the Moon on a particular night.

In support of the *pre-Rig-Vedic* origin of the *nakshatra* system in India, and its slow adoption by the Aryan immigrants, Dr. Parpola points to the fact that the earliest religious hymns of the Indo-Aryans in the *Rig-Veda* show a scarcity of reference to planets and asterisms. These features appear fully developed only about the 12th century B.C. in the *Atharva Veda*, *Mahabharata*, etc. This bespeaks of a lack of initiation of the early Indo-Aryans in the esoteric details of the astral lores of the Dravidians whom they subdued. Though the Aryans had their own celestial gods, such as Mitra, Varuna, Indra, Nasatiya (Asvina), etc.—confirmed as far afield as in the Mitanni lists of Bogazkoy in Asia Minor and El-Amarna in Egypt—there is no evidence so far of an equivalent of the Indian *nakshatras* in any of the ancient Aryan religious or linguistic sources, including the ancient *Avesta*, the sacred book of the Zoroastrians.[38]

An evidence of crucial importance, in favour of the theory of Dravidian origin of the *nakshatra* calendar, is the occurrence of the term *BHEKURA* in the Vedic accounts. According to Dr. Parpola, this non-Sanskrit word was rightly guessed to mean a *nakshatra* asterism by Weber.[39] In Dr. Parpola's view, the word comes from the Dravidian root *vaiku* (North Dravidian *beku*) meaning "to stay the night, to pass the night, to protract till dawn", and *uru/urai* "to be near, to be joined, come in contact with, to dwell, abide, have sexual intercourse with". He cites an important derivative from *vaiku* in the Tamil term *vaikuru-min* "morning star".[40]

24. A combination of pictographic symbols often noticed on the Indus seal is  . It is either preceded by a fish sign or stands alone as a complete expression. In Dr. Parpola's view, this could indicate the proper name of some ancient divinity, such as *Kanta-k-Katavul*, a Tamil name of the Vedic "god Skanda"—the god who transcends speech and mind or pervades the universe. Skanda, as we have noted before in this summary is also identified with Vishnu or Siva. Vishnu in the *Rig-Veda* appears to be an intruder in the proto-Aryan pantheon, and his chief attribute is the

traversing of the cosmos with three steps. Similarly, Siva as *tribhuvanesvar* is said to be the lord of the three words. In short, both the Hindu gods Vishnu and Siva, appear to have as prototype the Dravidian *Kanta-k-Katavul*, who commands the three ingredients of existence—speech, mind, and soul. This three-fold aspect of his domain is perhaps indicated by the three strokes as  , and sometime also as  in the Indus script.[41]

In the idiomatic combination of pictographs the large arrow-head with a short and featherless stem, has been interpreted as a rebus for the dedicatory suffix *koti*—"which has been given". This word is the past relative participle of the Dravidian verb *kotu*—"to give (to superior)".[42] The word appears to be etymologically connected with *kot, kottai, kuti, kota, koti*, etc. which variously mean fort, citadel, house, family, village, town, tip, peak, summit, etc. There are also the Dravidian homophones *kotai* (west wind, west), and kuta/-kku (west). Dr. Parpola points out the fact that many Indus settlements had citadels built on raised grounds on their western sides.[43]

Of our more immediate concern is the meaning assigned by Dr. Parpola to the first component  of the pictographic combination. The sign  or its variant  is interpreted as the traditional Indian churn, which consists of a pot with a dasher. This meaning fits well with the myth of the *churning of the oceans* at the second incarnation of Vishnu. The Dravidian word for churning is *katai*, and as such, the name *Kanta-k-Katavul* of the proto-Vishnu seems to bear a legitimate relation with churning.[44]

The occasion of *churning of the oceans* reminds us of the misdemeanor committed by the demon Rahu in taking a swig of the *amrita* (elixir of life). He met annihilation by the wrath of Vishnu, but his head and tail having become immortal, still survived in the heaven. These surviving limbs of the demon (Rahu and Mrtyu Dhumaketu) are mentioned as grahas (divicara) in *Atharva-Veda* (19, 9, 7, 10) together with the sun, moon, and the five planets.[45]

25. A notable case of interpreting one of the Indus seals in astronomical context was presented by the Finnish scholars in their research publication of 1970. This pictorial stamp seal (No. 2430) depicts in particular a long

SEAL No. 2430 SHOWING "JUPITER OF THE INDUS"
(enlarged about two times)

Note head-dress of the kneeling priest and all the deities, resembling the traditional Indian turban. The priest and the deity standing in the pipal tree also wear crescentic horns. The arms of all deities carry sharp spiky points like thorns of the cactus. The blank areas on two upper corners of the seal are damaged parts. Some pictographic characters are discernible, but the fish sign for Jupiter is quite distinct above the back of the human faced Ram.

thread of some lore of astral mythology, or some shamanistic performance of a totemic ritual.

The square seal bears the picture of a ram with long wavy horns and a human face; a deity with wide crescentic horns standing within the bifurcate boughs of a pipal tree; a priest kneeling outside at the base of the tree in a posture of supplication before the deity; and a tier of seven other deities standing in the lower portion of the seal. Opposite to the priest on the other side of the pipal tree is a small square marked into a half and two quarter parts, while beneath one of his bent knees is an unidentified object, seemingly an offering placed on a raised shelf or an altar. Along the left hand upper margin of the seal is a row of five pictographs, of which the last one (reading from right to left) clearly symbolizes a man. Above the

back of the ram is the fish sign  placed rather in some emphatic isolation from the five marginal pictographs.

In their study five years ago,[46] the Finnish scholars tentatively identified the figure in the pipal tree as the proto-Brahma of Dravidian origin, and named him as "Jupiter of the Indus". They backed this identification of the deity with Brahma or Jupiter by the fish sign of the "golden star". This identification further drew support from association of the planet Jupiter with the pipal tree according to the Sanskrit sources, and from the fact that the Dravidian term *aracu* for pipal or its derivative *aracan* (king) also denoted the golden planet Jupiter.

The scholars pointed out that Jupiter is known in Sanskrit sources as Brahma, Prajapati, Vacasapati, Brhaspati or by the composite name of Brahmanaspati. The last two names suggest almost a Sanskrit translation of the Dravidian epithet for the planet, meaning "the lord of creation and life". The god Jupiter in the guise of Prajapati is represented in the Vedic *agnicayana* ritual as a golden man, born of golden womb. He appears also in the *Brahmanas* as hatched out of some primordial egg, and as creator of the world. Jupiter as Brahma again appears with a more clearly defined personality in the epic of *Mahabharata* as hatched out of the golden egg that lay floating on primeval waters.

