Observational records of stars in Indian texts – III (Gemini)

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In continuation of the compilation of all bright stars in various texts based on the listed coordinates, we present here the coordinates of the stars in the region of Gemini. Using the 27 nakṣatras on the ecliptic, the coordinates were matched for the epochs of the catalogues to resolve possible ambiguity in the identification of faint stars. In an attempt to cover the stars beyond the zodiac, conversions of coordinates are very useful. Those lists which hint at the actual observational data are chosen for the study. Although the region specified is Gemini, it covers all Declinations within the Right Ascension 4 hours to 6 hours.

Standardizing the coordinate system

Coordinates of stars in all texts of Indian astronomy are expressed in *Dhruvaka* and *Vikṣepa*, which are different from those currently in use. The definition of this system and conversion into the conventional Right Ascension and Declination system have been explained earlier[1–3]. The stars have been listed in the catalogues in order of increasing Right Ascension and stars of all Declinations are included under the name of the relevant zodiacal constellation. Here, we discuss stars grouped under Gemini. The conversions of the coordinates are essential to compare the coordinates as derived from the current ephemeris. The ambiguity in the identification of stars arises because the east west coordinates are influenced by the shift of the reference point, the *First Point of Aries*, owing to precession of earth's axis of rotation, as has been pointed out earlier.

We examined earlier[1], the identifications of 27 stars named *Yogatāras* (*junction stars*) with the ones that are conventionally known to us now. The sources for star names are taken from refs 4–11.

We considered earlier[2], the stars classified under Aries and Taurus. In this paper, stars with all Declinations within the range of Right Ascension 4 to 6 hours are included. The texts by Nityānanda, Padmanābha and Malayendu Sūri provide direct reliable measurements, rendering comparisons easy. Malayendu lists another quantity named *Paramonnatāṃśa* which is the maximum altitude (at meridian transit). The recent catalogue[11] has served as a new source as almost every astrolabe has a list of stars. The catalogue provides Persian names and Sanskrit names and identifications as provided by Pingree. The astrolabes have a rotatable dial called rete which has markers for several bright stars. This serves as a calibration for fixing the coordinates based on measurements of altitude, azimuth and local time,

The commentary by Malayendu provides both the declination and maximum altitude; the Declination is given accurate to degrees, minutes and seconds. There is a small difference in the values of Declinations derived directly from the maximum altitude. As has been noted earlier, it can be a instrumental error or a correction applied uniformly. We can infer that they are calculated and/or corrected. Thus, the measured quantities are only *vikṣepa* and *paramonnatāmśa* (given values terminate with degrees and minutes).

We have discussed the brightness scale provided by Nityānanda as a scale which is referred to as *pramāṇa,* which is equivalent of the magnitude scale used today. The first *pramāṇa corresponds* to the brightest; the terms *dvimiti*, *trimiti* and *caturtha pramāṇa* correspond to decreasing brightness[1]. This value of the magnitude helps us to confirm the identification.

Discussion

The present study includes 23 stars and is the largest number within a single group of Right Ascension (Table 1). All the different names provided in the different lists are included in the Table. The translation of the names as provided in the astrolabes is included. We find such names in the list of Malayendu under the column head *Fārasika nāma*. As the manuals were for the use of astrolabes (originally from Arabs), all the stars on the rete do not have local (Sanskrit) names.

Brahmahṛdaya is a name found in all versions of *Sūryasiddhānta*; it has been identified as Capella (α Aur). Quite interestingly, this does not find a place in the sources mentioned above. A recent work by Ratnasree *et al.*[12], to measure the coordinates of the stars of two astrolabes (same as D011 and D012 catalogue of Sarma[11]) identify this as β Aur. They projected the star pointer of astrolabes on to a star field for an epoch of 1750 CE for measuring the accuracy of positions. However, as we see later the coordinates of this star match with yet another star. Chandraśekhara Sāmanta identifies it with α Aur. Nityānanda gives the values for the star called *skanda as*: *Satryaṃśarūpeṇa* (*1*|*20*) *tathādyamānaḥ skando vipādatriyamaiḥ* (*22*|*45*).

The coordinates given here correspond to 61|20 and 22|45 respectively. (It is to be noted that the *Dhruvakas* are represented starting from zero for every zodiacal constellation; thus we have to add 30 degrees per constellation. Thus all the *Dhruvaka* values have to be added to 60 as Gemini is the third zodiacal constellation. Thus 1/20 becomes 61/20). These coordinates exactly match with those of 'α Aur'. Thus we see that there is a confusion on the name of the man identified with Auriga (*Skanda* or *Brahma*).

Prajāpati and *Lubdhaka* have been discussed in the earlier papers.

Mithuna-dakṣiṇa-pāda is the name given to β Aur. Pingree identifies it based on the text of Mahendra Sūri. The commentary by Malayendu gives the correct coordinates. The coordinates from the astrolabe of Diya–Al–Din Mohammad dated 1663–64 also identify this name with β Aur.

