Astronomical data and the Aryan question

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1. Dating the Rg-Veda

The determination of the age in which Vedic literature started and flourished has its consequences for the Aryan Invasion question. The oldest text, the Rg-Veda, is full of precise references to places and natural phenomena in what are now Panjab and Haryana, and was unmistakably composed in that part of India. The date at which it was composed is a firm terminus ante quem for the entry of the Vedic Aryans into India. They may have come from abroad or they may have been fully native, but by the time of the Rg-Veda, they were certainly Indians without memory of a foreign homeland.

In a rather shoddy way, Friedrich Max Müller launched the hypothesis that the Rg-Veda had to be dated to about 1200 BC, and eventhough he later retracted it, that arbitrary guess has become the orthodoxy.1 It is forgotten too often that in his own day, other scholars rejected this extremely late date on a variety of grounds. Maurice Winternitz based his estimate on purely philological considerations: "We cannot explain the development of the whole of this great literature if we assume as late a date as round about 1200 BC or 1500 BC as its starting-point."2 Isn't it refreshing to find how logical and unprejudiced the early researchers were? You cannot credibly cram the complicated linguistic, cultural and philosophical developments which are in evidence in Vedic literature, into just a few centuries.

But since this argument of plausibility can always be countered with the argument that unlikely developments are not strictly impossible, we need a firmer basis to decide this chronological question. The most explicit chronology would be provided by astronomical markers of time.

2. Ancient Hindu astronomy

2.1. Astronomical tables

One of the earliest estimates of the date of the Vedas was at once among the most scientific. In 1790, the Scottish mathematician John Playfair demonstrated that the starting-date of the astronomical observations recorded in the tables still in use among Hindu astrologers (of which three copies had reached Europe between 1687 and 1787) had to be 4300 BC.3 His proposal was dismissed as absurd by some, but it was not refuted by any scientist.

Playfair's judicious use of astronomy was countered by John Bentley with a Scriptural argument which we now must consider invalid. In 1825, Bentley objected: "By his [= Playfair's] attempt to uphold the antiquity of Hindu books against absolute facts, he thereby supports all those horrid abuses and impositions found in them, under the pretended sanction of antiquity.

Nay, his aim goes still deeper, for by the same means he endeavours to overturn the

Mosaic account, and sap the very foundation of our religion: for if we are to believe in the antiquity of Hindu books, as he would wish us, then the Mosaic account is all a fable, or a fiction."4

Bentley did not object to astronomy per se, in so far as it could be helpful in showing up the falsehood of Brahminical scriptures. However, it did precisely the reverse. Falsehood in this context could have meant that the Brahmins falsely claimed high antiquity for their texts by presenting as ancient astronomical observations recorded in Scripture what were in fact back-calculations from a much later age. But Playfair showed that this was impossible.

Back-calculation of planetary positions is a highly complex affair requiring knowledge of a number of physical laws, universal constants and actual measurements of densities, diameters and distances. Though Brahminical astronomy was remarkably sophisticated for its time, it could only back-calculate planetary position of the presumed Vedic age with an inaccuracy margin of at least several degrees of arc. With our modern knowledge, it is easy to determine what the actual positions were, and what the results of back-calculations with the Brahminical formulae would have been, e.g.:

"Aldebaran was therefore 40' before the point of the vernal equinox, according to the Indian astronomy, in the year 3102 before Christ. (...) [Modern astronomy] gives the longitude of that star 13' from the vernal equinox, at the time of the Calyougham, agreeing, witjin 53', with the determination of the Indian astronomy. This agreement is the more remarkable, that the Brahmins, by their own rules for computing the motion of the fixed stars, could not have assigned this place to Aldebaran for the beginning of Calyougham, had they calculated it from a modern observation. For as they make the motion of the fixed stars too great by more than 3" annually, if they had calculated backward from 1491, they would have placed the fixed stars less advanced by 4°or 5°, at their ancient epoch, than they have actually done."5 So, it turns out that the data given by the Brahmins corresponded not with the results deduced from their formulae, but with the actual positions, and this, according to Playfair, for nine different astronomical parameters. This is a bit much to explain away as coincidence or sheer luck.

2.2. Ancient observation, modern confirmation

That Hindu astronomical lore about ancient tuimes cannot be based on later back-calculation, was also argued by Playfair's contemporary, the French astronomer Jean-Sylvain Bailly: "the motions of the stars calculated by the Hindus before some 4500 years vary not even a single minute from the [modern] tables of Cassini and Meyer. The Indian tables give the same annual variation of the moon as that discovered by Tycho Brahe -- a variation unknown to the school of Alexandria and also the the Arabs".6

Prof. N.S. Rajaram, a mathematician who has worked for NASA, comments: "fabricating astronomical data going back thousands of years calls for knowledge of Newton's Law of Gravitation and the ability to solve differential equations."7 Failing this advanced knowledge, the data in the Brahminical tables must be based on actual observation. Ergo, the Sanskrit-speaking Vedic seers were present in person to record astronomical observations and preserve them for a full 6,000 years: "The observations on which the astronomy of India is founded, were made more than three thousand years before the Christian era. (...) Two other elements of this astronomy, the equation of the sun's centre

and the obliquity of the ecliptic (...) seem to point to a period still more remote, and to fix the origin of this astronomy 1000 or 1200 years earlier, that is, 4300 years before the Christian era".8

All this at least on the assumption that Playfair's, Bailly's and Rajaram's claims about the Hindu astronomical tables are correct. Disputants may start by proving them factually wrong, but should not enter the dispute arena without a refutation of the astronomers' assertions. It is something of a scandal that Playfair's and Bailly's findings have been lying around for two hundred years while linguists and indologists were publishing speculations on Vedic chronology in stark disregard for the contribution of astronomy.

2.3. The start of Kali-Yuga

Hindu tradition makes mention of the conjunction of the "seven planets" (Saturn, Jupiter, Mars, Venus, Mercury, sun and moon) and Ketu (southern lunar node, the northern node/Rahu being by definition in the opposite location) near the fixed star Revati (Zeta Piscium) on 18 February 3102 BC. This date, at which Krishna is supposed to have breathed his last, is conventionally the start of the so-called Kali-Yuga, the "age of strife", the low point in a declining sequence of four ages. However, modern scholars have claimed that the Kali-Yuga system of time-reckoning was a much younger invention, not attested before the 6th century AD.

