A Descriptive Catalogue

of Indian

Astronomical Instruments

Sreeramula Rajeswara Sarma

Supplement

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PREFACE

In May 2023, David Sulzberger of London drew my attention to a fabulous astrolabe fabricated by Qā'im Muḥammad and Muḥammad Muqīm of Lahore in 1612; a few days later he sent me a full set of images of this massive astrolabe which measures 295 mm in diameter 295 and 398 mm in height.

While several specimens are extant of astrolabes made separately by Qā'im Muḥammad (between 1621 and 1636) and his younger brother Muḥammad Muqīm (between 1621 and 1660), just two specimens are known of astrolabes jointly produced by these two brothers. These are the astrolabe A017 which was in Baghdad and carried the names of Qā'im Muḥammad and Muḥammad Muqīm, but no date. The astrolabe A009 in the Kestner Museum at Hannover, Germany, on the other hand, carries an inscription stating that it was made by the two sons of cĪsā, son of Allāhdād in 1609-1610. Since Qā'im Muḥammad and Muḥammad Muqīm are the only persons who are known as the sons of cĪsā, it is assumed that it was made by these two.

But compared to these two specimens, the present astrolabe is very massive and superbly crafted. It also extends the floruit of Qā'im and Muqīm backwards by 7 years from 1621 to 1612. Therefore, I decided to add this unique astrolabe to the Catalogue, together with three other interesting instruments (D065a Sanskrit astrolabe; F032a Indo-Persian Celestial Globe; K005a Sanskrit Horary Quadrant).

In three cases (A054, C019 and D062) I have been able to substantially expand the descriptions with much additional material.

The existing file size of the Catalogue is too large to accommodate any additions or even to replace the entries A054, C019 and D062 with revised versions. Therefore, it was decided to create this Supplement to the Catalogue.

A17A ASTROLABE BY QĀ'IM MUḤAMMAD AND MUḤAMMAD MUQĪM¹ AH 1021 Rabi al-Awwal (= May 1612) Diameter 295, height 398 Sharjah, PC

Unlike A017, also crafted by Qā'im Muḥammad and Muḥammad Muqīm, this astrolabe is much larger and very massive with a diameter of 295 mm and a weight of 8.19 kg – an appropriate one for the Mughal noble Āqā Afẓal, who commissioned it.² He held several important positions under Jahangir and Shahjahan. As the inscription engraved on the front of the *kursī* (Figure A018.9) informs, he was in charge of the administration of Lahore at the time of commissioning this astrolabe.

COMPONENTS

Mater (d. 295, h. 298, t. 10) with shackle and ring, rete for 38 stars, 5 plates, alidade, pin and horse.

FRONT

The mater, the upraised rim and the $kurs\bar{i}$ appear to have been cast as one piece. The $kurs\bar{i}$ is high, the profiles consisting of a series of lobes culminating at the top in a trifoliate finial. The shackle, also of trifoliate shape, is attached to the $kurs\bar{i}$ by means of a rivet. Through this shackle passes the ring. The $kurs\bar{i}$ is solid without any perforations. On the front is engraved a long inscription which mentions that the Moghul noble $\bar{A}q\bar{a}$ Afzal commissioned the astrolabe and carries the date of its completion. On the back of the $kurs\bar{i}$ is a shorter inscription mentioning Qāim Muḥammad and the Muḥammad Muqīm as the makers of the astrolabe.

¹ David Sulzberger (Ahuan Islamic Art, London) drew my attention to this astrolabe; from the owner he obtained the images and the permission to use them. At his instance, Dr Manijeh Bayani-Wolpert, the renowned scholar of Islamic art and epigraphy, transcribed and translated the long inscription engraved on the front of the *Kursī*; she also provided a reference to the biography of the Mughal noble who commissioned the astrolabe. For all these gestures of kindness I am deeply grateful to Mr Sulzberger and to Dr Bayani-Wolpert.

On Āqā Afzal, see *The Maathir-Ul-Umara* by Nawwāb Ṣamṣāmuddaula Shān Nawāz <u>Kh</u>ān and his son ^cAbdul Ḥayy; translated into English by H. Beveridge; revised, annotated and completed by Beni Prasad, vol. 1, The Asiatic Society, Kolkata, 1941; reprinted 2003, pp. 548-550.



