Dating of *Rohiṇī-Śakaṭa-Bheda*[1]

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Abstract

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

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

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

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

1. Taurus Constellation

Taurus constellation is shown in figure 1. The stars α, ε and γ form a 'V' shape which represents the head of Taurus the bull. The stars β and ς form the horns of the bull. Alternately, it has also been imagined as a wain with the two

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outstretched stars (β and ς Tau) indicating where the bulls would be tied to the wain. The star Aldebaran (*Rohiṇī)* is the primary star of the constellation. In the Indian literature and calendrical system, Taurus constellation is called as ***Vṛşabha***. α Tau is referred to as ***Rohiṇī*** and the *Rohiṇī-Śakaṭa or the Wain of Rohiṇī* consists of α, ε and γ Tau (1) .

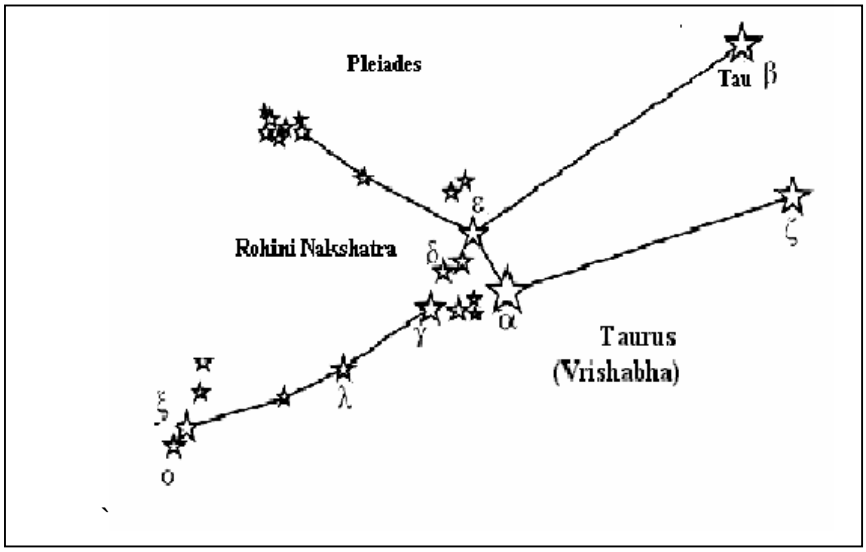

Figure 1: The shape of Taurus in the sky as it is seen today

2. Importance of *Rohiṇī-Śakaṭa-Bheda*

The ancient Indian literature is replete with references to *Rohiṇī-Śakaṭa-Bheda* (RSB). For example, according to Varhamihira's *Brihat-Saṁhitā* (BS) and his references to the work of *Garga* (2), when Mars, Saturn or a comet passes through the *Rohiṇī Śakaṭa* this event is called the *Rohiṇī-Śakaṭa-Bheda* (RSB). According to BS when it happens, a great disaster will occur. We reproduce below some examples of the references to RSB. In each case, we have given the *śloka*, along with a translation in bracket and an interpretation.

We first reproduce the couplet as given in BS (2):

रोहिणीशकटमर्कनन्दनो यदि भिनत्ति रुधिरोऽथवा शिखी
किं वदामि यदनिष्टसागरे जगदशेषमुपयाति संक्षयम् ऽऽ१४ऽऽ

Rohiṇī-śhakatam arkanandano yadi bhinatti rudhirosthavā shikhī
Kim vadāmi yadaniṣṭasāgare jagadaşėşam upayāti sakşayam

Brihat-Saṁ hitā XLVII// 14 //

(When Saturn, Mars or a comet cuts the Wain of Rohini, what shall I say, alas, for the whole world will perish being plunged in the ocean of misery) When

Mars, Saturn or a comet moves through the triangular Wain of *Rohiṇī*, a major disaster will occur.

Sūrya-Siddhānta (3) is even more specific about where the constellation should be located for RSB to occur. It refers to the same event in the following words:

वृषे सप्तदशे भागे यस्य याम्योंऽ शकद्वयात्
विक्षेपोऽभ्यधिको भिन्द्याद् रोहिण्याः शकटं तु सः ऽऽ१३ऽऽ

Vṛşe Saptadaśe Bhāge yasya yāmyośakadVayāt
Vikshepahsabhyadhikah bhindyāt Rohinyah Śakaṭam tu sah
Nakshatra graha yutyadhikara 8 //13//

(In Taurus, at 17th degree, a planet of which the latitude is a little more than 2 degrees, south, will split the Wain of *Rohiṇī*) The starting point of constellation *Vṛşabha* is at 30° longitude. Further 17° longitude into the constellation is the *Rohiṇī Nakshatra*. According to the *shloka*, a planet that is further 17° into the constellation of *Vrishabha*, and whose south latitude is little more than 2° will split the wain of Rohini. Here the latitude and longitude are with respect to Ecliptic.