Against this modernist opinion, Bailly and Playfair had already shown that the position of the moon (the fastest-moving "planet", hence the hardest to back-calculate with precision) at the beginning of Kali-Yuga, 18 February 3102, as given by Hindu tradition, was accurate to 37'.9 Either the Brahmins had made an incredibly lucky guess, or they had recorded an actual observation on Kali Yuga day itself.

Richard L. Thompson claims that in Indian literature and inscriptions, there are a number of datelines expressed in Kali-Yuga which are older than the Christian era (and a fortiori older than the 6th century AD).10 More importantly, Thompson argues that the Jyotisha-shâstras (treatises on astronomy and, increasingly, astrology, starting in the 14th century BC with the Vedanga Jyotisha as per its own astronomical data, but mostly from the first millennium AD) are correct in mentioning this remarkable conjunction on that exact day, for there was indeed a conjunction of sun, moon, Mercury, Venus, Mars, Jupiter, Saturn, Ketu and Revati.

True, the conjunction was not spectacularly exact, having an orb of 37°between the two most extreme planetary positions. But that exactly supports the hypothesis of an actual observation as opposed to a back-calculation. Indeed, if the Hindu astronomers were able to calculate this position after a lapse of many centuries (when the Jyotisha-Shâstra was written), it is unclear what reason they would have had for picking out that particular conjunction. Surely, such conjunctions are spectacular to those who witness one, and hence worth recording if observed. But they are not that exceptional when considered over millennia: even closer conjunctions of all visible planets do occur (most recently on 5 February 1962).11 If the Hindu astronomers had simply been going over their astronomical tables looking for an exceptional conjunction, they could have found more spectacular ones than the one on 18 February 3102 BC.

3. The precession of the equinox

3.1. The slowest hand on the clock

The truly strong evidence for a high chronology of the Vedas is the Vedic information about the position of the equinox. The phenomenon of the "precession of the equinoxes" takes the ecliptical constellations (also known as the sidereal Zodiac, i.e. those constellations through which the sun passes)12 slowly past the vernal equinox point, i.e. the intersection of ecliptic and equator, rising due East on the horizon. The whole tour is made in about 25,791 years, the longest cycle manageable for naked-eye observers. If data about the precession are properly recorded, they provide the best and often the only clue to an absolute chronology for ancient events.

If we can read the Vedic and post-Vedic indications properly, they mention constellations on the equinox points which were there from 4,000 BC for the Rg-Veda (Orion, as already pointed out by B.G. Tilak)13 through around 3100 BC for the Atharva-Veda and the core Mahabharata (Aldebaran) down to 2,300 BC for the Sutras and the Shatapatha Brahmana (Pleiades).14

Other references to the constellational position of the solstices or of solar and lunar positions at the beginning of the monsoon confirm this chronology. Thus, the Kaushitaki Brahmana puts the winter solstice at the new moon of the sidereal month of Magha (i.e. the Mahashivaratri festival), which now falls 70 days later: this points to a date in the first half of the 3rd millennium BC. The same precessional movement of the twelve months of the Hindu calendar (which are tied to the constellations) vis-a-vis the meterological seasons, is what allowed Hermann Jacobi to fix the date of the Rg-Veda to the 5th-4th millennium BC.15 Indeed, the regular references to the full moon's position in a constellation at the time of the beginning of the monsoon, which nearly coincides with the summer solstice, provide a secure and unambiguous chronology through the millennial Vedic literature.

It is not only the Vedic age which is moved a number of centuries deeper into the past, when comparing the astronomical indications with the conventional chronology. Even the Gupta age (and implicitly the earlier ages of the Buddha, the Mauryas etc.) could be affected. Indeed, the famous playwright and poet Kalidasa, supposed to have worked at the Gupta court in about 400 AD, wrote that the monsoon rains started at the start of the sidereal month of Ashadha; this timing of the monsoon was accurate in the last centuries BC.16 This implicit astronomy-based chronology of Kalidasa, about 5 centuries higher than the conventional one, tallies well with the traditional "high" chronology of the Buddha, whom Chinese Buddhist tradition dates to ca. 1100 BC, and the implicit Puranic chronology even to ca. 1700 BC.17

3.2. Some difficulties

These indications about the precessional phases may be unreliable insofar as their exact meaning is not unambiguous. To say that a constellation "never swerves from the East" (as is said of the Pleiades in the Shatapatha Brahmana 2:1:2:3) seems to mean that it contains the spring equinox, implying that it is on the equator, which intersects the horizon due East. But this might seem insufficiently explicit for the modern reader who is used to a precise and separate technical terminology for such matters. But then, the modern reader will have to accept that technical terminology in Vedic days mostly consisted in fixed metaphorical uses of common terms. This is not all that primitive, for the same thing will be found when the etymology of modern technical terms is analyzed, e.g. a telescope is a Greek "far-seer", oxygen is "acid-producer", a cylinder is a "roller".

The only difference is that we can use the vocabulary of foreign classical languages to borrow from, while Sanskrit was its known classical reservoir of specialized terminology.

Another factor of uncertainty is that the equinox moves very slowly (1° in nearly 71 years), so that any inexactness in the Vedic indications and any ambiguity in the constellations' boundaries makes a difference of centuries. This occasional inexactness might possibly be enough to neutralize the above shift in Kalidasa's date -- but not to account for a shift of millennia (each millennium corresponding to about 14 degrees of arc) needed to move the Vedic age from the pre-Harappan to the post-Harappan period, from 4000 BC as calculated by the astronomers to 1200 BC as surmised by Friedrich Max Müller.