There is no ambiguity with Mithunapāda identified with ζ Tau.

The star named *Mithuna-vāmaskandha* has been identified as κ Ori by Pingree; The name agrees with the translation from the Arabic name, *Yad al Jawza al*

Table 1. Identification of stars from the catalogue of Nityānanda and comparison with others

Star	Text	*Dhruvaka*	*Vikṣepa* (North = N, South = S)	Magnitude	Maximum altitude	Identification/remarks
Brahmahrdaya/ ब्रह्महृदयम्	SS	52	30 N			α Aurigae (Capella)
	SD	56	23 N			All texts and commentaries of SS, SD gives the size as 16″
Prajāpati/प्रजापतिः	SD	57	38 N			δ Aur? (see the text for discussion) No bright star matches the coordinates
Mithunadaksina-pāda/ मिथुनदक्षिणपादः	CYR	68|43|52	31|30 S		52|4	β Orionis (Rigel)
	A1	70				Rijl al-Jawzā' al-Kubrā
Mithuna-pāda-dakṣiṇa/ मिथुनपाददक्षिणः	YR	68|43	31|30 S			
Mithunapāda/मिथ्नपादः	CYR	56|0	1|18 S	**1**		ζ Tau (Tiānguān)
Mithunavāma-skandha/ मिथुनवामस्कन्धः	CYR	72|53/52	17|30 S		66|28	*k* Orionis is a better match. Yad al-Jawzā'al-Yusrā*
Vāmaskandha/वामस्कन्धः	YR	72|53	17|30 S			Identified as γ Orionis by Pingree
Ilvala/इल्वलः	SD	61	23|30 S			Three stars in the belt of Orion
Nṛyugaṃsaka/नृय्गांसकः	SR	60|10	17|15 N	**2**		γ Ori (Bellatrix)
Skanda/स्कन्दः	SR	61|20	22|45 N	**1**		α Aur (Capella)
Ṣaṇmukha/षण्म्खः	CYR	73|53|52	22|30 N		73|51	
Ṣaḍāsya/षडास्यः	YR	73|53	22|30 N			
Ambuvatsa/अम्ब्वत्सः	SR	61|50	5|20 N	**2**		β Tau (El-Nath)
Mithunamadhya/मिथ्नमध्यम्	SR	62|45	24|33 S	**2**		ε Ori (Al-nilam)
Varuṇa-bandhu/वरुणबन्धुः	YK	58	25 S			
Nṛhasta/नृहस्तः	SR	67|50	16|45 S	**1**		θ Ori
Mānuṣahasta/मान्षहस्तः	CYR	80|53|52	17|0 S		63|31	
Mṛgaśirā/मृगशिरा	SR	63|7|30	13|30 S	**3**		λ Ori (Meissa)
	SS	63	10 S			
	YK	62|2	10|9 S			
Saurokta-Rudra/सौरोक्तरुद्रः	YK	73|52	9|3 S			α Ori (Auriga)
Dhruva/ध्रुवः	SR	66|55	66|30 N	**3**		Polaris
Narāṃsa/नरांसः	SR	70|30	21|30 N	**2**		β Aur (Menkalinan)
Lubdhaka/लुब्धकः	SR	83	39|30 S	**1**		α CMa (Sirius)
	CYR	95|33|52	39|10 S		45|39	
	SS	70	40 S			
	YK	82|3	39|57 S			
Bhallūkapṛṣṭha/भल्लूकपृष्ठः	SR	86|30	49|24 N	**3**		β UMi (Kochab)
Agastya/अगस्त्यः	SR	89	75 S	**1**		α Car (Canopus)
	CYR	96|4|52	75 S		9|53	
	SS	90	75 S			

(*Contd*)

Table 1. (*Contd*)

Star	Text	*Dhruvaka*	*Vikṣepa* (North = N, South = S)	Magnitude	Maximum altitude	Identification/remarks
Ārdrā/आर्द्रा	SR	78|07	7|12 S	**3**		γ Gem (Alhena)
	YR	96|33	39|10 S			
	SS	67|20	9 S			
	YK	65|55	11|6 S			
Punarvasu/पुनर्वसुः	SR	92|30	6 N	**2**		β Gem (Pollux)
	SS	93	6 N			
	YK	93|38	5|57 N			
Prathama-bāla-śīrṣa/ प्रथमबालशीषः	CYR	102|13|52	8|40 N		86|38	α Gem (Castor)
Yāmyavasu/याम्यवस्ः	YK	95	16|20 S			α CMi (Procyon)
Lubdhaka-bandhu/ल्ब्धकबन्धुः	SR	95	19|10 S	**1**		
Vyādhānuja/व्याधान्जः	YR/CYR	108|43|52	19|10 S		66|36	

*Rijl al-jawzā' al-Yumnā κ Orionis.
SR, *Siddhāntarāja*/*Sarvasiddhāntarāj* of Nityānanda; YR, *Yantrarāja* by Mahendasūri (identifications by Pingree), SS, *Sūryasiddhānta*; CYR, Commenty on YR by Malayendu; YK,- *Yantrakiraṇāvali* by Padmanābha; SD, *Siddhāntadarpaṇa* by Sāmanta Candraśekhara; A1, Astrolabe by Diya-Al-Din Muhammad.