Burgess (3) has clarified this and we summarise his comment here. The asterism *Rohiṇī* is composed of 5 principle stars in the head of Taurus. The distances of the stars in longitude from the initial point of the sphere vary from 45° 46" for γ Tau to 49° 45" for α Tau (*Rohiṇī*). Hence, the 17th degree into *Vṛşabha,* commencing at the initial point of the sphere, (which is 180° opposite of α Virginis or Spica) is very nearly the middle of the wain. The latitude of its stars, again varies from 2° 36" for ε Tau to 5° 45" for θ Tau. Hence, to come into collision with, or to enter the wain, a planet must be more than 2° of south latitude. He notes that the *Siddhanta* does not inform us what would be the consequences of such an occurrence that belongs rather to the domain of astrology rather than of astronomy.

Mahāsiddhanta (4) by Aryabhatta 2 also expresses similar events as the earlier two verses.

याम्यो बाणोंऽशाधिको वृषेऽप्सांशसंस्थखेटस्य
यस्य स्यात् स भिनत्ति ब्राह्म्यं विशरो विबाणानि ऽऽ१३ऽऽ

Yamyo bāṇo sḿśādhiko Vṛshes psāḿśasaḿsthakhetasya
Yasya syāt sa bhinnati brāhmyam viśaro vibaṇāni
Bha graha yutyadhikara 12//13//

When the latitude is greater than 2° in *Vṛşabha rāśi at* 17°, when that happens, it splits the wain.

In *Graha-Lāghavam* (5) the same event is referred to in the following terms:

गवि नगकुलवे खगोऽस्य चेदद्यमदिगिषुः खशरांगुलाधिकः
कभशकटमसौ भिनत्त्यसृक्शनिरूडुपो यदि चेज्जनक्षयः ७ऽऽ

Gavi nagakulave khagosya chedyamadigiṣuhkha-śaranguladhikaḥ
Kabha-śakaṭam asau bhinatty asṛk-shanirudupo yadi chejjanakṣayaḥ
Nakshatra-Cayadhikaraḥ 11 // 7 //

(When the point reference is situated 17^o into Taurus and a planet whose latitude is more than fifty *angulas*, RSB is said to have occurred. When Mars, Saturn or Moon can perform RSB, great disasters occur). This passage is essentially a rephrasing of BS except that comet is replaced with moon and a better specification of where *Rohiṇī* should be with respect to the starting of *Vṛṣabha* is described. The unit of *angulas* used here is defined as follows. The angular diameter of Moon is said to be 12 *angulas* which amounts to 0.5^o. Hence fifty *angulas* comes slightly more than 2^o. It seems that addition of Moon is a translational re-assessment since moon is more systematic than comet. However, transit of Moon through Taurus is not infrequent and cannot possibly be associated with massive destructions. This is acknowledged by the author in the following verse. The next verse then says:

स्वर्भानावदितिभतोऽष्ट . ऋक्षसंस्थे
शीतांशुः कभशकटं सदा भिनत्ति ऽ
भौम्यार्क्योः शकटभिदा युगान्तरे स्यात्
सेदानीं न हि भवति दृशि स्वपाते ऽऽ८ऽऽ

Svarbhanāvaditibhato-aṣta Vṛkśasaṁsthe
Shitamshuh kabha-śakaṭam sadā bhinatti
Bhaumyārkyoh śakatabhidā yugāntare syāt
Sedānim na hi bhavati driṣi svapāte //8//
Nakshatra-Chayadhikaraha 11// 8 //

(RSB occurs when *Rāhu* is in the 8 *nakṣatras* between Gemini and Virgo, both inclusive. The 8 *Nakṣatras* are *Punarvasu, Puṣya, Âśleṣā, Maghā, Purvā Phālgunī, Uttarā Phālguni, Hasta,* and *Citrā*. RSB by Saturn or Mars happens very rarely. Given the present nodes of Saturn and Mars, this is not possible now). When the ascending node of Moon (*Rāhu*) is anywhere between asterisms *Punarvasu* and next 7 asterisms then Moon splits the Wain of *Rohiṇī* but this is not true for Mars and Saturn, because the motion of their nodes is very slow. They split the Wain of *Rohiṇī* after a long period of time (*yugāntara*).

In table 1 we have given a more extensive list of various ancient books in which reference to RSB can be found along with their period (See also Colebrooke (6)).