Among other pictorial elements of the seal No. 2430, the Finnish scholars interpreted the small square opposite the priest as a symbol of ritual purity, and the unidentified object beneath his bent knee as probably the *vahana* or "vehicle" of the planet Jupiter in the form of a wild yellow goose (*hamsa*). They could not understand the significance of the human-headed ram on the seal, apparently because of absence of the mention of any such creature in context with Brahma mythology in both the Sanskrit and Dravidian literature.

The seven deities standing in a row at the bottom of the seal were identified by the scholars in their study of 1970 as probably representing the seven children of Brahma from his spouse Sarasvati. As such, they were perhaps the "seven sages" as stars of the constellation of the Great Bear. Alternatively, the seven figures could also be the children of Brahma from his spouse Candramasi—the moon-goddess, who bore six sons and a daughter. Dr. Parpola informs me of his more recent change of view regarding the seven deities at the bottom of the seal,[47] whom now he regards as probably the stars of Pleiades.

An Appreciation of the Finnish Approach

26. In fairness to Dr. Parpola's astronomical interpretations of some of the characters of the Indus script, I agree unreservedly with his remark that "together they do make a consistent system".[48] At the moment this consistency appears to be the sole feature of strength, promising the possibility of a final decipherment of the Indus script. In the present state of study of the Harappan culture there remains, of course, much scope for scepticism and alternative interpretations of the pictographs, such as recently presented by Dr. Fairservis of the American Museum of Natural History in his excavation report of the site of Allahdino near Karachi.[49] Despite many useful hints given by Fairservis on the ancient techniques of seal engraving and the analytical tabulations of the script characters, his interpretations of the individual signs fail to strike any focal image from which one could determine even a general contex of the ancient messages.

The whole case of perceiving an astronomical or cosmological context in the Indus inscriptions depends, of course, on the basic assumption of the existence of a historical link between the language or languages of the ancient Indus basin and the Dravidian group of languages spoken today in the South Asian subcontinent. At first I took this assumption to be the most vulnerable point in the Finnish approach to the problem of decipherment of the Indus script, but lately my faith in it has increased after going through the discussions in another article by Dr. Parpola, "The Indus Script Decipherment: the Situation at the end of 1969", published in the *Journal of Tamil Studies* (Vol. II, No. 1, April 1970, pp. 89–109).

The thorny question of linguistics apart, nobody can be a better judge of the inherent strength of the astronomical context in the Indus script than Dr. Parpola himself. He appears to have expressed his views in a more cogent and confident way in his paper presented before the 29th International Congress of Orientalists in Paris in 1973. The full text of his paper is not yet accessible to me, but the one page abstract (*Parpola*, i) already referred to, gives sufficient hint of the drift of his arguments in establishing the roots of the ancient Indian astronomy and cosmology in *pre-Rig-Vedic* astral religion. It would appear from the foregoing summary of the Finnish approach that most of the unscrutable and problematic features of the ancient Indian astronomy and cosmology, as we sorted out in Section 12 of the present paper, are already traceable to the primitive notions of the Dravidians of the Indus Valley civilization.

27. Among the problematic features of the ancient Indian astronomy and cosmology the most significant question relates to the origin of the *nakshatra* system. In Section 6 of the present paper we have already alluded to the unsatisfactory attempts of some of the pioneer investigators of the ancient Indian astronomy in tracing its origin to the Chinese *sieus*, the early Mesopotamian lunar zodiac, etc.; while in Section 23 we have briefly examined the views of Dr. Parpola regarding its Indian origin in the *pre-Rig-Vedic* traditions of the Indus Civilization. A noteworthy point of his arguments is the negative proof in the absence of the *nakshatra* system in all ancient Aryan religious or linguistic sources outside the South Asian subcontinent; whereas on the positive side, he points to the occurrence in the Vedic accounts of the term *Bhekura*, which deserves further elaboration.

It needs first be pointed out that the concept of a heavenly river flowing in the sky in the ancient Dravidian philosophy or astral religion, as suggested by Dr. Parpola, shares a common characteristic with the notions of an encircling ocean or a broad river in ancient Mesopotamian and Egyptian cosmology.[50] Whether this human habit of visualizing waterways in heaven—as imaginary superimpositions of the geographic features of a familiar territory onto the sky above—is a manifestation of the inherant mysticism or a primitive tendency to classify and arrange Nature, are questions to be decided outside the present context. What we have to consider here is the plausibility that a westerly flowing river in the greater Indus basin, called Sarasvati in the Vedic accounts, should have provided an easy analogy of an imaginary river traversing the heaven from east to west, in which the sun, moon, and other planets were thought to be swimming creatures.

The association of the Sarasvati with the *nakshatra* system as a whole, and its pools and puddles with particular asterisms is a matter of great cultural and geomorphological interest. The river Sarasvati exists today only as a series of scars and marshy depressions showing a great deal of changing and shifting of the channel in its upper reaches. This process probably started about the 12th century B.C., and resulted into its virtual disappearance as a perennial river late in the Islamic period.[51] Sarasvati is popularly known as the "lost river", and the dry bed of its middle and lower reaches is traceable in southwesterly course through the arid parts of Bahawalpur and Sind to the Rann of Kutch. A large concentration of ancient sites along its middle reaches, including those of the Harappan

cultures, indicates that it was one of the principal rivers of the greater Indus basin in ancient times.[52]

The dry bed of this historic river in its middle and lower reaches is usually marked on the maps by the local names of Ghaggar and Hakra. These names do not occur in *Rig-Veda*, which speaks of the river only by the Sanskrit name of Sarasvati. I strongly suspect that the names Ghaggar and Hakra are survivors of some older but phonetically related names of the river, which might have been current in the days of the Indus Civilization, long before the rechristening of the river as Sarasvati by the Aryan newcomers. In view of Dr. Parpola's suggestion of its being the earthly counterpart of the heavenly stream, or of the primitive zone of the ecliptic embracing the *nakshatras*, I feel inclined to think that this ancient name would have sounded like *Bhekura* or *Bhakra*. The names Ghaggar, Hakra, Bhekura and Bhakra are then perhaps, the reminiscents of the same astral tradition of the *pre-Rig-Vedic* culture of the Indus Valley,[53] as diagnosed by the Finnish scholars.

The birth place of the god Skanda, stated to be in the *alar-kutam* (fire pond) of this heavenly river, might possibly have been some spot just near to the point where the river emerges from the Siwalik hills. It might have been marked in ancient times by jets of natural gas issuing from fissures in the rocks and ignited by brush fire. Such phenomena are quite common in the Quaternary fold-structures of the Subcontinent.

