Records of supernovae from India

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Extensive searches for possible records of supernovae have been carried out by earlier researchers in astronomical texts from India. A study of the inscriptions has shown that they have documented many celestial events like eclipses, solstices and conjunctions. This study has identified possible metaphorical records of the historic supernova sightings in inscriptions. We have identified two cases of metaphors for the description of supernovae of 1054 CE and 1604 CE. A reference in an astrolabe has been found, where a name has been coined for the new star. It has been identified with another fainter star in a recent study. A 16th century Sanskrit text on figures of speech aptly describes the supernova of 1572 CE.

Supernova is an event associated with the death of a massive star. The explosive event with release of about 10^{50} ergs/s energy makes it appear as a very bright 'new' star in the sky. The adjective 'new' refers to the brightness itself, since the star starts glowing with brilliancy comparable to that of Venus in a region where hitherto no star was seen by the naked eye. The supernova event generates a lot of interest. Several debates among astronomers have been documentted as seen from the historical records of the events of 1572 CE (Tycho's nova) and 1604 CE (Kepler's nova). The appearance of the 1604 supernova as a very bright object at dusk would have been a spectacular sight since the planets Jupiter, Saturn and Mars formed a small group with this bright star (Figure 1).

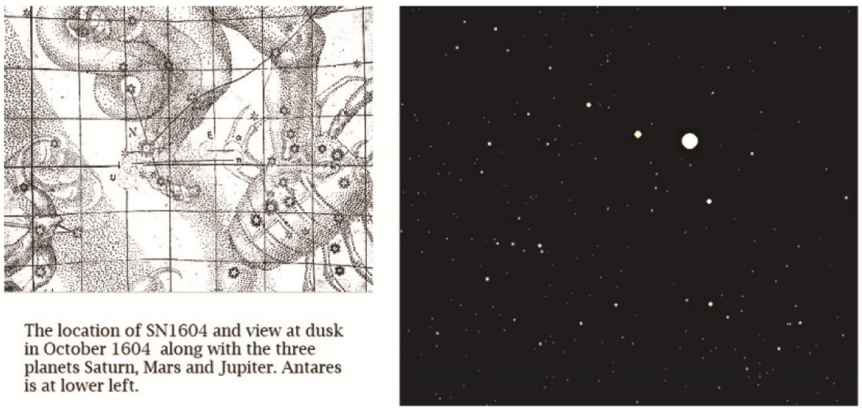
The identification of Crab nebula with the supernova event of 1054 CE from the records of China marks a turning point in the understanding of the physics of supernovae. Since then, the search for such records in all civilizations has yielded some important results. The absence of such records from India is rather conspicuous. Extensive search in texts has been carried out in recent years, in vain[1,2]. Here we have searched an unusual source of records of celestial events – stone inscriptions, astrolabes and texts on grammar.

Stone inscriptions

The inscriptions on stone are seen all over the country. These are edicts or records of grants released to scholars and temples. There are also stones erected in the memory of war heroes, self-immolation by sun worshippers or wives of war heroes. Usually, these grants and records are engraved on the occasion of eclipses and similar events. The records are written by commoners (not necessarily professional astronomers), and details of the time are recorded meticulously[3]. The information available about the year is in the form of *śaka* number, or the *kali* year count along with the name of the *samvatsara*. This is the 60-year cycle with names as *Prabhava*, *Vibhava*, and so on, and is currently being used. There are two types of *śaka* number, *śālivahanaśaka* (which is also the system used for the national calendar) with epoch 78 CE, and *Vikramsamvat* with epoch 58 BCE. Generally, the number count of years after coronation of a King along with the name of the *samvatsara* (60-year cycle) is provided; this helps in fixing the year. The numbers are provided either in the *bhūtasamkhya* system or *katapayādi* system. The former in which specific objects are used to denote the numbers, is popular. For example, *śaka* 1234 is written as *vēda* (four) *agni* (three) *cakṣu* (two) and moon (one). The reading is from right to left.

The lunar or solar month is specified along with the *thithi*, the phase of the moon. The name of the star defining the position of the moon is specified so that the day count can be established. Every year has one or two records of eclipses, which help in fixing the date[3]. The planetary positions also are provided in some cases. The planets here imply the sun, moon and nodes of the orbit of the moon. A total eclipse can be expected to have been recorded in a good number of places in and around the path of totality. Such records with specific mention of totality or annularity have been utilized to fix the variation of ΔT (the small difference between a uniform clock and the measure from earth's rotation) over centuries[4].

While all these details help us in fixing the date, generally a remark on the position of a star specifically is not noticed. In the case of a Sanskrit inscription from Angkor Wat in Thailand, the word *Kētu* created confusion[5]. This word is used for the descending node as well as for a comet. It was possible to assign this to a possible pre-planetary nebula event[6].