Table 1: Reference to *Rohiṇī-Śakaṭa-Bheda* in Various ancient Indian literatures arranged according to the approximate dates of their publication

Name of Book	**Reference**	**Approximate period**	**Chapter**	***Śloka***
Surya Siddhānta (Modern)	3	400 – 800 AD	8	13
Brihat Saṁhitā	1,2	505 AD	47	14
Mahā-Bhaskarīya	7	~ 600 AD	3	71, 75
Mahāsiddhanta	4	853 – 990 AD	11	13
Khandakhādyakā	8	628 AD	10	15, 16
Bramhasphuṭa-Siddhanta	9	628 AD	10	11, 12
Siṣyādhivrddhida-tantra by Lallā	10	638 AD	11	11
Grahalāghav of Gaṇeśa Daivajña	5	1545 AD	11	7,8

In summary, therefore, the RSB is said to occur when either Saturn or Mars pass through the *Rohiṇī Nakṣatra.* It is interesting to note that *Gaṇeśa Daivajña* (5) has clearly noted that this event can occur only in some other future Yuga since in the present movements of the stars, RSB is impossible. This passage is correlated by some with a major upheaval on Earth.

Considering the range of references to RSB, the event must have been of considerable magnitude and importance and left a deep impression on its observers. It is unlikely that references to events associated with intra-human affairs would have created such a sensation. Of all the literature where references to RSB are found the work of *Garga* as noted in (2) is probably the oldest. The date of *Garga* is unknown.

3. Analysis of the Astronomical Data

Amongst the objects capable of RSB, we ignore comets in this analysis because there are many long-term comets whose trajectories cannot be determined. We also ignore Moon since the passage of Moon through *Rohini* is a common affair. Hence we have searched for RSB with either Saturn or Mars using the best available commercial software SkyMap Pro 8.0 (11), which incorporates the most accurate ephemeris of planetary movements as well as the most accurate available data on stellar movements. It should be noted that the sidereal period of Saturn is 29.46 years (12). Hence, we need to check only once every 30 years for a potential RSB. We discuss the various aspects of our astronomical search below.

Based on currently available ephemeris, SkyMap Pro (11) simulates the night sky accurately till Julian Day 1, i.e. January 1, 4713 BC (11). This

software incorporates Tycho and Hipparcos data of stellar location and movement allowing accurate extrapolation of data into deep past and future. In this search we found there are no events of RSB from 4713 BC to 10,000 AD. We then extended the search till 10,000 BC using the NASA database of ephemeris (Horizons DL-408 (13)). We found 4 events of RSB in 5284 BC, 9339 BC, 9371 BC and 9860 BC, all by Mars. We also found one event in 9828 BC where ε Tau is occulted. According to the presently used ephemeris RSB by Saturn has not occurred since 10,000 BC.

3.1 Possible errors in calculations

The angular error for Saturn over the 3,000 years is about 0.5 arcseconds; the radial error is about 400 km. At the distance of Saturn from the earth at opposition, this error is 0.5 arcseconds, that is, about 3,500 km. For Mars, the angular error is less than 8 arcseconds, which is about 3,000 km at opposition. The radial error can be up to 100 km. The ephemeris used here (10,000 BC to 9,999 AD) shows that the period of Mars' nodal regression is about 145,000 years and for Saturn, about 165,000 years.

Over 3000 years, the errors in the geocentric right ascension and declination (longitude and latitude) of Saturn grew to only about 0.5 arcseconds (400 km); those for Mars, no greater than 8 arcseconds (5-20 km). For a time of even 10,000 years, though the errors may be at most 10 times as large as those over the 3000 years. The present orbital plane of Saturn is known better than 1 arc-second and that error does not grow much in time. The back track error, however, might grow as much as 10 arcseconds in 3,000 years, possibly 40-50 arc seconds in 10,000 years. Even so, it is sufficient accuracy for this study.

We have also checked the Tycho Catalogue, finding an uncertainty in the declination proper motion of ε Tau to be 0.8 milliarcseconds/year; i.e. 0.8 seconds/millennium; 8 arcseconds in 10,000 years. Thus, the motion of the star is also accurately known for these purposes. We can say with some degree of certainty that Saturn has not appeared below ε Tau i.e. there has been no RSB by Saturn since at least before 10,000 BC. ε Tau moves -0.036 arcseconds/year in declination, so it was actually more northwards than it is now. Even so, there is no instance when Saturn passes through the triangle formed by ε Tau, γ Tau, and α Tau.

3.2 Results

- **Saturn:**

The closest that Saturn came to ε Tau is at 5300 BC and 3500 BC, and they are no closer than about 0.27 degrees. The points of closest approach for Saturn are given in Table 2. Saturn normally remains above this star and hence outside RSB. As column 1 shows, this distance has not become negative for the last 10,000 years, which would have implied as RSB.