28. In the Indus pictographs, recognition of the fish sign as signifying stars in general seems to be confirmed in the few cases where names of constellations in Old Tamil have been equated with expressions combining a fish with specific number of the vertically drawn numerical strokes. The Old Tamil names *elu-min* (seven-star) of the polar constellation Ursa Major represented as  , the name *aru-min* (six-star) of the *nakshatra* asterism Krittika (Pleiades) represented as  , and the name *mu-m-min* (three-star) of the *nakshatra* asterism Mrigasirsha (λ Orionis with two other companions) represented as  are clear cases in point. The name *vata-min* of the "north-star" identified in the script as

 also favours the Finnish approach, given the role assigned to the banyan tree in the cosmic myth of the Vedic sources, and the conjecture of relation to the *pre-Rig-Vedic* cult of the tree in the Indus Civilization.

At the moment it is difficult to say what other combinations of the fish sign in the Indus script would stand for names of other individual stars, or for the individual asterisms of the *nakshatra* system, specially where two or more of them have the same number of stars in the group, or where a group is thought to have a variable number of stars. The subject needs further study. For the present, the seemingly correct identities of the "north-star", of the polar constellation Ursa Major, and of the *nakshatra* asterisms Krittika and Mrigasirsha would serve as sufficient indicators of the acumen of the Finnish approach in reconstruction of the theoretical aspects of the primitive astronomy and cosmology in the Indus Valley Civilization.

Possibilities of the Ancient Indian Astronomy & Cosmology

29. It would certainly be a folly to vest the astronomy in the Indus Civilization with advanced mathematical concepts and accuracy of observations. The fragments pieced together from the Finnish studies point to an astronomy of primitive and pre-scientific level, combining myths and superstitions with a few elementary facts. These basic features appear to be the recognitions of certain constellation patterns, a crude system of seasonal computation by noting the positions of the moon against the background of *nakshatra* asterisms situated in a zone straddling the ecliptic, and the mobility from west to east in the same zone of the five visible planets, identified by their colours.

Devoid of any concept of the celestial coordinates, the naked eye observations in this primitive astronomy would naturally have made use of the "north-star" as the only fixed point of reference in all seasons for determining the orientation of the constellations in the night sky. In the heydays of the Indus Civilization, nearly 2500 years B.C., the distinction of being the "north-star" did not belong to the star Polaris as it does in the present age, but to the star Thuban (α Draconis) which stood at that time almost within half a degree of the celestial north pole. Thuban as a

star of the 4th magnitude is not so prominent as the Polaris, but with relation to the precessional circle traced by the celestial north pole around the north pole of the ecliptic in a counter-clockwise direction nearly every 25,800 years, it stood almost the same distance from its circumference in 2500 B.C. as the star Polaris will stand in about 2150 A.D. The coming of the north celestial pole to such close proximity of a visible star is a rare situation in human history. The age of the Indus Civilization in 2500 B.C. had a visible north pole of the sky more accurate than that of our own time!

The fact that Thuban occupied almost the exact position of the "north-star" in 2500 B.C. did not diminish the role of Ursa Major as pole finder. In the present age, an easy way to locate the Polaris is to extend northward an imaginary line connecting its two "pointer stars", Merak and Dubhe. Thuban as the "north-star" could also have been located easily with the help of Ursa Major, but this time the "pointer stars" had to be Phecda and Megrez—the inner two stars of the Dipper. These "pointer stars" of the Ursa Major have, of course, their own proper motions, but these would be negligibly small in the age nearly 4500 years back.

The apparent constancy of position of the "north-star" led no doubt, to a special reverence for it in the astral religion of the Indus Civilization. It was probably visualized as the pivot centre or *dhruva* of the whole universe, its earthly form was associated with the sacred banyan tree, and its influence was held to be salutary in strengthening the fidelity in friendship and matrimony.

So far, there appears nothing odd in the hints of Dr. Parpola in tracing the origin of certain social rites of the Vedic religion to the *pre-Rig-Vedic* traditions of the Indus Civilization, and the post-Vedic celestial model of Indian astronomy seems to have a genuine deep root in the cosmic speculations of the people of the Indus Valley in the third millennium B.C. I, however, doubt whether the concept of Mt. Meru and the geographical scheme of the earth as presented in Jaina cosmology, can also be traced to such ancient times with satisfactory logic. For the moment it had better be left as a contribution of the Avestan philosophy, in agreement with the views of G. R. Kaye.[54]

30. The demonstrable fact that in the days of the Indus Civilization the celestial north pole was almost exactly represented by a visible star, does not suffice alone for the formulation of the star calendar—about which

otherwise, there is general agreement that it was compiled about 2400 B.C.[55] A necessary condition for such formulation or at least for fixing of the beginning point of such calendar year, would either be: (a) a determination of the equinoctial and solstitial lengths of the shadows of the mid-day sun or: (b) a recognition of some particular stars or constellations rising and setting in different seasons of the year at particular moments, such as immediately before sunrise or soon after sunset.

Of these two conditions given above, the first involves a consistency of accurate daily observations over a long period of time and some familiarity with the mathematical principles of the sundial. Such feats were achieved with tolerable accuracy by Meton and Euctemon in Athens in 432 B.C.—the year which may be called the beginning of the scientific era of astronomy. But the same may be rejected *prima facie* for an age as remote as that of the Harappan culture. This does not, however, exclude the possibility of the use of the gnomon in Harappan culture for the limited purpose of orientating the houses and streets in their sophisticated town-planning, as discussed by Dr. Parpola.[56] If, therefore, there was really any star calendar in use in the Harappan culture, the beginning point of its year would have been determined through the second condition.

The Indian *nakshatra* calendar as known from the *Atharva-Veda*, is based on the opposition of the sun and the full moon. The twelve months of varying lengths in the year receive their names from the successive asterisms with which the full moon stands in conjunction from month to month. In my view, Dr. Parpola is right in upholding its purely Indian origin going back to the days of the Indus Civilization,[57] but in error in believing it to have been based on the opposition of the sun and the full moon from its very inception in that primitive age. He seems hesitant to assign it a heliacal basis even in its *pre-Rig-Vedic* phase, perhaps to forestall any claims to its being of "an ultimately Mesopotamian origin".[58]

It may be noted in passing that the commonly held belief that heliacal observations call for some special skill and advanced astronomical theories, has been disproved from the study of very primitive stages of astronomy in Egypt, Mesopotamia and elsewhere. Heliacal observations to ascertain the turning points of the seasons appear to be the most common practice in both literate and preliterate cultures. A very notable example comes from the Hottentots of South Africa as discussed by Prof. Leach.[59]

31. I perceive here a possibility that the star calendar of the Indus Civilization might actually have been based on the heliacal observation of some constellation to determine at least the beginning of the year. The meanings of the Tamil term *vaikuru-min* "morning star" as quoted by Dr. Parpola[60] from the *Dravidian Etymological Dictionary* might have rightly led him to explaining the word *bhekura* in the sense of some *nakshatra* asterism, as discussed earlier.[61] But its significance becomes greater if this asterism is taken to be the first star or constellation observed just before sunrise to mark the beginning of the year.