The location of SN1604 and view at dusk in October 1604 along with the three planets Saturn, Mars and Jupiter. Antares is at lower left.

Figure 1. Planetary positions at the time of discovery of the supernova by Kepler in 1604.

The 1054 event

There are many Sanskrit inscriptions in Cambodia. Direct translations to English are available for Sanskrit verses[7]; those in Khmer language have not yet been decoded completely. Most of the inscriptions provide complete details of the positions of the sun, moon (with phase), planets, nodes and even the ascendant (*lagna*). Therefore, time of event can be fixed precisely. The planetary positions are verifiable and agree within a few degrees with those from modern software.

The inscription of interest (number 153, p. 382) is from a small village called Phum Da in Kampong Cham Province, written partly in Sanskrit and partly in Khmer. The Sanskrit part consists of nine verses mostly in praise of Lord Shiva. Only the *śaka* year is mentioned in the *bhūtasankhya* system as *ṣat* (6) *nāga* (7) *randhra* (9). The inscription is about the installation of the *lingam* for worship by a *yogin* named *Jnyānapriya*. The phrases praising Lord Shiva include an adjective '*śukratārāprabhāvāya*' which means 'one who creates a star as bright as Venus'. The date *śaka* 976 is equivalent of 1054 CE. Therefore, this phrase can mean the sighting of a star as bright as Venus, in other words, the supernova[8].

The Khmer language part gives details of the grant for land, tanks and arrangements for worship within the domain of the temple. It should be interesting to read and check if any other adjective is included therein.

The 1604 event

A stone inscription from the *ēnūru* (*Vēnūru*) in Dakshina Kannada district of Karnataka, describes the consecration of the statue of *Jina* named *Bhujabalin*. It is a Sanskrit verse written in Kannada script. The verse has been translated by epigraphers as follows[9]:

> 'After the *śaka* years (measured by the objects) senses (5), eyes (2), arrows (5) and moon (1), has passed, while the cyclic *śōbhakrit* was current, in the month of *Phālguṇa*, on the brilliant (?) tenth thithi of the bright fortnight, in (the nakṣatra) *Puṣyaka* (combined with) Thursday in the auspicious lagna *Mithuna* – at the divine order of the sage *Cārukirthi*, the sun of the firmament of the *Dēśigaṇa* (and) the moon in milk-ocean of the pontificate of the town named Belagola – he, who was named Timmarāja, the ornament of the family of Cāmuṇḍā, the son in law of the glorious, Rāyakuvara, the victorious son of his sister, the great queen named Pāṇḍyaka, the younger brother of prince Pāṇḍya, consecrated and set up the Jina named Bhujabalin, at the town of Enūru.'

This clearly gives the date as *śaka* 1525 and the name of *samvatsara* as *śōbhakrit*, the 37th in the list of 60. Epigraphists have dated this as corresponding to 1603 CE. We will now use other inscriptions to find the exact date. A *samvatsra* commences on the day after new moon around the vernal equinox and concludes on the same new moon the next year; *śōbhakrit* is the 37th in the list.

The inscription number EKU Vol. V Part I, no. 345 gives *śaka* 1524 *śubhakritmāghabaśivaratri* – equivalent to 23 February 1603. The inscription EKU Vol. III Appendix no. 87 gives *śaka* 1526 *Krōdhi Puṣyaba* 3 as Makara Sankranti – equivalent to 28 December 1604.

It may be seen that there is disagreement in the conversion of *śaka* to CE. Some inscriptions mention the current *śaka* year and some the past year. Since we have to accommodate *śōbhakritu* (37) between the above two, we can consider that *śubhakrit* (36) was current between April 1602 and March 1603, and *Krodhi* (38) from April 1605 to March 1606.

Therefore, we can take the duration of *śōbhakrit* extending from April 1604 CE to March 1605 CE. Thus the date of the inscription under study can be fixed as 17 March 1605. Here we need to look at some adjectives that have been used for saint *Cārukirthi* – he is compared to the moon in milk-ocean of the pontificate of the town named Belagola. The word used for the moon is '*nishāpathi*', meaning the lord of the night. This word has another meaning – camphor. Milk-ocean is the translation for *kṣeerāmbudhi*. This is also the word for Milky Way galaxy. Therefore the intended meaning may be 'bright like a burning camphor in the Milky Way', which aptly describes a bright star in the Milky Way (in Sagittarius).