Table 2: Points of closest approach by Saturn to ε Tau (see text)

Angular dist (deg)	Date	Saturn		ε Tau	
		RA	Dec.	RA	Dec.
0.276	-3773 OCT 05	66.9488	19.5123	66.9810	19.2380
0.277	-3567 SEP 16	66.9299	19.5073	66.9872	19.2360
0.280	-3508 OCT 09	66.9548	19.5130	66.9889	19.2354
0.281	-3832 SEP 15	66.9583	19.5187	66.9792	19.2386
0.283	-4274 OCT 02	66.9253	19.5234	66.9660	19.2430
0.287	-4333 SEP 17	66.8838	19.5190	66.9642	19.2436
0.288	-4539 OCT 06	66.9403	19.5327	66.9580	19.2457
0.288	-4862 MAY 15	66.9091	19.5345	66.9483	19.2489
0.290	-4598 SEP 12	66.9081	19.5323	66.9562	19.2463
0.295	-4921 MAY 27	66.9201	19.5437	66.9465	19.2495
0.299	-4803 MAY 1	66.9091	19.5446	66.9501	19.2483
0.301	-4215 OCT 14	66.9392	19.5425	66.9677	19.2424

- **Mars:**

In figure 2 we have given some examples of the transit of Mars close to Rohini around 5000 BC. Period for each figure is from left to right and top to bottom are given in table 2.

Table 2: Period of plots (from left to right and top to bottom) in figure 2.

Year (BC)	Day of the year (DOY)
5299	229.38 – 217.32
5297	257.87 – 249.83
5284	206.00 – 158.15
5282	247.64 – 239.60
5280	271.02 –

	264.08
5267	236.32 – 226.09
5265	262.61 – 254.58
5252	219.88 – 207.83
5252	139.89 – 126.74
5250	253.48 – 245.45
5235	242.16 – 234.13
5235	267.36 – 259.33

As can be seen from the figure, for the entire period of sixth millennium BC, RSB occurred only in 5284 BC. The analysis was done for the entire period from 3000 BC to 10,000 BC.