Figure A017a.1- Front of the Astrolabe (© photo curtesy the owner)

The rim is divided into 3 degrees of arc and marked in 3s in *Abjad* notation, starting from the south point and proceeding clockwise. Each of these 3° units is divided into 3 parts of 1° each, and each of these 1° units is further subdivided into 3 parts, each of $1/3^{\circ}$.



Figure A017a.2 – Rete (© photo curtesy the owner)

Rete

In the openwork rete, the broad ring of the Tropic of Capricorn at the periphery and the equally broad ring of the ecliptic are held together by a very slender equinoctial bar with counterchanges at its joints with the ecliptic ring both in the west and in the east. There is a large handle a little above the north point at the bottom; the Capricorn index is at the uppermost point of the ecliptic ring.

The ecliptic ring is divided into 12 signs of the zodiac and their names are engraved in elongated letters covering the entire length of the sign. Each sign is divided into 10 parts of 3° each and numbered in 3s. On the sloping edge these units of 3° are further subdivided into 3 parts of 1° each. There are 36 star pointers which are joined by an elegant floral tracery which is almost symmetric on the left and right. Muqīm's favourite motif of tulips with flared petals occurs a few times here. From the available photographs it was rather difficult to decipher some star names.

At a latter point, some Hindu astronomer got the Sanskrit names of the zodiac signs engraved in Devanagari script with much deeper letters (see Figure A018.3 below).



Meşa (Aries); Vışa (Taurus)Mithuna(Gemini); Karka (Cancer)Figure A017a.3 – Sanskrit Names of Zodiac Signs (Detail of Figure A018.2)

In the following table, the stars on the rete are arranged according to their right ascension.

	Table	017a.1	Stars	on	the	Rete
--	-------	--------	-------	----	-----	------

	Star Name	Identification
1	Dhanab al-Qayṭus Janūbī	β Ceti
2	Batn al-Ḥūt	β Andromedae
3	Rijl al-Musalsala	γ Andromedae
4	Fam al-Qayțus	γ Ceti
5	?	
6	Ṣadr al-Qayṭus	π Ceti
7	Rās al-Ghūl	β Persei
8	Al- ^c Ayyūq	α Aurigae
9	^c Ayn al-Thawr	α Tauri
10	?	
11	Rijl al-Jawjā' al-Yusrā	β Orionis
12	Rijl al-Jawjā' al-Yumnā	к Orionis
13	Shi ^c rā Yamānī	α Canis Manoris

	Star Name	Identification
14	Shi ^c rā Shāmī	α Canis Minoris
15	Ṭarfat al-Safina	ρ Puppis
16	Fard al-Shujā	α Hydrae
17	Qā ^c idāt al-Bāṭiya	α Crateris
18	Żahr al-Asad	δ Leonis
19	Al-Ṣarfa	β Leonis
20	Janāḥ al-Ghurāb	γ Corvi
21	Simāq al-A ^c zal	α Virginis
22	Al- ^c Anāq	ξ Ursae Majoris
23	Simāq al-Rāmiḥ	α Bootis
24	°Unuq Hayyah	α Serpentis
25	Rās al-Ḥawwā	α Ophiuchi
26	Nasr Wāqi ^c	α Lyrae
27	Rās al-Jāthī	α Herculi
28	?	
29	Minqār Dajāja	β Cygni
30	Nasr Ṭā'ir	α Aquilae
31	?	
32	Dhanab Dajāja	α Cygni
33	Dhanab al-Jadī	δ Capricorni
34	Mankib al-Faras	β Pegasi
35	Janāḥ al-Faras	γ Pegasi
36	Dhanab al-Qayṭus Shumālī	ι Ceti

PLATES

There are five plates stacked beneath the rete. At the bottom of each plate, there is a small rectangular slit which fits into the lug inside the rim of the mater and makes the plate firm in position.

Lahore astrolabes contain generally a plate one side of which is designed as safthat $m\bar{z}an al^{-c}ankabut$ (plate of ecliptic coordinates) and the other side as saftha al-afaqiya(plate of ecliptic coordinates). In the present astrolabe, however, 2b is designed as the plate of horizons, but no provision is made for the plate of ecliptic coordinates.