The 1572 event

We now need to find if the word *kṣeerāmbudhi* specifies the Milky Way. This question arises because Ramayana of Valmiki refers to it as *surapatha* (*Ayōdhyākanda* 2.80-13,14) and *nakṣtrapatha* (*Aranyakānda*, 3-43-22, 23a); Kalidāsa refers to it as *cāyapatha* (*Raghuvamśa*, 13-2). A contemporary text on figures of speech not only uses the word but also gives an excellent description of the supernova.

Kuvalayānanda is a widely used text for understanding figures of speech in Sanskrit. It was composed in the 16th century by Appayya Dikshita (1520–1593), a well-known philosopher[10]. The text describes 50 types of *alankāras* (figures of speech). In the context of explaining *apahnyutalankāra* Dikshita gives the following two examples. *Apahnuti* means denial or concealment. This simile denies the character of the object being described (*upamēya*). There are six subgroups in this variety. For the first variety called *śuddhāpahnutih*, he describes the example 'What is this lotus in the sky in the *vyōmagangā*? Not the moon' (verse no 24). Here the object is being denied the virtue of being the moon (because it is in the Milky Way). Hence it is chosen as the example. Here we encounter the word *vyōmagangā*, or *ākaśgangā* – currently in usage for the Milky Way. Dikshita continues with the example for the second variety *hētvaphnutih* – the denial being supported by a reason or cause. 'The object seen is not the moon because it is hot, not the sun because it is night, it looks like a *badabāgni* rising from the interior of the ocean' (verse no. 25).

The example chosen was an object in the sky with brilliance more than that of the moon and like fire. It was seen in that part of the Milky Way where the moon is generally not visible. The stretch of the Milky Way extends to Cassiopeia, where the supernova was seen in 1572. Thus these verses are actually describing the supernova itself.

The astrolabes

The exhaustive work on astrolabes from all over the world by S. R. Sarma has become an authentic source on them[11]. The position of a star as noted by an astronomer who constructed an astrolabe in 1605 is of interest here. The star has been designated as *Dhanuḥśira* (the head of Sagittarius). It is quite common to see the names coined for the purpose of

engraving on astrolabes. The extensive catalogue prepared by Sarma on astrolabes has been of help in decoding the evolution of astrolabes and star names. Many names are literal translations of the Persian/Arabic names. In the process of translation, synonymous terms appear in catalogues prepared by different individuals at different times[12,13]. For example, α Peg has been translated as *Turagāmśa* and *Hayāmśa*, this will be easily understood without any ambiguity since *Turaga* and *Haya* both mean a horse.

The earliest Sanskrit astrolabe (C001 in the catalogue) is of interest to us. It was prepared in Ahmedabad by *Candidāsa* for his son *Dāmōdara*, and is dated 25 December 1605, according to the inscription on the instrument itself. It refers to the Mughal Emperor as Salim Shah. The star pointer dial (called *nakṣatracancu*) has a star by name *Dhanuḥśira* to the south of *Dhanukoti*, α Oph (the brightest star in the constellation of Ophiucus, named Ras Alhague). While the latter is found almost all astrolabes, a counterpart of *Dhanuḥśira* has not been found in any other astrolabe (Sarma, pers. commun.). The position on the dial fixes it at almost the same location where the supernova was seen. The reconstructed light curve of the supernova indicates that it was visible for almost a year or so[14]. Therefore, when the astrolabe was constructed the supernova was identified as a regular star and marked. The identification in the catalogue (done in recent years by David Pingree, according to Sarma, pers. commun.) puts it as μ Sgr. Further, a corresponding correction for its name is suggested as *Dhanuḥśarāgra* (tip of the arrow of Sagittarius). μ Sgr is too faint a star to be included into an astrolabe and does not find a place in any astrolabe. It is a multiple star system with the brightest component at fourth magnitude.

This clearly indicates that the supernova was indeed observed and recorded at its decline, as it appeared at the time of preparation of the astrolabe. Figure 2 shows a chart with the stars marked and it is clear that the intended star was not μ Sgr.

The exhaustive catalogue of Sarma also lists a number of astrolabes prepared during 1572–1604. The prefix A in the catalogue number refers to the productions of the Lahore family. The father, son and grandson were active for almost 75 years from about 1570 CE. Prefix C in the catalogue number refers to the Sanskrit astrolabes. Almost all from the Lahore school list β Cas. One of the earliest, numbered A 013, has the northern stars of Ursa Major listed but not β Cas. The name for β Cas is given as *Krittitakāra* in Sanskrit astrolabes. However, the Sanskrit astrolabe numbered C021 gives the name *Ramjitkāra*. The same name appears in the large astrolabe in the observatory campus of Jantar Mantar in Jaipur. C001 mentioned above in the context of SN 1604 does not list β Cas. The catalogue further lists Sanskrit astrolabes separately. Among them, only four list β Cas. Astrolabes prepared by the Lahore school and others like *Hāmīd* and *Jamāl Uddin* after the 18th century do not have β Cas marked on the rete. This shows that the choice of β Cas for the rete was arbitrary.