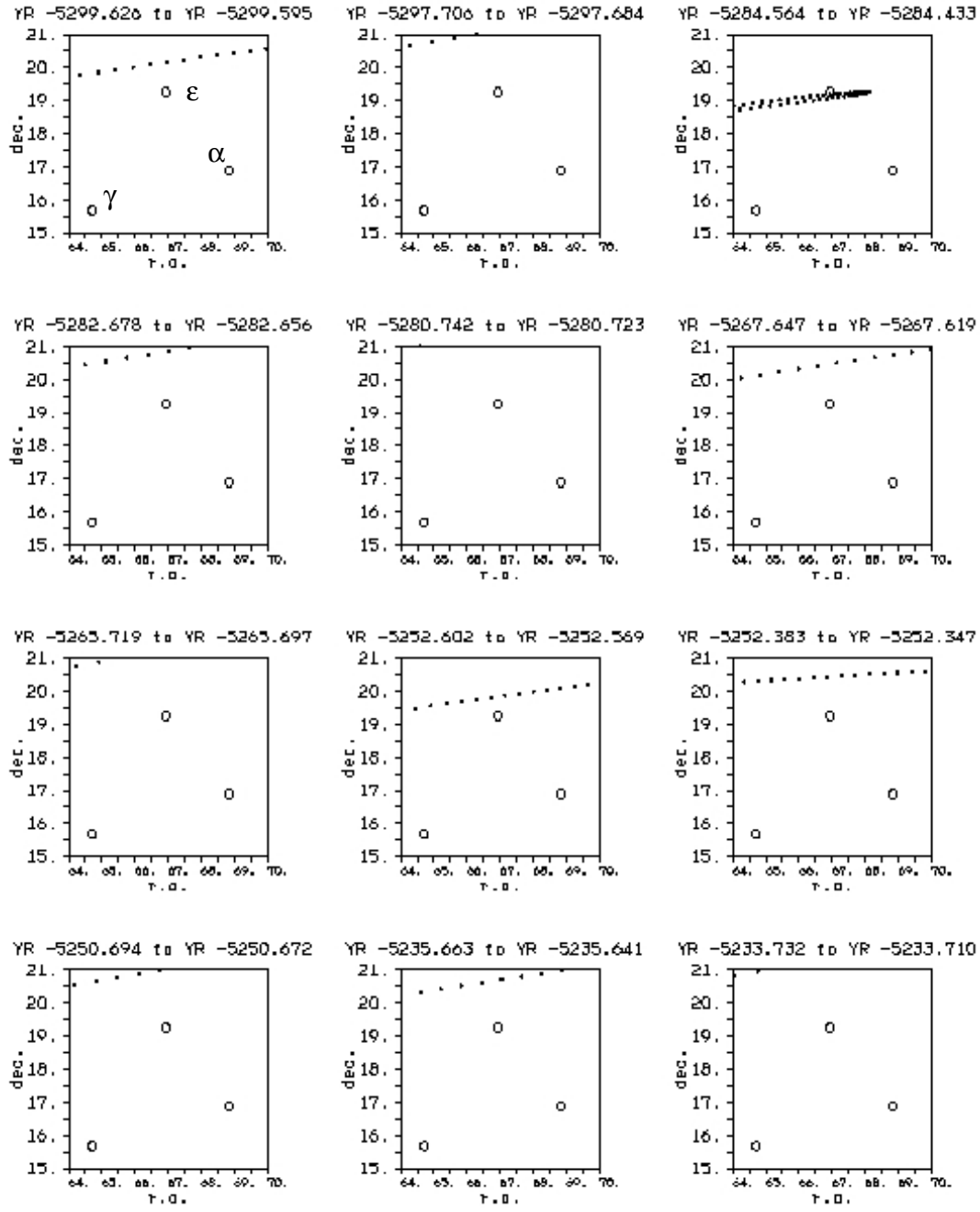

Figure 2: Movement of Mars around Rohini Nakshatra for selected periods in 6th Millennium BC. The periods are given in Table 3. The graphs are of sky location right ascension (X-axis) and declination (Y-axis). In each figure, the three stars are shown with open circle (o) while the motion of Mars in steps of 1 day are shown using (•). The period of plotting is given on the top. Note that the 3 stars, α, ε, and γ Tau are in anticlockwise direction starting with bottom right. This is in reverse order compared to figure 1.

There have been only 4 clear instances of RSB by Mars in 5284 BC (7287 BP), 9339 BC (11,342 BP), 9371 BC (11,374 BP) and 9860 BC (11,863 BP). The event in 9828 BC (11831 BP) was an occultation of ε Tau and hence is a borderline case for RSB. Amongst these, in 5284 BC, and 9371 BC, Mars initially moves east in retrograde motion and then after a maximum displacement outside the circle it returns into RSB. The five instances are given in figures 3a to e. As stated earlier, we found no RSB instances by Saturn.

In (13) originally published in 1896, S. B. Dikshit has analyzed the RSB in great details and based on his calculations on the methods given in (14), he has proposed that RSB by Saturn must have occurred at 5371 BC. However, we do not find this association using current ephemeris.