On the other hand, it is encouraging to note that the astronomical evidence is entirely free of contradictions. There would be a real problem if the astronomical indications had put the Upanishads earlier than the Rg-Veda, or Kalidasa earlier than the Brahmanas, but that is not the case: the astronomical evidence is consistent. Inconsistency would prove the predictable objection of AIT defenders that these astronomical references are but poetical fabulation without any scientific contents. However, the facts are just the opposite. To the extent that there are astronomical indications in the Vedas, these form a consistent set of data detailing an absolute chronology for Vedic literature in full agreement with the known relative chronology of the different texts of this literature. This way, they completely contradict the hypothesis that the Vedas were composed after an invasion in about 1500 BC. Not one of the dozens of astronomical data in Vedic literature confirms the AIT chronology.

3.3. Regulus at summer solstice

In the Shulba Sutra appended to Baudhayana's Shrauta Sutra, mathematical instructions are given for the construction of Vedic altars. One of its remarkable contributions is the theorem usually ascribed to Pythagoras, first for the special case of a square (the form in which it was discovered), then for the general case of the rectangle: "The diagonal of the rectangle produces the combined surface which the length and the breadth produce separately." This and other instances of advanced mathematics presented by Baudhayana have been shown by the American mathematician A. Seidenberg to be the origin of similar mathematical techniques and "discoveries" in Greece and Babylonia, some of which have been securely dated to 1700 BC. So, 1700 BC was a terminus post quem for Baudhayana's mathematics, which would reasonably be dated to the later part of the Harappan period which ended in ca. 1900 BC.

However, Seidenberg was told by the indologists that these Sutras, or any Vedic text for that matter, were definitely written later than 1700 BC. But mathematical data cannot be manipulated just like that, and Seidenberg remained convinced of his case: "Whatever the difficulty there may be [concerning chronology], it is small in comparison with the difficulty of deriving the Vedic ritual application of the theorem from Babylonia. (The reverse derivation is easy)... the application involves geometric algebra, and there is no evidence of geometric algebra from Babylonia. And the geometry of Babylonia is already secondary whereas in India it is primary."18 To satisfy the indologists, he said that the Shulba Sutra had conserved an older tradition, and that it is from this one that the Babylonians had learned their mathematics: "Hence we do not hesitate to place the Vedic (...) rituals, or more exactly, rituals exactly like them, far back of 1700 BC. (...) elements of geometry found in Egypt and Babylonia stem from a ritual system of the kind

described in the Sulvasutras".19

This is then one of those "entities multiplied beyond necessity": a ritual, annex altar, annex mathematical theory, which is exactly like the Vedic ritual, annex altar, annex mathematical theory, only it is not the Vedic ritual but a thousand or so years older. Let us simplify matters and assume that it was Baudhayana himself who devised his mathematical theories "far back of 1700 BC". Is there a way to find independent confirmation of this suspicion. Yes, there is: the precession of the equinoxes.

In their Index of Vedic Names, A.A. MacDonell and A.B. Keith cite the opinion of several philologists about a reference to a solstice in Magha in the Baudhayana Shrauta Sutra (as well as in the Kaushitaki Brahmana 19:3), to which the Shulba Sutra is an appendix. Magha is the asterism around the star Regulus, but the name is used for an entire month (names of months are typically the name of the most prominent one of the two or three asterisms/nakshatras which make up that one-twelfth of the ecliptic), spatially equivalent to a zone of about 30° around that star, so any deduction here must take a fair degree of imprecision into account. The 18th- and 19th-century philologists cited disagree about whether a Magha solstice was in 1181 BC or in 1391 BC. The authors themselves consider it "only fair to allow a thousand years for possible errors", and settle for a date between 800 BC and 600 BC, "quite in harmony with the probable date of the Brahmana literature".20

However, it is very easy to calculate that Regulus, currently at almost exactly 60°from the solstitial axis, was on that axis about 60 x 71 years ago, i.e. in the 23rd century BC. Though we must indeed allow for an inexactitude of up to 15°, equivalent to about 1100 years, the Magha solstice described is much more likely to have been in 2200 BC than in 1100 BC (with Keith's and MacDonell's 600 BC being already quite beyond the pale). It may have taken place even before the 23rd century BC: maybe only the asterism around Regulus had reached the solstitial axis but not yet the star itself. Most likely, then, this reference to a Magha solstice confirms that the Brahmana and Sutra literature including the Baudhayana Shrauta Sutra (annex Shulba) dates to the late 3rd millennium BC, at the height of the Harappan civilization. In that case, Seidenberg's reconstruction of the development and transmission of mathematical knowledge and the astronomical references in the literature confirm each other in placing Baudhayana's (post-Vedic!) work in the later part of the Harappan period.

3.4. One Veda can hide another

At this point, the only defence for the AIT can consist in a wholesale rejection of the astronomical evidence. This can be done in a crude way, e.g. by simply ignoring the astronomical evidence, as is done in most explicitations of the AIT. A slightly subtler approach is to explain it away, as is done by Romila Thapar, who affirms her belief in "the generally accepted chronology that the Rig-Vedic hymns were composed over a period extending from about 1500 to 1000 BC". When "references to what have been interpreted as configurations of stars have been used to suggest dates of about 4000 BC for these hymns", she raises the objection that "planetary positions could have been observed in earlier times and such observations been handed down as part of an oral tradition", so that they "do not constitute proof of the chronology of the Vedic hymns".21

This would imply that accurate astronomical data were indeed made from the 5th

millennium onwards, and that they were preserved for more than two thousand years, an unparalleled feat in oral traditions. If such a feat is not an indication of literacy and of written records, at the least it supposes a mnemotechnical device capable of preserving information orally, and the one that was available then was verse. So, some poems with the memory-aiding devices of verse, rhythm and tone must have been composed when the information was available first-hand, i.e. close to the time of the actual observation, and those hymns would of course be the Vedic hymns themselves. Otherwise, one has to postulate that the Vedic hymns were composed by borrowing the contents of an earlier tradition of verse, composed at the time when the equinox was observed to be in Orion.

In other words, the Rg-Veda contains literal (though unacknowledged) quotations from another hymns collection composed 2,500 years earlier. This is as good as asserting that Shakespeare's works were not written by Shakespeare, but by someone else whose name was also Shakespeare. However, the point to remember is that even Romila Thapar does not deny that somebody's actual observation of these celestial phenomena was the source of their description in the Vedas.