Yusra which translates as the left hand of *al Jawza*. Some astrolabes list it as *Yad al Jawza Yamani* implying the right foot. This right-left reversal (in naming the stars) has been observed for the human figures like Perseus and Orion[11].

Chandrśekhara Sāmanta lists a lesser known star called *Ilvala*. The coordinates exactly correspond to the belt of Orion. This is a new name not seen in any other source cited above. However, Sanskrit dictionaries like *Amarakoṣa* give this name that of a star also. (Otherwise it is the name of a demon.)

The name *Nṛyugāṃsaka* also is a new name not cited in any source other than *Siddhāntarāja*. The literal meaning of this is *the two shoulders of a man* or *shoulders of two men*. The coordinates given are 60|10 and 17|15 respectively and it well agrees with γ Ori.

Auriga is one of the brightest constellations; α Aur, Capella was identified as *Brahmahṛdaya* as mentioned earlier. However, in these sources we find the names *Skanda*, *Ṣaṇmukha* and *Ṣaḍāsya*. All the three names refer to a deity who has six faces.

The list provided by Pingree gives the names *Brahmahṛdaya* and *Ṣaḍāsya* two different stars. As the coordinates point to the same star, it has to be verified if there was a change in the name over the years. *Skanda* is identified as a God with six faces.

The star β Tau is grouped into this Right Ascension zone according to its coordinates. It is called *Ambuvatsa*. Its meaning as 'child of water' can mean, lotus flower or a pearl. It does not agree with the Arabic name El-Nath which means the horn of a bull. Therefore, the name is not a translated one and its origin needs to be explored.

ε Eri can be identified with *Mithunamadhya* without any ambiguity; Malayendu gives its name as *Varuṇa-bandhu*, (relative of *Varuṇa*, the rain God). This name is not well known. It does not agree with any Arabic name.

θ Ori is identified as the hand of the character corresponding to Orion. It is called *Mānuṣahasta* by Malayendu and *Nṛhasta* by Nityānanda – it may be seen that both meanings (hand of a man) are the same. Its magnitude as 1 agrees with the brightness.

All the texts identify Mṛgaśīrṣa with λ Ori (ref. 1) although there is a small difference in the declination.

There is a star in Padmanābha's list named *Saurokta-Rudra* which literally means *Rudra* as mentioned in *Sūryasiddhānta*. The coordinates match with α Ori. This is a very bright red star and it is puzzling that none of the other sources lists this. As the specific citation from *Sūryasiddhānta* is made, we wonder whether the intended star '*Rudra*' mentioned in *Sūryasiddhānta* is *Ārdrā,* as *Rudra* is the presiding deity for the star *Ārdrā* as per the vedic literature. But, we have identified *Ārdrā* with γ Gem[1]. This is leading to confusion, on whether *Ārdrā* and *Saurokta-Rudra* are same or different.

The pole star *Dhruva* is included in this zodiacal sign. Its listed coordinate 66°55′ gets converted to 4 h 20 m after precession correction (as per the epoch of the text mentioned therein; ref. 1). The declination is 88°29′.

β Aur is identified with *Narāṃsa* with no ambiguity. The literal meaning of the term *aṃsa* is shoulder. The man depicted is Auriga from the original Arabic name *Menkalinan*, which means shoulder of the rein holder.

Bhallūkapṛṣṭha (the back of a bear) is the next star and is easily identifiable with Kochab, β UMi with the coordinates. The origin of the word needs to be explored because the position does not coincide with the back of Big Bear or the Small Bear.

Nityānanda's list ends with *Agastya*; he puts the next three stars, now identified as β Gem, α Gem and α CMi in to Cancer. But, we have included them in

this list itself. α Gem is named as *Prathama-bālaśīrṣa* which literally translates as the 'head of the first boy'.

Conclusions

We have identified the stars in the group identified with Gemini from *Siddhāntarāja*/*Sarvasiddhāntarāja* by Nityānanda which provides coordinates of stars based on observations. We have also included stars from other sources like the manuals for astrolabes. Some new star names have been identified for the first time. These names include *Varuṇa-bandhu*, *Lubdhaka-bandhu*, *Bhallūka-pṛṣṭha*, *Narāṃsa*, *Ambuvatsa*, and many more. There seems to be a confusion regarding the stars such *saurokta-Rudra* and *Ārdrā*. Likewise the name *Skanda* has been used for Orion as well as Auriga. Names like foot of a man or hand of a man also are confused between Orion, Auriga and Gemini. The star names *Varuṇa-bandhu, Lubdhaka-bandhu, Ambuvatsa* and *Ilvala* are of Indian origin.

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