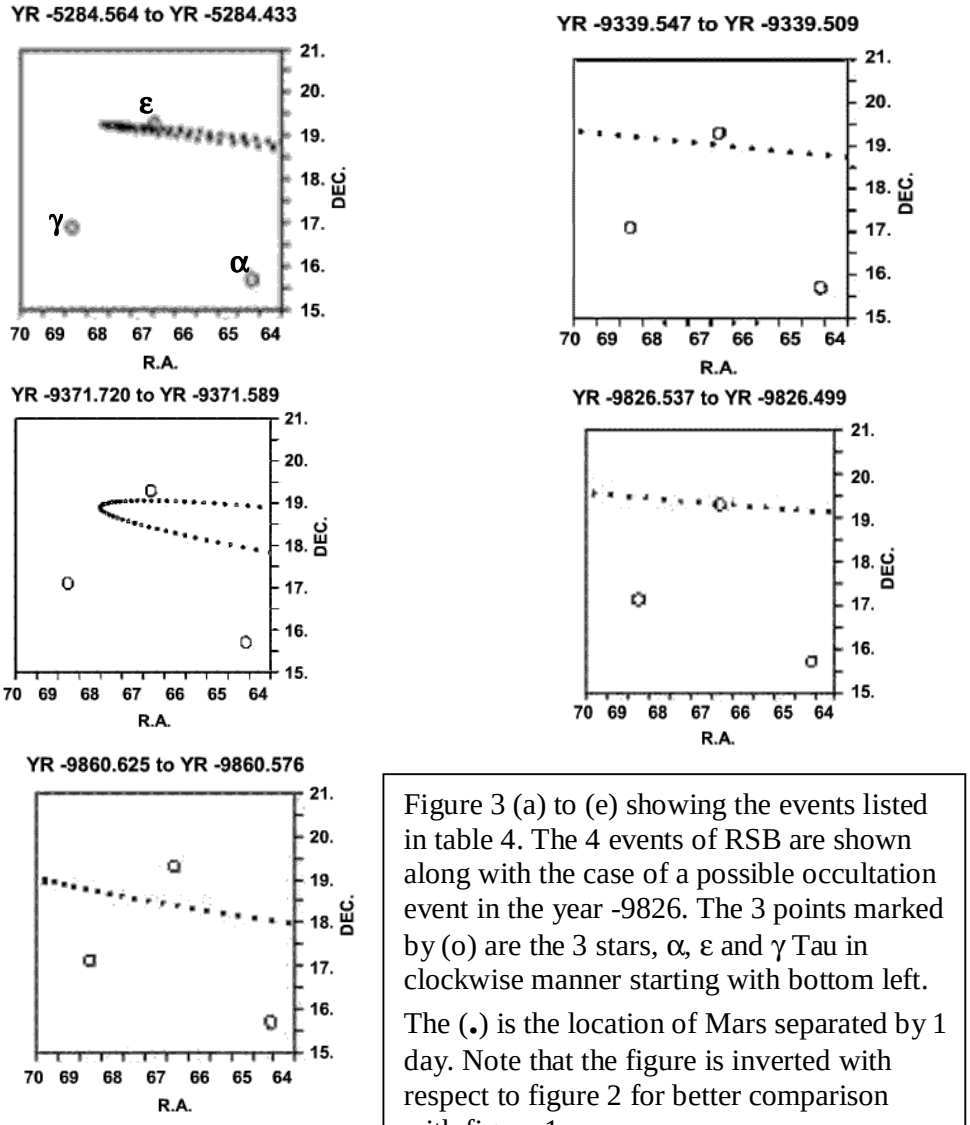

Figure 3 (a) to (e) showing the events listed in table 4. The 4 events of RSB are shown along with the case of a possible occultation event in the year -9826. The 3 points marked by (o) are the 3 stars, α, ε and γ Tau in clockwise manner starting with bottom left. The (**.**) is the location of Mars separated by 1 day. Note that the figure is inverted with respect to figure 2 for better comparison with figure 1.

4. Search for Correlated Geological Event associated with RSB

In the literature, RSB is associated with a major disaster (1). In the exact description of the authors use the words “the whole world will parish, being plunged in the ocean of misery” (2). In *Graha-Lāghavam* (5) the disaster described as large scale death of people (*Janakşaya*). These descriptions imply either a massive earth quake or flooding. We have looked for events of possible large scale flooding of land by a sudden rise in sea levels (15). However, it is not possible to get detailed information on sea level or water level changes in different regions of the earth in great details. We therefore assume that dramatic rise of sea levels at any location of the Earth that have occurred due to global phenomena would be reflected elsewhere. Kelley and Dickson (15) have given the sea level records around Maine, USA from 16000 BP till today (figure 4). The rise in sea levels is due to the melting of ice after the last ice age. Two instances of dramatic rises in sea levels are recorded. The first one lasted between 11,000 BP (~ 9,000 BC) and 9,500 BP (~ 7,500 BC) when the sea level rose by 22 mm/year. After that, for about 2500 years from 9500 BP (~ 7500 BC) to 7000 BP (~5000 BP) the levels remained steady. Then around 7000 BP (5000 PB) the sea again rose dramatically by about ~ 10 mm/year for 2000 years. The first rise, corresponding to the years close to the second set of RSB in figure 4, is a very sharp one with the sea levels rising by 33 meters in 1500 years. Similarly the second rise is time correlated to the second RSB.