It is not good enough for those who don't like this evidence, to object that they are not convinced by these astronomical indications of high antiquity, on the plea that their meaning might be somewhat unclear to us. It is clear enough and undeniable that the Vedic seers took care to mention certain astronomical positions and phenomena. A convincing refutation would therefore require an alternative but consistent (philogically as well as astronomically sound) interpretation of the existing astronomical indications which brings Vedic literature down to a much later age. But so far, such a reading of those text passages doesn't seem to exist. In no case is there astronomical information which puts the Vedas at as late a date as "generally accepted" by Prof. Thapar and others.

4. Additional astronomical indications

4.1. The Saptarshi cycle

Apart from the hard evidence, there are a few elements in Hindu astronomical tradition which would not count as evidence all by themselves, but which may gain a new significance when studied in the company of the more solid elements already considered. We will mention four of them: the Saptarshi cycle, the Vedic description of a particular eclipse, Kabbala-like numerical games in Vedic texts and ritual, and the surprising presence of the Zodiac.

A lesser-known Hindu system of time-reckoning is the Saptarshi cycle of 3600 years. My suspicion is that Saptarshi, "the seven sages", sometimes referring to the seven stars of the panhandle in Ursa Maior, in this case means "the seven planets" (later replaced with Navagraha, "the nine planets", including the two Lunar nodes); that the Saptarshi cycle was conceived as the period between two conjunctions of all the seven planets; and that 3600 years was but a conventional and arbitrary approximation of that ideal cycle. At any rate, by the Christian age we find writers who take this concept of a 3600-year cycle literally, and it is hard to either prove or refute that this may have been a much older tradition.

The medieval Kashmiri historian Kalhana claimed that the previous cycle had started in 3076 BC, and the present one in AD 525. J.E. Mitchiner has suggested that the beginning of the Saptarshi reckoning was one more cycle earlier, in 6676 BC.22 This

would roughly coincide with the start of the Puranic dynastic list reported by Greco-Roman authors as starting in 6776 BC.

Indeed, the Puranic king-list as known to Greek visitors of Candragupta's court in the 4th century BC or to later Greco-Roman India-watchers, started in 6776 BC. Pliny wrote that the Indians date their first king to "6,451 years and 3 months" before Alexander the Great (d. 323 BC), while Arrian puts "Dionysus" as head of the dynastic list at 6,042 + 300 + 120 = 6,462 years before Sandrokottos (Chandragupta), to whom a Greek embassy was sent in 314 BC. Both indications add up to a date, give or take a year, of 6776 BC. This would, according to the implicit chronology of Puranic tradition, be the time of Manu's enthronement, Manu being the Aryan patriarch who established his kingdom in North India after having survived the Flood. One of Manu's heirs was Ila, ancestress of Yayati, whose five sons became the patriarchs of the "five peoples" who form the ethnic horizon of the Vedas, one of them being Puru; in Puru's tribe, then, one Bharata started the Bharata clan to which most of the Vedic seers belonged.

It so happens that in 6776 BC (and still in 6676 BC), the oceans were still in the process of recovering the ground they lost during the Ice Age, when the sea level was for thousands of years nearly a hundred metres below the present level. The importance of the Glaciation, which peaked ca. 16,000 years ago, in the reconstruction of Eurasian migration histories can hardly be overestimated. The Channel between Britain and France, with sea bottom at ca. 40 metres, was a walkway until it was inundated again in ca. 6500 BC, when the sea was already more than halfway back to its normal (or at least its present) level. This means that for centuries before and for some more centuries after that time, the sea level was progressively rising. Since large populations had settled in the coastal areas vacated by the receding sea at the beginning of the Ice Age, the progressive melting of the ice-caps led to the progressive flooding of ever higher-situated population centres, for several millennia until perhaps 5,000 BC.

One can imagine what would happen if today the sea level would rise a mere 10 metres: densely populated countries like the Netherlands and Bangladesh would get largely submerged, along with major cities like New York and Mumbai, and at least a quarter of the world population would have to move. But that was, for several millennia, the human condition: one after another, low-lying villages had to be abandoned to the rising sea. It must have seemed like a law of nature to them that the sea was forever rising, forcing men to seek higher habitats. And this process was probably continuous only when looked at from a distance, the reality being more like periods of stable sea levels followed by sudden jumps, catastrophes when considered on the scale of a human lifetime. Most probably, that is the origin of the Flood story.23 The Puranas describe Manu as the leader of mankind after the Flood, and if we apply a realistic average length to the rulerships of the kings mentioned in the Puranic dynastic lists, Manu must have lived in the 7th millennium BC, the time of the rising waters, warranting the suspicion that the Flood story is related to historical events at the end of the Ice Age.

The myth of Atlantis and other submerged continents probably has a similar origin. The Tamils have a tradition of a submerged land to India's south, of which the Maledives and Sri Lanka are remaining hilltops: Tamilakam or, in the parlance of the Madras-based Theosophical Society, Lemuria. The city in which their poets' academy or Sangam (recorded in the early Christian era, but claimed to be ten thousand years old) was established, was said to have been moved thrice because of the rising waters. Though it

is hard to see how poets working at the turn of the Christian era could have a memory of events five millennia older, one cannot dismiss as pure fable a story which tallies neatly with the known geological facts of the rising sea level at the end of the Ice Age.

And if such memory was possible, the existence of a system of time-reckoning going back that far, is not impossible either. But we must admit that for the time being, this is merely "not impossible". However, even if we let the Saptarshi cycle start only in 3076 BC, unrelated to Manu and the Flood, this is still hard to reconcile with the theory of an Aryan invasion in the 2nd millennium BC.