The occasion probably called for a night long vigil, rituals, sacred baths, prayers, shamanistic orgies and celebrations to greet the harbinger of the new year, charged with hopes and apprehensions. Once this important event had been given its due obeisance and attention, the rest of the year would have been left to its natural divisions into 12 lunar months of alternating bright and dark halves, the concept of which is retained in the Vedic accounts as *sukla paksa* and *krsna paksa* of a lunar month. A count of the daily eastward drift of the moon would have been kept by its presence in the successive *kutam*, *apsara*, "pothole" or embrace of the "heavenly damsels". Thus in short, the beginning of the year in the Indus calendar was probably determined by the position of the sun through heliacal observation of rising of some star or constellation, while the reckoning of the months was made by the presence of the moon in different mansions.

This very early possible calendar of the Indus Civilization would naturally have been a shifting one, like the Sothic calendar of the ancient Egyptians, with the difference that while in the latter case the year was subdivided into a series of 36 decades of entirely heliacal nature, in the former the subdivisions were based on the eastward drift of the moon every day through a series of 27, or more appropriately 28 asterisms of the heavenly river.

It was perhaps during the time lying between the coming of the Aryans into the Indus Valley and the compilation of the *Atharva-Veda* that some kind of a reform of the shifting calendar might have been attempted, keeping alive the *pre-Rig-Vedic* scheme of *nakshatras* but changing the basis of the calendar from heliacal beginning to one of the oppositions of the sun and the full moon.

32. Having advanced so far in our speculation of the tentative manner in

which the beginning of the year in the star calendar of the Indus Civilization was possibly determined, it remains important to seek which of the *nakshatra* asterisms served as the harbinger of the new year by its heliacal appearance. Of the many possible choices—Krittika, Mrigasirsha, Vishakha—all indications point in favour of the first.

The role played by the Pleiades (η Tauri) or Krittika as indicator of the beginning point of the yearly cycle in the primitive calendars from Kamchatka to the Cape of Good Hope, from Australia to North and South America, is a widely confirmed fact.[62] Actually we cannot make an exception to this seemingly general rule in cultural anthropology for any good reason in the case of the Indus Civilization. In post-Harappan period the heliacal observation of Krittika probably lost its significance in India, yet the constellation occupied its first place in the gamut of the *nakshatra* asterisms, and signified the beginning of the Vedic calendar in Spring season. Here we are reminded of the studies of Archdeacon Pratt and Prof. Max Muller who claim the beginning of the Vedic calendar year from the Vernal equinox, being placed in Krittika in 1181 B.C.[63]

If we take the location of the Vernal equinox as 8° of Aries in the time of Hipparchus, c. 150 B.C., and accept the approximate rate of the precession as 1°24′ per century, we can calculate back its position as about 9°30′ of Taurus in the year 2400 B.C. in the days of the Indus Civilization. The asterism Krittika (Pleiades or η Tauri) constituting mostly of stars varying in magnitude from 2.96 of the brightest Alcyone to 5.85 of the faintest visible Asterope, is contained within a circle with twice the diameter of the moon, and lies in about the 3rd degree of Taurus.

In the year 2400 B.C., if the asterism were to be viewed ascending above the eastern horizon just before sunrise on the day of the Vernal equinox, it would have an elongation of only about 6 degrees, which is hardly sufficient for its visibility to the keenest eyes in the glare of the dawn. I suppose that in the age of Indus Civilization the heliacal observation of Krittika from the latitude of Harappa would have been possible a good many days later than the actual day of Vernal equinox, when the sun had proceeded farther east towards the end of Taurus—and this happened probably on the morning of 3rd or 4th of May in Julian calendar.

33. Chances are that along with the observation of the Pleiades, a note was also taken of such other celestial features as any of the five planets which happened to be visible above the horizon. Some of the Indus seals

show two or more planetary fish signs together, indicating that at the particular epochs of observation there happened to be present different planets in the same section of the sky. Such juxtapositions, if not the exact conjunctions of the planets shown, hold the germ of a hypothetical epoch of *Kali Yuga*, which became an obsession of the later Hindu astronomers.

The visibility of any of the planets of a particular colour at the beginning of the new year probably helped as a sign and portent of the coming prosperity or calamity to the agrarian people. It probably also helped them in determining the degree of propitiative measures to the good and evil deities of the upper and the nether worlds, and allocation of charity funds to the ruling priests or state treasury during the particular year. The frequency of planetary signs along with the symbols of dedicatory and obsequious expressions in the Indus script, as interpreted by the Finnish scholars, seem to support this view. Some of the pictorial seals also appear to be concerned with these ideas.

34. Once the beginning of the year had been determined by the heliacal appearance of the Pleiades, it is not easy to speculate in what manner the progress of the lunar months was tied to the solar year, unless a particular phase of the moon had been known or predicted in a particular asterism, just before or immediately after the appearance of the Pleiades. Possibility of some kind of an intercalary arrangement cannot be ruled out. Sumerian records from c. 2400 B.C. give evidence for the practice of inserting months from time to time in order to keep the traditional month of the barley harvest, the Nisanu of the Babylonians, in the harvest season.[64]

In the case of the Indus Valley calendar a more promising mechanism to reconcile the solar year with its division into lunar months appears to be the concept of a five-day week, which seems to be associated in its elaborate and reformed shape to the latter Indian *tithi*. We are familiar with the Indian *tithi* only from post-Vedic times, and have already referred to its role in the computation of the *ahargana* (note 11). A unit of time similar to the mean *tithi* in India, has also been recognized in Babylonian planetary texts and lunar ephemerides of the Seleucid times, in the studies of Pannekoek, van der Waerden and Neugebauer. The Babylonian texts do not indicate any particular term used for this unit, but in some Greek astrological works of the Hellenistic times this is often referred to as the "lunar day". According to Prof. Neugebauer,[65] the concept of *tithi* was transmitted to India probably through the medium of Greek astrology.

This appears, however, to be an oversimplified picture of the origin of the Indian *tithi*, as a concept borrowed by the Indians from late Babylonian astronomy, and tells nothing of the origin of the Babylonian "lunar day" itself.

The beginning of the Babylonian "lunar day" may be traced to the five-day week or *hamuštam* of the Old Assyrian calendar. Instances of such two units joined to form a ten-day period, and called after the eponym officials, are attested even from comparatively late documents of the time of Ashuruballit I (c. 1350 B.C.).[66] A tradition of dividing the mean lunar month into six weeks of five "lunar days" each, has been pointed out by Sir Leonard Woolley[67] in the merchant colony of Kanesh, and in other Anatolian and Sumerian trade centres as early as 2000 B.C.