No. A017 prepared by Muḥammad Muqin lists another star along with β Cas. It is named Al-Farās Nathra, whose identity is not known. This assumes importance since β Cas was quite close to SN 1572 and generally (see Figure 3), astrolabes designed for a small number of bright stars do not include β Cas on the rete. This gives scope for speculation – whether the intended star was the supernova and arbitrariness in the choice may be due to the fact that it was included by those who had seen it. This can be confirmed only by measuring the exact position indicated by the pointer on the rete of A 017. A small difference of about 5° can be read out with the altitude and azimuth circles provided. Since the astrolabes have dates engraved on them, it can be verified if β Cas has different coordinates around 1572 and in later

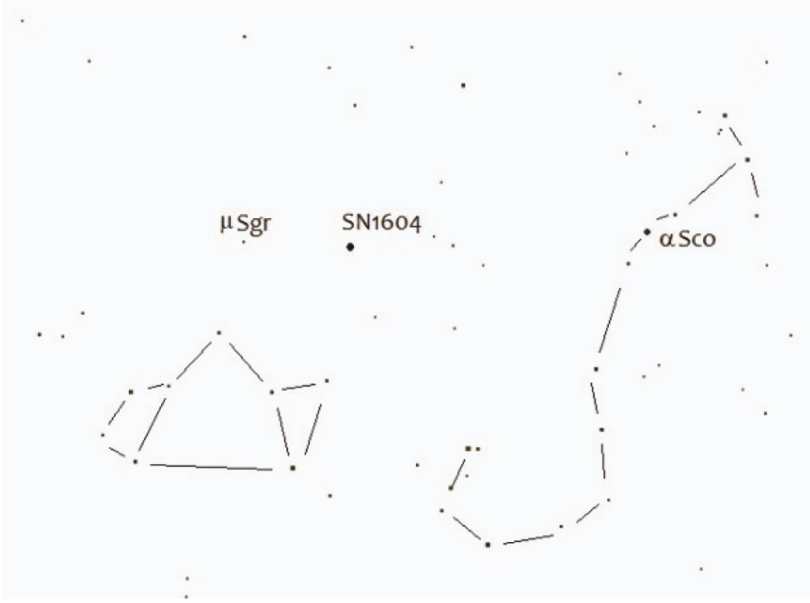


Figure 2. Star chart indicating the location of μ Sgr and the supernova of 1604; brightness of magnitude 2 corresponds to the declining phase after about 150 days.

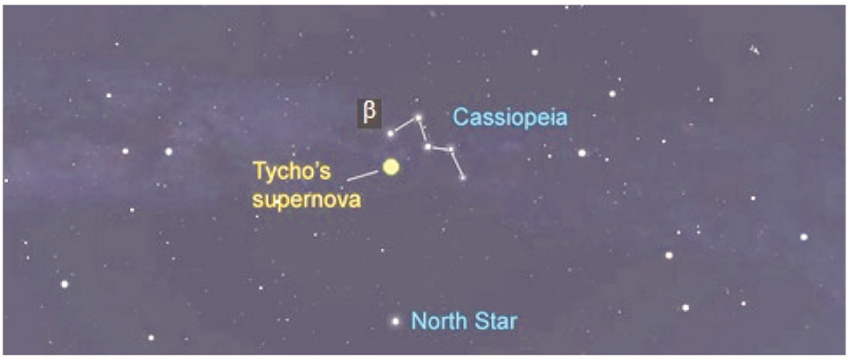


Figure 3. The chart for SN 1572; notice the proximity to β Cas.

years. The names are not clearly legible and the coordinates cannot be read out from photographs. A physical verification would help verify these aspects. Similarly, the 1604 star also would be represented perhaps by an extra pointer (with or without a name), which can be verified by physical examination only.

Conclusion

The metaphors used to describe God and a sage in stone inscriptions can be interpreted as records of supernova events of 1054 CE and 1604 CE. The former event has been recorded in Phum Da, Cambodia, while the latter is in Venūru, Karnataka. The declining phase of SN 1604 has been identified and given a new name in a Sanskrit astrolabe made in Ahmedabad in 1605. Not being able to relate it to any bright star during a study in recent years, it has been mis-identified and catalogued as μ Sgr, a fainter star in the vicinity. The sighting of SN 1572 has been used as an example for metaphors in a Sanskrit text of the 16th century. A possibility of its record on astrolabes around that period is suggested.

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