4.2. A remarkable eclipse

For another chronological marker, Rg-Veda 5:40:5-9 describes a solar eclipse. From the description, one can deduce a number of conditions determining the times at which it could have taken place: it was at that site a central, non-total exclipse, which took place in the afternoon on the Kurukshetra meridian, on a given day after the summer solstice, at least in the reading of P.C. Sengupta. Only one date satisfies all conditions, which he calculated as 26 July 3928 BC.24 We have to add, however, that this calculation stands or falls with the accuracy of the unusual translation of the word brahma as "solstice". This reading is supported by later scriptural references to the same event, Shankhayana Aranyaka 1:2,18 and Jaiminiya Brahmana 2:404-410. N.S. Rajaram has identified an even more explicit use of brahma in the sense of "solstice": in Rg-Veda 10:85:35, where brahma is associated with the division of the solar cycle in two halves.25

Moreover, the astronomical interpretation (e.g. by B.G. Tilak) of Rg-Veda 10:61:5-8, where brahma is the equinox and the fruit of the union between a divine father and daughter,

i.e. the two adjoining constellations Mrgashira/Orion and Rohini/Aldebaran, if not moreabstractly the intersection of two related celestial circles, may be cited in support: equinox is not the same as solstice, but it is at least one of the cardinal directions, a purely astronomical rather than a religious concept; the common meaning of brahma would then be "cardinal direction". The division of the ecliptic in 4 parts of 90°by the solstice axis and the equinox axis is already obliquely referred to in RV 1:155:6, so the concept of "cardinal direction" was certainly understood. Still, this construction remains sufficiently strange to be a reasonable ground for skepticism. On the other hand, it is up to the skeptics to come up with a convincing alternative translation which fits the context.

4.3. Vedic Kabbalism

A different type of astronomical evidence, not to fix a precise date but to give an idea of the scientific spirit of the Vedic Aryans, is the interpretation of numerical facts about the Vedas as implicit references to astronomical data. If this seems far-fetched, it should be borne in mind that ancient mythology and religion were primarily concerned with the visible heaven-dwellers, i.e. the heavenly bodies. Many myths are nothing but anthropomorphic narrations of celestial phenomena such as eclipses, solstices and equinoxes, the angular relations between the orbiting planets (e.g. the regular overtaking of the planets by the fast-moving moon, therefore imagined by the Greeks as a huntress, Artemis), the analogy between the twelve-month solar cycle and the twelve-year Jupiter cycle, and even the precession.26

Apart from this figurative representation, there is also a numerical representation of

astronomical data in ancient traditions. Thus the Bible, written by a satellite culture of the astronomically astute Babylonians, used the device of enciphering astronomical data in all kinds of contingent numerical aspects of the narrative, e.g. the ages of the antediluvian patriarchs in Genesis turn out to be equal to the sums of the planets' synodic cycles (period from one conjunction with the sun till the next): Lamech dies at age 777 = 399 (number of days in Jupiter's synodic cycle) + 378 (Saturn's); Mahalalel at 895 = 116 + 779 (Mercury + Mars); Yared at 962 = 584 + 378 (Venus + Saturn). Similarly, the symbolism of 12 and 13, referring to the lunar months in a year, is omnipresent in the Bible: 12 sons of Jacob plus 1 daughter; 12 tribes of Israel with a territory plus the 1 priestly tribe of Levi; 12 regular apostles of Jesus plus the one substitute for the traitor Judas, Matthias; the "thirteen-petalled rose" as Talmudic symbol of the Torah.

In the past decades, scientists and orthodox religionists have often made fun of attempts to connect religion with science, as in Frithjof Capra's Tao of Physics and numerous other books. Yet, in ancient religious texts we already see this attempt of religious thinkers to keep up with the latest in science, as outlined above for astronomy. In his Gospel, John takes the trouble of counting the fish caught by the apostle-fishermen in their nets: 153. Number theory was fairly advanced among the Pythagoreans, and some of its remarkable findings were well-known among the educated in the Hellenistic world. They were aware of the unique property of 153: it is equal to the sum of the third powers of its own constituent figures: 1 + 125

+ 27. Somehow, John assumed that the religious depth of his text would gain from including some allusions to mathematics. In ancient Pagan civilizations, this fusion of religion and proto-science was the done thing; it was usually the priests who used their leisure to develop scientific knowledge, for they were not troubled by the conflict between faith and religion which would characterize the Christian and Islamic Middle Ages.

So in the Vedas as well, we find astronomical data enciphered in all kinds of ways. Thus, the Hindus' most sacred number 108 is, with an inaccuracy of only 1%, the distance earth-sun expressed in solar diameters (i.e. the radius of the earth's orbit divided by the sun's diameter), as well as the distance earth-moon expressed in lunar diameters. Subhash Kak has checked if such numerical combinations as just cited from Genesis also appear in the Vedas.27 They do, though they are often quite complicated and only obvious to someone well-versed in the idiosyncrasies of the multiple Vedic calendar systems. An easy example is: the number of hymns in books 1, 2, 3 and 4 of the Rg-Veda adds up to 354, the number of days in the Lunar year consisting of 12 moon cycles. Similarly, the total number of hymns in books 4, 5, 6 and 7 is 324, the number of days in the so-called Nakshatra year, being the duration of the sun's stay in 24 of the 27 lunar mansions. Coincidence?

According to Kak: "By adding the hymn counts of the ten books of the Rig-Veda in different combinations, we obtain numbers that are factors of the sidereal periods and the five synodic periods (...) The probability of this happening is about one in a million. Hence whoever arranged the Rig-Veda encoded into it not only obvious numbers like the lunar year but also hiden numbers of great astronomical significance."28

This choice of numbers in a cosmically meaningful way is also present in the construction of the Vedic altar, such as the numbers of bricks in each layer being equal

to the number of days in given planetary cycles.29 It involves fairly complicated arithmetic, and shows the kind of concern which the Vedic seers had for the harmony between their own religious practices and the astronomical cycles. That mentality led logically to painstakingly accurate observations and calculations, and thereby supports the suspicion of reliability of the internal Vedic astro-chronology.