The origin of the five-day week is not yet known. But it seems to have been particularly suited to the people of the business class, who sought for a regularity in their working and holidays. The priestly convention of the seven-day non-rotating week of the age, with intrusion of feast days at uncertain occasions of the lunar phases, must indeed have been very upsetting for commercial ethics.

Even though it was an age of bullock carts and sail-boats, the business schedule stood nowhere more vulnerable to religious caprices than in dealing with foreign traders and merchants. It is quite possible that the Mesopotamian tradition of a five-day week owes its origin to traders from some distant clime such as *Melluha*, coming over land routes converging towards the bank of Diyala, or sea route of the Persian Gulf. A most likely area of origin of the five-day week then, seems to lie in the direction of India of *pre-Rig-Vedic* times.

On some of the Indus Valley stamp seals a symbol standing like a dome with five short vertical strokes enclosed within  , seems to convey to me the idea of a five-day week. The dome signifies perhaps the vault of heaven meaning a day, made plural as five units by the numerical strokes. The five days were most likely to be lunar rather than *savana* or civil days, thus keeping possible an even division of a lunar month into six sucn weeks. Perhaps one or two weeks of five lunar days were more handy for intercalation or omission to score up the lunar count with the solar year than an entire lunar month.

35. The conjecture of transmission of the idea of the five-day week from

the Indus Valley to Mesopotamia through the trade channels during Akkadian times (2300 to 2000 B.C. or a little later) opens up a whole series of possibilities of taking root there of other elements of the Indus Valley astronomy and cosmology. For instance, the idea of the heliacal basis of the Mesopotamian calendar might originally have been borrowed from the Indus Valley—a suggestion which turns the table on Mesopotamian hegemony over the origin of everything, and which might hurt the feelings of the panbabylonians.

Among other things it may also be claimed, that the Venus tablets of Ammisaduqa (1678 to 1657 B.C.), containing expressions of planetary omens have their prototypes in the pictorial stamp seals of the Indus Valley; that the tablet reported by Prof. Neugebauer[68] in the Hilprecht Collection in Jena, Germany (written perhaps in the Cassite period, but probably copied from an earlier document) represents only a Mesopotamian version of some earlier god-stars myth of the Indus Valley cosmology; and that of the three ways in heaven, Enlil, Anu, Ea—defined in the *mul-APIN* texts (written in 700 B.C. but based on older material), at least the middle one—the "Way of Anu", could originally have been the "heavenly river" of the planetary traffic of the Indus astronomy.

The "Way of Anu" of Mesopotamian astronomy is a wide belt of the sky whose boundaries run almost parallel to the celestial equator on both sides. The belt is marked with 23 asterisms serving as references to define the positions of the moon and planets. This seems to be an abridgement of the original 27 or 28 stage-posts of the *nakshatra* asterisms in Indus astronomy. The identity of most of the stars of the "Way of Anu" remains uncertain, yet could we suggest that the Babylonian *mul MUL* is the *aru-min* or "Krittika" of the Indian nakshatra, *mul SUDUN* is the asterism "Svati" (Arcturus), *ZI·BA·AN·NA* is the asterism "Vishakha" (iota Librae) personifying the goat faced rival of Skanda and living half way across the heaven in the ancient sign of the beginning of the autumn opposite to Krittika, *mul UZA* is the asterism "Abhijit" (Al-Nasr al-Waqai, Vega)?

36. Besides these few likely identities, the Indus pictographs and pictorial seals suggest many other animals and legendary heroes visualized in constellations, which the Babylonians seem to have retained with certain changes and modifications to suit their own mythology, pantheon, and environmental familiarities. In the Old world pattern of constellations

every nation has tried to change or modify the mythological lores in heaven, and the areas covered by different constellations have expanded or contracted or split into twain like amoeba. It was only in 1930 that the boundaries of our present constellations were standardized by an international convention. For some of the mythological animals and humans, still surviving in heaven from ancient times, we owe a great deal of gratitude to Eudoxus, Aratus of Soli, Hipparchus, and other astronomers of the Hellenistic world, who kept alive this largely Babylonian legacy of astral lores—perhaps ultimately of an Indian origin.

In the decorative motifs of sculptural art of the Indus civilization and of Mesopotamia, there have been pointed out several similarities, such as the trefoil pattern on the robe of the "King Priest" of Moenjodaro, and on the "Bull of Heaven" of the kingdom of Gudea. Most of the deified animals seen on Indus Valley seals are draped at their shoulders with a covering which recalls to mind the wig worn by King Sargon I and others. In some cases these draperies show rounded off corners, again resembling the curves and lobes of the trefoil motif of celestial significance. Religious or magical symbols like the cross and the swastika are also common features in the civilizations.[69]

The point which needs emphasis here is that almost every feature in the "prehistory" of Babylonian astronomy (say from 1800 to 700 B.C.) can be shown to have already existed, in nascent or cruder form, in the Indus Valley Civilization, as revealed by its stamp seals. The Mesopotamians rightly deserve credit for elaborating later most of these elements, and for recording more systematically the astronomical phenomena—and in that process discovering the cyclic occurrences of celestial events by the numerical manipulations, termed by Prof. Neugebauer as "step-" and "linear zig-zag" functions.

37. Excavations at the Indus sites have yielded two kinds of stamp seals —those of rectangular shapes bearing only the pictographic inscriptions (the so-called small seals of Harappa), and those of square shapes bearing inscriptions, as well as the pictures of real or imaginary animals or mythological heroes and deities.

It is unfortunate that in the early archaeological operations at Harappa and Moenjodaro, no specific attention was given to stratigraphical method, thus making the chronological sequence of the two kinds of seals a highly mixed up affair. Even so, in the opinion of some of the great archaeologists

associated with the excavations, the first kind of seals shows a more consistent stratigraphic succession going almost to the earliest levels of the mature Harappan phase, whereas the square and pictorial seals occur mostly in the middle and upper stratifications.

The Indus Valley pictorial seals used in trade and commerce appear to be the only definite carriers of astronomical and calendarical ideas to Mesopotamia at the moment. There is every place for doubt whether the Indus pictographic writing could be read easily by the contemporary Mesopotamians. In my view, the people of the Indus Valley were also aware of this problem, and that is why they took pains to make the main ideas clear by pictographic representations of the principal characters involved in the astronomical reckonings from their astral mythology. It appears that the rectangular seals bearing only pictographic inscriptions were meant for use within the country, whereas the square seals bearing both inscriptions and pictorial representations were meant for use in foreign trade. As stated earlier (*supra*, 16), the square pictorial seals, therefore, appear to convey some astronomical and calendarical ideas attached with *nakshatra* asterisms through bilateral presentations, which make at least a poor substitute for bilingual expressions for the purpose of their decipherment.