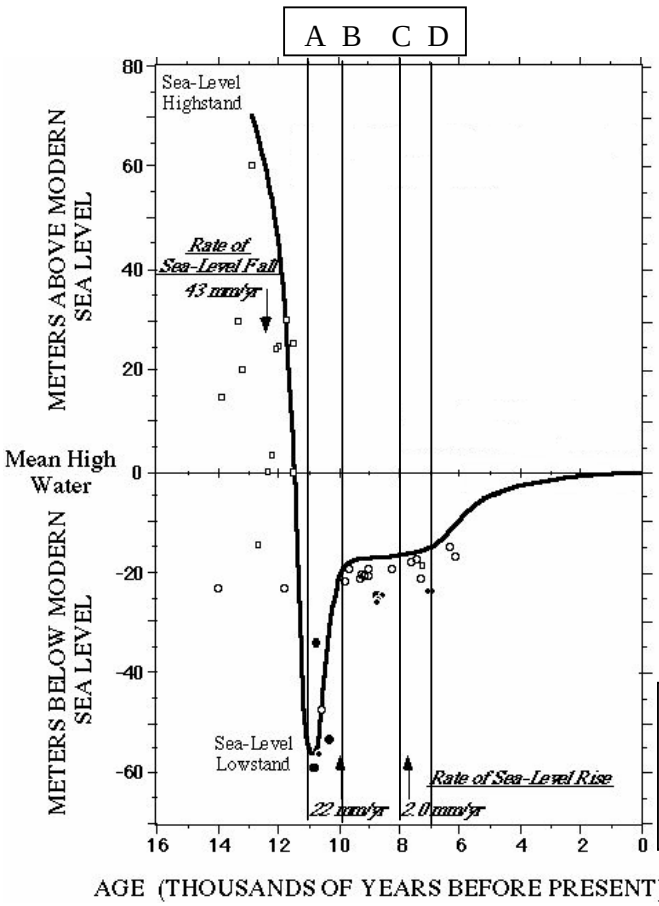

Figure 4: Changes in Sea Level from 16,000 BC to present as noted on the sea coast of Spain. (15, 16)

In the figure, we have added 4 markings as lines A, B, C and D as follows: first steep rise (line A) at 11,000 BP (9,000 BC), end of this rise (line B) at 10,000 BP (8,000 BC) and the start of second major rise (line C) at 8,000 BP (6,000 C). The last major rise (line D) occurred at 7,000 BP (5,000 BC). There was a major rise from 7000 BP till about 2000 BP, but since this is not under study here, we ignore the issue here. The rise in level between lines A and B is 22 mm/year and that between lines C and D is 2 mm/year. These numbers are given by the original authors. From line D to about 5000 BP (3000 BC), the rise is 7.5 mm/year. Hence the period of RSB which are around 11,300 BP (9300 BC) falls at the start of the first severe rise of 22 mm/year and the second at the start of the second rise at 7,200 BP (5,200 BC) falls at line D, the period of second rapid rise phase.

We therefore feel that the original memory of RSB must been incorporated in the tradition most probably in 5284 BC by someone with some memory of the events in the tenth millennium BC. We conclude that the authors who associated the RSB with *pralaya* must have formed the text at least around 5200 BC.

5. Discussion

According to our study, RSB last occurred in 5284 BC but was first reported by *Varāhamihira* in 6th century AD who quotes *Vṛdha Garga*. While there have been several references to *Vṛdha Garga* in ancient literature right from Vedic periods, no authentic work of *Vṛdha Garga* has been found. Also, authors of later period have pointed out the RSB cannot possibly be a recent event but must refer to an ancient epoch (5). It is also clear that, as per our present conservative opinion, the Indo European people would be in Central Asia around 6th millennium BC. They were nomadic in habitat and would not have been sensitive to night sky to the extent where they would notice an event like RSB. However, the Harappan people would have been capable of such observations as well as sensitive to noticing changes in astronomical patterns in view of their sea faring habits. We analyse this in detail below.

The current commonly agreed chronology suggests that the period of Vedas is around 1200 BC (3200 BP) and the oldest parts of Ṛg-Veda date back to 3000 BC (5000 BP). It is also now clear that the Vedic people came from Central Asia and gradually assimilated into the Harappan Civilisation, eventually crossing it and going to the Gangatic Planes. The oldest sites associated with the Harappan Civilisation unearthed till today date back to earlier than 6000 BC (8000 BP). Harappan people are known to have a settled life as inferred from the site of Mehergarh (19, 20). Also, it seems that the Harappan Civilisation had no tradition of large scale written manuscripts (16). Since the civilisation itself was highly evolved, it must have had a huge storehouse of knowledge which must have been passed on by a strong oral tradition.

The Indus Valley Civilisation grew around the *Sarasvati* and Indus rivers and had strong sea faring traditions. Hence they must have been sensitive to

astronomy as well as sea level changes (which can also produce river level changes upstream), especially for ports and other facilities that are typically built less than 1 to 10 meters above sea level. It is apparent that Indus Valley Civilisation would have been sensitive to the movement of the Seas and that the Vedic and late Vedic period would certainly have known about the accumulated knowledge of the Harappan Civilisation.

Geological upheaval in the form of the rise of sea levels is known through the studies of sea levels. It is probably not a coincidence that the great rise in sea levels occurred in the 10^{th} to 6^{th} millennium BC. It is obvious that the pre-historic man must have made this observation in different parts of the world. Memory of such floods is preserved in different cultures (19). The legend of Noah's arc in the Judaic Tradition and similar Vedic tradition like reference to *Manu* and *prayala* might be quoted as an example.

The region of the Indus valley also lies on one of the most seismically active regions and has been hit by several major earthquakes (17). It forms the region where the Indian tectonic plate meets the Asian plate and hence this region has been seismically very active from ancient times. However, there are few reliable data in Archeo-seismology to confirm whether major earthquakes occurred in 5284 BC or thereafter around the Indus-Saraswati river region. We therefore mention this as a possible catastrophic event that could have been precipitated due to heavy flooding and in the absence of any firm data; we do not pursue it further here.