4.4. The Zodiac

To conclude this brief acquaintance with Vedic astronomy, we want to draw attention to the presence in the Rg-Veda of a momentous cultural artifact, the origin of which is usually situated in Babylonia in about 600 BC: the twelve-sign Zodiac. In RV 1:164:11, the sun wheel in heaven is said to have 12 spokes, and to be subdivided into 360 pairs of "sons": the days (consisting of day and night), rounded off to an arithmetically manageable number, also basis of the "Babylonian" division of the circle in 360°. The division in 12 already suggests the Zodiac, and we also find, in the footsteps of N.R. Waradpande, that a number of the Zodiacal constellations/rashis (classically conceived as combinations of 2 or 3 successive Lunar mansions or nakshatras of 13°20' each) are mentioned: Simha/Leo (5:83:3 and 9:89:3), Kanya/Virgo (6:49:7), Mithuna/Gemini (3:39.3), and Vrshabha/Taurus (6:47:5 and 8:93:1).30

Here again, the precession has located them where we would expect them in about 4000 BC. The Vrshabha rashi is said to have stabilized the heavens with a mighty prop, apparently a reference to the Taurus equinox in the 4th millennium BC; the same verse links the Taurus month with its opposite, Shukra/Jyeshtha (coinciding with Scorpio, which contained the autumnal equinox), confirming that Vrshabha, "bull", is used here in an astronomical-calendrical sense. That the seasons are linked with the constellation which is "heliacally rising" (i.e. rising just before dawn) is perhaps indicated by RV 8:93:1: "Surya, than mountest up to meet the vrshabha", the sun rises as if to meet the constellation which is just above the horizon.

We are aware that, like the Chinese, the Hindus link the season to the lunar constellation/nakshatra in opposition, i.e. the one which rises at sunset and may contain the full moon. This approach, if applied to modern astrology, would mean that those who think they are Taurus (sun in Taurus) would become its opposite, Scorpio (sun opposite Scorpio, full moon in Scorpio). By contrast, the Babylonians linked the seasons to the solar constellation/rashi in heliacal rising. If that method were used in modern astrology, those who consider themselves Taurus (sun in Taurus) would find themselves to be Aries (last constellation to rise before the sun-in-Taurus rises).31 However, Waradpande's discovery seems to imply that the Hindus too used the constellation (at least the rashi, not the nakshatra) in heliacal rising, like the Babylonians did.

If in Rg-Vedic astronomy the twelve constellations are not linked to the time of the year when they are heliacally rising, but to the time when they are "inhabited" by the sun (as is the practice in modern Hindu astrology), then the whole story would move up at least a thousand and possibly two thousand years, putting the Rg-Veda in about 2000 BC. This is because the sun is in mid-Taurus a month before Taurus's heliacal rising, or about 30° of the cycle, a distance covered by the precession of the equinox in about two thousand years. But it is unlikely that they considered the constellation containing the sun rather than the constellation heliacally rising, as astronomy was based on actual observation more than on calculation, and consequently required that the constellation

be visible.32 The constellation temporarily inhabited by the sun is invisible, and that is why the ancients made do with the constellation rising before the one in which the sun is located (heliacal rising), or the one rising when the sun sets, in practice the one inhabited by the full moon (opposition).

The difference between the sun, which obscures the constellation it inhabits, and the moon, which is seen against the background of the constellation it inhabits, explains why a moon-based system uses moon-in-constellation or, via full-moon-in-constellation, sun-in-opposition (the full moon being by definition opposite to the sun); while a sun-based system had to make do with a derivative relation between sun and constellation, typically the constellation's heliacal rising. My suspicion is that India originally had both systems: a Lunar 27-part Zodiac (nakshatras) using the opposition, exactly like in China (and its derived system of 12 months, based on combinations of 2 or 3 nakshatras and still in use); and a Solar 12part Zodiac (rashis) using the heliacal rising, exactly like in Babylonia.

The Mithuna rashi/Gemini is said to destroy darkness and to be basis (budhna) of heat (tapas) (RV 3:39:3). During Gemini's heliacal rising in 4000 BC, the sun was in Cancer, then coinciding with our month of May, in northern India the first month of summer (May-June), a season of drought and extreme heat. During Leo's heliacal rising, around summer solstice in 4000 BC, the rainy season began. Therefore, verse 5:83:3 says: "Like the charioteer driving the horse by the whip, he releases the messengers of shower. From afar the roars of the simha declare that the rain-god is making the sky showering." It could not be clearer.

Leo is followed by Virgo, indicating the second half of the rainy season, when the water level in the rivers rises dramatically: in verse 6:49:7, she is called "the purifier Kanya with Chitra as her life, waterstream-full". The reference to Chitra, the asterism Spica, the most conspicuous part of the constellation Virgo, dispels any lingering doubt that Kanya/Virgo does indeed mean the sixth constellation of the Zodiac. This means that the Zodiac is as old as the oldest Veda, and that the Zodiac itself helps to date the Vedas to the age when Virgo was connected with the rainy season. Even if we consider sun-in-Virgo rather than Virgo's heliacal rising, this would still indicate the centuries around 2000 BC, well before the 1500 BC taught in our universities as the earliest possible date of the Rg-Veda. Either way, it also upsets the current assumption that the Zodiac was invented in Babylon in the last millennium BC.

4.5. India as the metropolis

Off-hand, while trying to give a solid astronomical basis to Vedic chronology, we discover a case of cultural transmission in which India is no longer a rather late receiver but, on the contrary, the extremely ancient source. Indeed, both the solar and the lunar Zodiac may well originate in India. If the Rg-Veda does refer to a 12-part Zodiac, it precedes the Babylonian Zodiac by 5 centuries even in the lowest AIT-based chronology for the Vedas. As for China: in his famous Science and Civilization in China, Joseph Needham notes, again by using the precession as a time marker, that the Chinese 27-part Zodiac dates back to the 24th century BC.33 He recognizes a common origin with the Hindu nakshatra Zodiac, and then surmises that the Hindus had it from China, on the assumption that the Vedic references to the nakshatras are from 1500 BC at the earliest. But that assumption, a by-product of the AIT, is seriously undermined by all the data we have been considering here.

Another indication for Indian influence on Chinese astronomy is the 60-year century, known in Vedic literature (the Brhaspati cycle) and still commonly used in the Chinese calendar. The 6th-century astronomer Aryabhatta reports that he was 23 when the 60th cycle ended, implying that the system was set rolling in 3102 BC. In China, the system was adopted a few centuries later: according to Chinese tradition, it started with the enthronement of the legendary Yellow Emperor in 2697 BC.