38. Reverting to our discussion of the pictorial seal No. 2430 (*supra*, 25), I consider it a typically commemoration seal depicting the heliacal observation of the Pleiades at the beginning of the particular year. From its class, the seal appears to have been meant for use over consignment going abroad—perhaps to some Mesopotamian destination. I record here my own Thematic Apperception of the seal before opening correspondence with Dr. Asko Parpola in October 1975.

The row of seven standing deities at the bottom of the seal suggested to me the seven stars of the asterism Krittika (Pleiades). Their place at the bottom of the seal suggested a position just a little above the eastern horizon. The human faced ram above the Krittika represented the asterisms Bharani and Asvini, both of which probably constituted the picture of the divine animal in the Indus astral myth. This animal in heaven seems to have come down to our days almost intact in the shape of Aries in the 12-fold solar zodiac. As the two asterisms of Bharani and Asvini are situated west of the Krittika, their place in the sky is obviously much higher above the eastern horizon than that of the former at the

time of heliacal observation. At the particular epoch of observation, perhaps the planet Jupiter happened to be located near or a little distance further west to the horns (Sheratan and Hamal) of Aries, as could be judged from its pictographic symbol  inscribed above the back of the Ram.

The horned deity standing in the pipal boughs signified that the moon was in its dark phases and invisible to the eye at the epoch of the new year. The prominent crescentic horn on his head seemed to testify this identity with the moon. Such horns are absent on the heads of the seven deities at the bottom. The kneeling priest and other symbolic objects defined by Dr. Parpola could just be treated as the ritualistic paraphernalia attendant upon the important occasion of the beginning of the new year. About the pictographic inscription at the top of the seal, nothing could be guessed with any certainty, except that perhaps it was a dedicatory incantation imploring blessings of the heaven upon the owner of the merchandize.

In the successive order of the celestial features recorded upward from the eastern horizon, I discerned something of the schematic arrangement in primitive observations, such as seen in the Egyptian astronomical texts in the tombs of Ramses VI, VII, and IX. In these texts the position of a star from hour to hour is defined as "over the right ear", "over the heart", "over the left shoulder", etc. of the picture of a sitting man.

I noted here with some dismay that the asterism Krittika shown as a group of seven deities contradicted the identity of the pictograph  or the Tamil word *aru-min* (six-star) with the Pleiades. According to the Finnish interpretation of the symbol, the Indians counted only six stars in the Pleiades, whereas in its pictorial representation in this seal, seven stars seem to have been assigned to it. Could my apperception have gone wide of the mark, and the seven deities actually portrayed some other constellation, such as the Ursa Major? But in that case the whole hypothesis of calendarical association of the pictorial seals would have collapsed. I was much relieved by the letter of Dr. Parpola, dated Helsinki, the 10th December, 1975. I quote here the relevant passage from his letter:

> To avoid misunderstanding, I would like to explain that I was previously thinking that the seven figures in the seal 2430 most probably are the seven sages of the Great Bear. I have later changed my view, and now think that they probably are the stars

of the Pleiades. This conclusion, however, is not based on the Indus characters on *this* seal, but on studies of the Vedic & Epic mythology and the connection of Skanda with the Pleiades, also in the Indus script.

Actually the number of visible stars assigned to the Pleiades varies between six and seven among different primitive people. The Mesopotamians considered it a group of seven stars, as can be judged from an early Assyrian superstition in which the heliacal rising of the Pleiades in the second month of Khabur was associated with "seven evil spirits of the nether world".

The apparent discrepancy in the picture of the Pleiades in the seal may be a deliberate attempt to keep the identity of the asterism beyond any possibility of confusion and consequent mistake in calculation of the time factor involved in the terms of business at the receiving end of the merchandize in Mesopotamia. Such concession amounts to our modern practice of business ethics in using patent names or standardized phrases in business correspondence with dealers in foreign countries.

39. After surveying this far the possibilities of transmission of the crude astronomical ideas from the Indus civilization to Mesopotamia, it remains important to dilate upon the problem of diffusion of the primitive Indus astronomy into the culture of the Aryans who occupied most of the northern half of the Sub-continent by the end of the 12th century B.C.

Studies of the *Rig-Veda* indicate that in the earlier phase of Aryan immigration into the Indus Valley their acquaintance with the Indian astronomical ideas like *nakshatra* asterisms, star-calendar, planets, etc. was very poor, whereas these features appear fully developed later in the *Atharva-Veda* and subsequent Vedic literature. If the roots of the ancient Indian astronomy and cosmology actually lie in the Harappan culture, it looks incongruent that later Aryans, separated by about five hundred years from the end of the Harappan culture, should appear more adept in the crude science of the *pre-Rig-Vedic* age.

This apparent anachronism in the history of ancient Indian astronomy may be explained by the sociological factors of hatred and apathy of the conquering race for the science and culture of the conquered one in the days when the pride and passion for subduing an inferior people and usurping their land was still the ruling order of the day. When the *Rig-Veda* was being composed the god Indra still triumphed while Vishnu remained

morose and thoughtful. The excitement and fervour of smashing the citadels and committing genocide of the "snub-nosed barbarians" was a transient phase in which prominent cities like Harappa and Moenjodaro were laid waste. But this state of affairs could not have lasted for long and all the people of the Indus Valley could not possibly have been killed.

Even before the coming of the Aryans there are indications of decline of the Indus Civilization due to changing circumstances, like the frequency and severity of the monsoon floods, and probably also an increasing draught in the rest of the seasons. Archaeological studies suggest that the people of the Indus Valley were already on the move towards the eastern side of the Sarasvati in the Panjab and towards the southern parts around the Gulf of Cambay and in the Bikanir area. The invasion of the Aryans is likely to have hastened the exodus towards the Malwa plateau, along the Satpura and Vindhya ranges, and across down southwards into the peninsular India.

After the initial fervour of Aryan invasion had subsided, the two racial groups are likely to have met in relative peace in various areas where exchange of thoughts, language, and cultural difusion could take place. This probably resulted into intellectual and spiritual victory of the vanquished over the victors. Within the course of a few centuries the Aryans were so throroughly indianized that they even included some of the non-Aryan gods into their pantheon. Many an important feature of Brahmanic faith is clearly traceable to the Indus Civilization. In the final analysis, it it was Vishnu who stood in triumph, overshadowing the exploits of Indra.

40. So far astronomy is concerned, the most likely place where the Aryans learnt the heavenly science from the Dravidians, appears to be the area of the Malwa plateau. This seems to have happened more specifically in the ancient city of Ujjain, whose reputation as a centre of astronomical studies in India from times immemorial is attested from various literary accounts.