The initial literature of the Ṛg-Vedic (Indo Iranian) people clearly makes no mention of the Harappan people and their interactions even though there is strong evidence that such interactions must have occurred before the Vedic literature was formally codified. It therefore seems that the non Indo-European knowledge was consciously not codified in the Vedic literature and was continuously passed on by oral traditions only. An evidence of this attitude is that even knowledge of large cities of Harappan Civilisation that the Vedic people must have known, is not mentioned in the ancient Vedic literature. In this vain, it seems that other information such RSB were also not recorded in the Vedic Literature. Hence events like RSB which were not of Indo-European in origin but of Harappan origin would not have been noted until much later, probably in literature now lost, from which *Varāhmihira* made his noting in 6^{th} century AD in *Brihat-Saṁhitā* (1).

While it is possible to argue that RSB was not a genuine observation but was imagined simply as an astrological omen, other evidence is against such an interpretation for the following reasons. *Varāhmihira's* work itself does not claim to have observed the event but claims to reproduce the earlier reference to *Vṛdha Garga*. While there are several references to *Vṛdha Garga* in ancient literature, no specific document authored by him has been found indicating that his work seems to have been lost. Also, the omen of *RSB* is said to bring overall destruction ('*pralaya*') and is clearly not something an astrologer would create to scare a king or a common man. It does not say, for example, that if *RSB* occurs, people born under some specific sign should be careful or that a particular God will get upset or that the King should beware of

some type of a person: the kind of forecasts of greater utility to Astrologers. Prediction of a general catastrophic disaster is of no value to an astrologer. It is clear that even those who have reproduced the noting on *RSB* knew that is cannot be an observed event of the present epoch and could only refer to observations of an earlier epoch. This re-enforces the point that *the RSB could not have been conjectured for astrological reasons as it had no usable astrological connection*.

We propose that the confusion of either Mars or Saturn causing the RSB is primarily due to the oral transfer of knowledge and the fact that both Mars and Saturn have similar apparent magnitude (~ $\pm$1) as visible from earth and hence can be confused by all but the most careful observer. So the confusion of Mars and Saturn indicates the incompleteness in orally transmitted information rather than a random astrological signing. (Some later reproduction of RSB have attempted to make the plausible by including comets as possible sources of RSB). This confusion is in fact indicative of confused reporting of a genuine event rather than an arbitrary creation of an omen, which would be far more precise.

We feel that in view of the rarity of the event of RSB, it is impossible that the event must have been added *post facto* into any document at a much later date since it is nearly impossible to guess the occurrence of RSB. Hence the original reference to RSB must have been introduced by *direct* observations which should allow dating of the period of serious scientific observations. From purely astronomical arguments, the RSB is an extremely rare event due to very slow nodal regression of Mars and Saturn and the requirement of co-alignment with an observer from Earth. Even if post 6th millennium observers may have been able to decipher this, extrapolation from this to RSB would be an intellectual jump of great magnitude and could not have been used by any dishonest author wishing to make the document appear older than its actual date. There would be much easier “predictions” that could be added *post facto* by a dishonest author.

Similarly, the observers must have noticed the sea levels also, since they too are impossible to guess and add *post facto*. This is obvious since the Harrapans had spread themselves in the Sarasvati valley and travelled extensively down the river (19). A rise in sea level necessarily reduces the water flow from Sarasvati to the Arabian Sea increasing the general water level of river. A dramatic rise in sea level can cause gigantic flooding when a sudden rise in sea level blocks the drainage of river into the sea and the situation can be further accentuated by gigantic downpours in the upstream region and possibly precipitate into major earthquake in a vulnerable regions. Hence the Harappans must have made observations regarding the fluctuations in the sea levels, possibly first in Kutch area. As these two extraordinary natural phenomena of RSB and sea level rises have occurred simultaneously *twice* in tenth and sixth millennium BC, the Harappans, must have associated the two as law in Nature.

6 Conclusions

We feel that the present work strongly indicates that the tradition of making and recording intricate astronomical events in the Harappan Culture was very strong in 6th millennium BC and probably as early as 10th millennium BC and that the memory of such reports were available several centuries later.

However, since the knowledge was not Indo-European in origin, it was not codified in the Vedas even though the Vedic scholars would have learnt about this from their Harappan counterparts. This information was kept in the oral tradition and astronomers in 7th Century and 15th Century AD who referred to this work and even tried to work out its possible repetition must have been very impressed by the references to RSB in the ancient documents that have since been lost. Hence the very mention of RSB and its re-evaluation over several centuries indicates the emphasis and importance associated with astronomical events in the Indian literature several millenniums ago.

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