A stellar myth which was apparently transmitted from India to China is the notion that after death, the souls go to the Scorpio-Sagittarius region of the sky (specifically Phi Sagitarii), where the autumnal equinox was located in the 4th millennium BC. There, they were to be judged by Yama or a similar god of the dead.

The influence of Indian astronomy on both China and Babylonia confirms the Vedic-Harappan civilization's status as the world metropolis in the 4th-3rd millennium BC. In the official cults in imperial China and in Babylon, stellar science, stellar symbolism and stellar worship were central. But the same central place had already been accorded to astronomy in the Vedas, as we have seen here (if only fragmentarily, for numerous Vedic motifs not discussed here are also related to astronomy, e.g. the twelve Adityas or divine children of the sun, Prajapati as personification of the year cycle, etc.); and also in the culture and religion of

Joseph Needham: Science and Civilization in China, part 1, ch.20: "Astronomy", p.253-254.

the Indus-Saraswati civilization, as Asko Parpola and others have shown.34

Remark that Parpola often tries to make sense of Harappan data by referring to Vedic data, on the AIT-based assumption that the Aryan invaders integrated Harappan astronomy and religion.35 This is again a case of multiplying entities without necessity: instead of saying that there are two cultures which happen to share some astro-religious lore, we might assume that these two cultures are one, until proof of the contrary. Parpola's arguments for a Harappan origin of Vedic and Hindu cultural items, e.g. of astronomy-based nomenclature (names like Karttika, "of the Pleiades"), are just as much arguments for an identity of Vedic and Harappan.36 The point to remember is that even Parpola, often cited as an argument of authority by Indian defenders of the AIT, fully acknowledges the continuity between Vedic and Harappan culture. The common emphasis on astronomy in both Vedic and Harappan sources, is certainly an indication of their close kinship if not their identity.

5. Conclusion

The astronomical lore in Vedic literature provides elements of an absolute chronology in a consistent way. For what it worth, this corpus of astronomical indications suggests that the Rg-Veda was completed in the 4th millennium AD, that the core text of the Mahabharata was composed at the end of that millennium, and that the Brahmanas and Sutras are products of the high Harappan period towards the end of the 3rd millennium BC. This corpus of evidence is hard to reconcile with the AIT, and has been standing as a growing challenge to the AIT defenders for two centuries.

Footnotes:

1. The story of Max Müller's chronology and its impact is told by N.S. Rajaram: The Politics of History, Voice of India, Delhi 1995, ch.3.

2. M. Winternitz: History of Indian Literature (1907, reprint by Motilal Banarsidass, Delhi 1987), vol.1, p.288.

3. Playfair's argumentation, "Remarks on the astronomy of the Brahmins", Edinburg 1790, is reproduced in Dharampal: Indian Science and Technology in the Eighteenth Century, Academy of Gandhian Studies, Hyderabad 1983 (Impex India, Delhi 1971), p.69-124.

4. John Bentley: Hindu Astronomy, republished by Shri Publ., Delhi 1990, p.xxvii; also discussed by Richard L. Thompson: "World Views: Vedic vs. Western", The India Times, 31-3-1993. On p.111, we find that Bentley has "proven" that Krishna was born on 7 August in AD 600 (the most conservative estimate elsewhere is the 9th century BC), and on p.158 ff., that Varaha Mihira (AD 510-587) was a contemporary of the Moghul emperor Akbar (r.1556-1605).

5. J. Playfair in Dharampal: Indian Science and Technology, p.87.

6. Quoted in S. Sathe: In Search for the Year of the Bharata War, Navabharati, Hyderabad 1982, p.32.

7. N.S. Rajaram: The Politics of History, p.47.

8. J.Playfair in Dharampal: Indian Science and Technology, p.118.

9. J.Playfair in Dharampal: Indian Science and Technology, p.88-89.

10. R.L. Thompson: Vedic Cosmography and Astronomy, Bhaktivedanta Book Trust, Los Angeles 1989, p.19-24. Unfortunately, he gives no examples of the early use of Kali-Yuga, contenting himself with references to Indian publications offering such examples, unlikely to convince Western scholars, viz. S.D. Kulkarni: Adi Sankara, Bombay 1987, and G.C. Agrawala: Age of Bharata War, Motilal Banarsidass, Delhi 1979. Kulkarni's book (p.281 ff.) offers Kali-Yuga dates such as 509 BC, but from marginal Sanskrit sources which most Western scholars would consider unreliable.

11. On that day, Hindu astrologers gathered for prayer-sessions on hilltops to avert the impending catastrophe; they were moderately successful.

12. The sidereal Zodiac, used in astrology by most Hindu and some Western astrologers, consists of the actually visible constellations on the ecliptic. It is contrasted with the tropical Zodiac, an abstract division of the ecliptic in twelve equal sectors of which the first one starts by definition at the equinox axis. This tropical Zodiac, used by most Western and some Hindu astrologers, is unrelated to the background of constellations (it could be constructed even if the universe consisted only of the sun and the earth); but it does not figure anywhere in the present discussion. As far as we know, the process of abstraction from visible constellations to geometrical sectors took place only in the Hellenistic period, ca. 100 BC, and was unknown to the Vedic seers, though they did know the solstice axis and equinox axis.

13. We are aware that the equinox axis never points exactly towards the constellation Orion, which lies south of the ecliptic; but it is understandable that the relatively starless area between the constellations of Gemini and Taurus was named after the conspicuous constellation Orion which lies nearby on the same longitude.

14. Remark that the second half of the 3rd millennium BC, the high tide of the Harappan cities, is also identified by K.D. Sethna (Karpasa in Prehistoric India: a Chronological and Cultural Clue, Impex India, Delhi 1981) as the period of the Sutras, the Vedas being assigned to the pre-Harappan period, all on the basis of the evidence of material culture (with special focus on cotton/karpasa) as attested in the literary and archaeological records.

According to Asko Parpola, Indus-Saraswati seal 430 (reasonably datable to the 24th century BC) depicting the Seven Sisters seems to refer to the observation of the Pleiades.

15. Hermann G.Jacobi: "On the Date of the Àgveda" (1894), reproduced in K.C. Verma et al., eds.: Rtambhara: Studies in Indology, Society for Indic Studies, Ghaziabad 1986, p.91-99.