Ujjain remained the centre of astronomical studies even during the Classical and Medieval periods of ancient Indian astronomy. By virtue of its supposed location just on the meridian linking the Island of Ceylon with the North Pole, it came to be treated as the "Cupola of the Earth" (*al-Qubba*) by some of the Islamic astronomers and medieval European geographers.

There are no definite indications of any astronomical observatory built

at Ujjain before that of Raja Sawai Jaisingh II, early in the 18th century. But we cannot exclude the possibility of the existence of some kind of astronomical school early in Vedic times. It was probably there that most of the esoteric details of the crude astronomy and cosmology of the Indus Civilization were learnt by the Aryans from the Dravidian *jyotisha* or calendar-makers—despised and unlettered scamps of a down trodden race but still conversant with rudiments of the art of their noble forefathers—who had already started referring to the banyan tree as "tree of the north".

It would certainly be an injustice to overlook the contribution of Aryans in this survey of the problems and possibilities of ancient Indian astronomy. After they had been initiated into the crude science of prehistoric origin in the Indus Valley, they appear to have made several attempts at the reform of the peasant calendar. In one such reform, they tried to divide the natural year into four seasons of three months each, and named them after the solar season-months as *Madhu*, *Madhava*, *Sukra*, *Suchi*, *Nabhas*, *Nabhasya*, *Isha*, *Urja*, *Sahas*, *Sahasya*, *Tapas*, and *Tapasya*. But the *nakshatra* calendar still remained the basic instrument of Indian chronology. In the attempt of luni-solar adjustment, they also seem to have evolved the artificial cycle of five-years, as discussed in *Kautilya's Arthasastra*. That brings us close to the era of the Classical Indian astronomy which is beyond the scope of present discussions.

Conclusions

41. As long as the antiquity of the Indian civilization remained an undetermined factor, the pioneer investigators of the history of ancient Indian astronomy felt unsure of assigning the origin of features like the *nakshatra* system to the native genius.

Unfortunately Mons. Jean-Sylvian Bailly, who first pushed the inception of the Indian astronomical system into remote prehistory of 4300 B.C., certainly overshot the mark. What was worse, he gave all the credit to the Indo-Aryans, whom he thought to have come originally from regions beyond the Arctic Circle of Eurasia. Such conceptual aberrations, combined with an undue faith in the myth of the grand conjunction of all planets, observed by Indian astronomers from Ujjain at the epoch of the *Kali Yuga* in 3102 B.C. exposed him to much criticism by Bentley and others.

In the Bailly-Bentley extremes of the date of origin of Indian astronomy, the former estimate received some vindication from the cumulative result of the more balanced studies of the subject in the Vedic literature. The date of beginning of the Vedic astronomy appeared to rally round a more stable position in the 12th century B.C. A deeper bed-rock of the antiquity of Indian civilization in the Indus Valley had not yet been fathomed.

42. Even at a relatively early date of the 12th century B.C., most of the elements of ancient Indian astronomy were susceptible to doubt regarding their indigenous evolution. Scholars looked east toward China or west toward Mesopotamia as possible places of origin of such ideas.

In these efforts, no doubt, they came upon some definite evidence of borrowing from the Graeco-Seleucid system of astronomy in the works of Indian astronomers of the Classical period. They even found some instances of the borrowing of ideas from China in the mechanism of a few antique astronomical instruments and time-measuring devices, such as the *swanyaha yantar* or the perpetual motion wheel turned by the weight of mercury, as described by Bhaskara Acharya in his *Siddhanta Siromani* (xi, 50–57) of the Medieval period. These discoveries tended to create an axiom that everything which showed scientific cunning in Indian culture must have originated either from China or Mesopotamia!

The history of astronomy in China shows indeed a precocious development onwards from the 15th century B.C. when lunar eclipses could be predicted in advance within errors of 24 hours. From the tower of Weng Wang about 1000 B.C., the Chinese astronomers kept a watch of the irregularities of the planets, positions of the Ursa Major, phases of the moon—and observed comets, supernovae, and even sunspots! Study of the "Oracle Bones" from Anyang shows that their *Ssu-fen* or quarter-day calendar, developed during the Yin period of Shang dynasty, recognized cycles of 19- and 76-years, antedating the similar Metonic and Kallippic cycles of the Greeks by about a thousand years!

Yet, despite these spectacular achievements of the Chinese science during the second millennium B.C. the identity of the Chinese *sieus* as progenitors of Indian *nakshatras* has been proved fallacious. The Indian system of *nakshatra* asterisms, crude as it is, shows nonetheless the merit of a scientific frame of reference in marking the positions of the moon and planets. As Dr. Parpola has shown, its origin is palpably traceable at least to 2400 years B.C. in India, when China had not achieved the level of urban civilization comparable with that of the Indus Valley.

In view of a great wealth of cuneiform tablets studied by the Assyriologists during the last eighty-five years or so, it looked more difficult to save the origin of the ancient Indian astronomy from the stricture of Mesopotamian parentage. Not until the attempt started by the Finnish scholars (in interpreting certain characters of the Indus script in terms of celestial entities) was there a single tool available to rebuke the tide of Mesopotamian precedence encroaching even beyond the date of the *Rig-Veda*.

In order to show the indigenous origin of the Indian *nakshatra* system, independent of the Babylonian lunar zodiac, Dr. Parpola has made only a sort of mild protest by differentiating it from the Mesopotamian system on the basis of opposition of the sun and full moon versus heliacal observations. In the survey of possibilities I have shown that both the Babylonian lunar zodiac and the Indian *nakshatra* system have the common basis of heliacal observation, and have taken a bolder step in reversing the direction of the flow of certain ideas, which appear inscribed on the Indus Valley seals but recur in the Mesopotamian astronomy of later periods. Let me emphasise here that these are only possibilities, and *not* confirmed facts. As such these suggestions stand subject to amendments by future studies with more concrete evidence.

43. The Finnish attempt at decipherment of the Indus script still remains at a primary stage, based on debatable premises. It has yet to go far in explaining and verifying the linguistic mechanism from pictographic, ideographic or logographic symbols to their phonetic quality. But the few hints extracted so far by Dr. Parpola in context with ancient Indian astronomy and cosmology, do suggest a consistent picture of origin of the crude scientific ideas in the Indus Civilization, and their preservation in the later Vedic traditions.

The study of crude scientific ideas in ancient cultures of the South Asian subcontinent can hardly be divorced from occult practices and the religious rites and rituals. Existence of the Great Bath of Moenjodaro, excavated on top of the citadel mound amidst a setting of monastic architecture, acquires a new meaning when viewed in the light of possible traditions of an astral religion of the ancient people of the Indus Civilization. Perhaps this exalted swimming pool was meant for an ablution or a bath of purity on such occasions as the one depicted on seal 2430.

We are not sure whether such a bath also existed on the citadel mound

of Harappa. The excavations in that area there remain incomplete. But this religious custom, even if restricted only to Moenjodaro, appears to have originated from an earlier practice of taking holy baths in the sequestered pools and puddles of the river Sarasvati, the heavenly river, and seemingly the mother of the ancient Indian astronomy and cosmology.

The institution of taking holy baths at particular planetary epochs and lunar phases was duly passed down in subsequent ages to the Brahmanic religion. Here we find a proliferation of watering places for taking sacred baths from Gangotri, Prayag, Benares, to Sila Devi Ghat on the bank of Karatoya in Bengal, and on the seashore at Puri in Orissa. Even the temple tanks of southern India seem to be the distant cousins of the Great Bath at Moenjodaro, reminiscent of the watery and fishy origin of the ancient Indian astronomy in the days of the Indus Valley Civilization.

Abbreviations

CAH *The Cambridge Ancient History*, Vol. I, Part 2, 1971.

ESA *The Exact Sciences in Antiquity*, by Otto Neugebauer, Brown University Press 1957. Dover Publication (Second Edition), 1969.

JAOS *Journal of the American Oriental Society.*

JRAS *Journal of the Royal Asiatic Society of Great Britain and Ireland.*

JRGS *Journal of the Royal Geographical Society.*

MASI *Memoirs of the Archaeological Survey of India.*

Parpola, i Abstracts of the article "Harappan Roots of Ancient Indian astronomy and Cosmic Speculation" presented by Dr. Asko Parpola before the 29th International Congress of Orientalists in Paris, 1973.

Parpola, ii Pre-print copy of the article by Dr. Asko Parpola on "Interpreting the Indus Script" written in June 1974 for publication in *Fifty Years of Harappan Studies* (Sir Mortimer Wheeler Felicitation Volume: Editors B.B. Lal and S.P. Gupta) to appear from New Delhi.

Proc. APS *Proceedings of the American Philosophical Society.*

ZA *Zeitschrift für Assyriologie.*

ZDMG *Zeitschrift der Deutschen Morgenländischen Gesellschaft.*

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23. Asko Parpola, Seppo Koskenniemi, Simo Parpola, and Pentti Aalto, *Further Progress in the Indus Script Decipherment*, Scandinavian Institute of Asian Studies, Special Publication No. 3, Copenhagen, 1970. Extracts also published in *UNESCO-Courier*, December 1973, pp. 31–33.
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38. Ibid. Sec. 20.
39. Weber, "Die Vedischen Nachrichten von den Naxatra", *Abhand. Akad. Berlin*, 1861, p. 274f.
40. *Parpola*, i, para 6c and *Parpola*, ii, Sec. 20.
41. *Parpola*, ii, Sec. 15.
42. Ibid. Sec. 12.
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44. Ibid. Sec. 15.
45. Ibid. Sec. 19.
46. See extracts in *UNESCO-Courier*, Op. cit. pp. 31–2.
47. Private communication dated Helsinki, the 10th December, 1975.
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51. Oldham, C. F., "The Saraswati and the Lost River of the Indian Desert", *JRAS*, 1893, pp. 49–76.
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53. Recently my colleague Dr. M. R. Mughal has done extensive fieldwork in the Ghaggar basin of the Cholistan area for charting the locations of ancient sites and for collecting ethnographic material. Lately, in our discussions on the cultural peculiarities of the region, he gratuitiously expressed his view that the "Hakro" tribe inhabiting the area seem to be a very ancient people, whose origin may date back to the *pre-Rig-Vedic* times – possibly to the age of Harappan culture.
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55. *Parpola*, ii, Sec. 20.
56. *Parpola* i, 6b; *Parpola*, ii, Sec. 20.
57. *Parpola*, ii, Sec. 20.
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61. *Supra*, Section 23.
62. Frazer, J. G. *The Golden Bough*, Part V, Vol. I, London 1912, Note, pp. 307–19.
63. *Supra*, Sec. 6, note 8.
64. Bickerman, E. J. *Chronology of the Ancient World*, London 1968, p. 22.

65. Neugebauer, *Proc. APS*, 98(1), Op. cit. p. 63.
66. *CAH*, p. 770.
67. *History of Mankind* (UNESCO), Vol. I, London, 1963, pp. 677–80.
68. Neugebauer, *ESA*, p. 99.
69. Childe, V. Gordon, *New Light on the Most Ancient East*, Op. cit. pp. 185–86.

Postscript

Further Indications from Finland

1. Dr. Asko Parpola of the Department of Asian and African Studies, University of Helsinki, has been kind enough to go through the pre-print copy of the article "Astronomy in the Indus Valley Civilization" at my request, and to suggest the following amendments:

a) In Section 20, the name Vishnu be deleted from the list of mixed identities of the god Rudra.
b) In Section 21, the Sanskrit word *vata* for the banyan tree and the Old Tamil word *vata* for north (as in *vata-min*, the "north star") may just be a coincidence. In the Finnish interpretations, originally, the banyan tree does not mean "north". The tree is fairly distributed over southern India as well.
c) In Section 24, the name *Kanta-k-Katavul* ("a being to whom a sacrifice debt is due") may be taken just as an example from modern Tamil for occurrence of the word *Katavul* in the sense of "god". The combination of the pictographs does not necessarily mean *Kanta-k-Katavul* (god Skanda). However, the word *Katavul* retains its etymological association with the word *katai* for "churning".

2. Besides these amendments, Dr. Parpola has expressed his satisfaction with the thesis of the originally heliacal observation for fixing the epoch of the new year, suggested by the meaning of *vaikuru-min*, as shown in the article. In this context, the relevant extracts are quoted from his letters:

a) Letter dated Helsinki, November 10, 1976.
" ... It accords very well with the fact that there are only 24 (or 25) original nakṣatra names (3 new ones have been obtained by halving the Phalgunī, Aṣādhā and Proṣṭhapada nakṣatras) which seem to have had a model in the 24 plates of the outmost row in the tortoise shell (cf. W. Kirfel, *Symbolik des Hinduismus und des Jainismus*,

Stuttgart 1959, p. 66f.), the tortoise shell representing according to *Śatapatha-Brāhmana* (7, 5, 1, 2) the vault of heaven, and the tortoise himself the sun (*ibid.* 7, 5, 1, 6 and elsewhere). Here is another water-animal with astral connotations in addition to the fish!"

b) Letter dated Helsinki, November 25, 1976.
" ... I would also like to point out that your thesis of the originally heliacal use of the naksatras seems to me to gain support also of the myths of the 'primeval incest' in the *Veda*, where the Heaven/Sun (i.e. night sun) fecundates his own sister/daughter = the Dawn (vaikuṛumīn) with the result that Rudra (the rising sun) is born, to kill his father (= the Night Sun, the god of Death) in punishment of the incurred sin."