16. "We can, therefore, say that about 2000 years have elapsed since the period of Kalidasa", according to P.V. Holay: "Vedic astronomy, its origin and evolution", in Haribhai Pandit et al.: Issues in Vedic Astronomy and Astrology, Rashtriya Veda Vidya Pratishthan & Motilal Banarsidass, Delhi, p.109.

17. The argument for a higher chronology (by about 6 centuries) for the Guptas as well as for the Buddha has been elaborated by K.D. Sethna in Ancient India in New Light, Aditya Prakashan, Delhi 1989. The established chronology starts from the uncertain assumption that the Sandrokottos/Chandragupta whom Megasthenes met was the Maurya rather than the Gupta king of that name. This hypothetical synchronism is known as the "sheet-anchor of Indian chronology". In August 1995, a gathering of 43 historians and archaeologists from South-Indian universities (at the initiative of Prof. K.M. Rao, Dr. N. Mahalingam and Dr. S.D. Kulkarni) passed a resolution fixing "the date of the Bharata war at 3139-38 BC" and declaring this date "to be the true sheet anchor of Indian chronology".

18. A. Seidenberg: "The ritual origin of geometry", Archive for History of Exact Sciences, 1962, p.488-527, specifically p.515, quoted by N.S. Rajaram and D. Frawley: Vedic 'Aryans' and the Origins of Civilization, WH Press, Québec 1995, p.85.

19. A. Seidenberg: "The ritual origin of geometry", Archive for History of Exact Sciences, 1962, p.515, quoted by N.S. Rajaram and D. Frawley: Vedic 'Aryans' and the Origins of Civilization, p.85.

20. A.A. MacDonell & A.B. Keith: Vedic Index of Names and Subjects, vol.1 (1912, reprint by Motilal Banarsidass, Delhi 1982), p.423-424, entry Nakshatra. Romila Thapar: "The Perennial Aryans", Seminar, Dec. 1992.

21 Romila Thapar: "The Perennial Aryans", Seminar, Dec. 1992.

22. J.E. Mitchiner: Traditions of the Seven Rishis, Motilal Banarsidass, Delhi 1982, quoted in Kak: Astronomical Code of the Rg Veda, Aditya Prakashan, Delhi 1994, p.64.

23. The worst case was probably the Black Sea, which was a lake during the Ice Age, until some time in the 7th millennium BC. When rising waters in the Mediterranean inundated the dry Bosporus straits and plunged into the Black Sea, the latter rose dramatically, forcing coast-dwellers to flee as much as a mile a day for months on end. Many of them didn't survive, and entire states (or whatever political units were in existence) were drowned. The fact that the Biblical Flood story has Noah land on Mount Ararat, not far from the Black Sea, may be due (apart from the presence of a boat-like rock formation there) to the memory of the Black Sea flood drama. In most parts of the world, the flooding of coastal villages must have been more gradual.

24. P.C. Sengupta: "The solar eclipse in the Rgveda and the Date of Atri", Journal of the Royal Asiatic Society of Bengal Letters, 1941/7, p.92-113, also included in his Ancient Indian Chronology, Calcutta 1947; discussed in K.V. Sarma: "A Solar Eclipse Recorded in the Rgveda", in Haribhai Pandya et al., eds.: Issues in Vedic Astronomy and Astrology, Motilal Banarsidass, Delhi 1992, p.217-224.

25. N.S. Rajaram (with D. Frawley):Vedic Aryans and the Origins of Civilization, WH Press, Québec 1995, p.106.

26. This position is argued powerfully in the classic study by Giorgio de Santillana & Hertha von Dechend: Hamlet's Mill, David R. Godine, Boston 1992 (1969); in Norman Davidson: Astronomy and the Imagination, Routledge & Kegan, London 1986 (1985); and in Thomas D. Worthen: The Myth of Replacement. Stars, Gods and Order in the Universe, University of Arizona Press, Tucson 1991.

27. S. Kak: Astronomical Code, Ch.5-6.

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University of Arizona Press, Tucson 1991.

27 S. Kak: Astronomical Code, Ch.5-6.

28. Georg Feuerstein, Subhash Kak and David Frawley: In Search of the Cradle of Civilization, Quest Books, Wheaton IL 1995, p.208.

29. S. Kak: Astronomical Code, Ch.4.

30. Argued in N.R. Waradpande: New Light on the Date of the Rgveda, Sanskrit Bhasha Pracharini Sabha, Nagpur 1994, p.13-24.

31. This remains true whether one uses the Tropical (abstract, solstice/equinox-based) or the Sidereal (visible, constellation-based) Zodiac, a question which is not really relevant here. The Vedic Zodiac was sidereal, more based on observation than on calculation; the tropical Zodiac apparently dates from the time when Sidereal and tropical signs coincided (around the turn of the Christian era), i.e. when the constellation of Aries filled the 30° sector following the spring equinox in the sun-earth cycle, a tropical sector known since then as Aries regardless of the position of the constellation Aries. The concept of the Tropical Zodiac was apparently thought up in Hellenistic circles, but who knows what more surprises the Brahmins have up their sleeves?

32. Other possible Vedic indications that the seers used the concept of heliacal rising, are the descriptions of the last stars fading before the almost-rising sun: RV 1:50:2, and metaphorically RV 7:36:1, 7:81:2, 9:69:4..

34. Asko Parpola: Deciphering the Indus Script, Cambridge University Press 1994, contains a large section on and numerous references to stellar motifs in the Harappan seals.

35. See e.g. Parpola: "The Harappan priest-king's robe and the Vedic tarpya garment: their interrelation and symbolism (astral and procreative)", in J. Schotsmans & M. Taddei, eds.: South Asian Archaeology 1983, Naples, p.385-404; and Parpola: The Sky-Garment: a Study of Harappan Religion aand Its Relation to the Mesopotamian and Later Indian Religions, Finnish Oriental Society, Helsinki 1985.

36. Asko Parpola: "Astral proper names in India. An analysis of the oldest sources, with argumentation for an ultimately Harapan origin", Adyar Library Bulletin #53, Madras 1989-90, p.1-53.