Plate faces 1a-b, 2a, 3a-b, 4a-b are calibrated for use at specific terrestrial latitudes. 5a carries double projections for latitudes 39° and 44° and 5b for 35° and 90° . While the rest of the latitude values are marked *Abjad* numerals, latitude 90° is mentioned in words: *^card tis^cīn*. Double projections have certain theoretical value, but not much practical relevance. Qā'im Muḥammad's astrolabes contain several plates with double projections. They are also meant to show off the astrolabe maker's dexterity in engraving such plates (see Figure A018.5).

	-	-
	φ	Longest Day
1a	17;20° [Bijapur]	13;2 hours
1b	49;30° [Bulghār]	16;4 hours
2a	21;40° [Mecca]	13;17 hours
2b	Plate of horizons	
3a	24° [Ajmer]	13;15 hours
3b	35° [Kashmir, i.e., Srinagar]	14;25 hours
4a	31;50° [Lahore]	14;8 hours
4b	48;15° [?]	13;49 hours
5a	$39^{\circ} + 44^{\circ}$ double projection	
5b	$35^{\circ} + 90^{\circ}$ double projection	

Table 017a.2 Plates

On all the sides of the plates, except 2b, altitude circles are drawn for each 1°. Thus 90 circles are drawn, where each 6th line is dotted in order to facilitate counting. These are numbered from 1 to 90 in *Abjad* numerals on both sides of the meridian. When the plates carry 90 altitude circles in this manner, the astrolabe is called *aṣturlāb e tām* (the complete astrolabe). That is why the present astrolabe is referred to in this manner in the inscription on the front of the *kursī*.

In most cases azimuth arcs are drawn for every 6° below the oblique horizon and numbered in 6s on both sides of the meridian. On 1a, these are drawn above and below the oblique horizon, but numbered below. On 1b and 2a they are drawn above the oblique horizon and numbered along the oblique horizon. Lines for both equal hours and unequal hours are drawn on all latitude plates (i.e., those except 2b and 5 a-b) and numbered from the western horizon.

On the plate of horizons four sets of half-horizons are drawn for each 1° from 8° to 66° in four sets. Scales of declination are marked along each radius, for both south and north, and labelled as 3, 6, 9, 12, 15, 18, 21, 24.



Figure A17a.4 – Plate for Lahore at latitude $31;50^{\circ}$ (© photo curtesy the owner)



Figure A017a.5 – Plate with double projection of latitudes 39° + 44° (© photo courtesy the owner)

GEOGRAPHICAL GAZETTEER

In the large astrolabes made by Qāim Muḥammad and by Muḥammad Muqīim the inner side of the mater is completely filled with several annuli of the geographical gazetteer. But in the present astrolabe there are just 2 annuli with empty spaces between them. These carry the names of 94 cities and their longitudes and latitudes; 4 of these names could not be deciphered.



Figure A017a.6 - Geographical Gazetteer (© photo curtesy the owner)

Table A017a.3 Geographical Gazetteer

	Place Name (<i>al-bilād</i>)	L (<i>al-ţūl)</i>	Ф (al- ^c arḍ)
Out	ter Annulus		
1	Madīnat Rasūl	75;20	25;0
2	Makka Mubārak	77;10	21;40
3	Ṭā'īf	77;30	21;20
4	Mahdiyya	42;0	32;30

	Place Name (<i>al-bilād</i>)	L (al-țūl)	Ф (al- ^c arḍ)
5	Iskandarya	61;54	30;58
6	Mişr	68;20	30;20
7	^c Adan	76;0	11;0
8	Bayt al-Maqdis	66;30	31;50
9	Dimashq	70;0	33;15
10	Ba ^c alabak	70;45	33;15
11	<u></u> Halab	72;10	35;50
12	?	85;27	41;50
13	Rās al- ^c Ayn	74;0	36;50
14	Marāgha	82;0	37;20
15	Tabrīz	82;0	38;0
16	Ardabīl	82;30	38;0
17	Saflān	83;30	39;50
18	?	85;0	43;0
19	Bulghār	90;0	49;30
20	Kūfa	79;30	21;50
21	Bagdād	82;0	33;25
22	Başrah	84;0	30;0
23	Fīrūzābād	87;30	28;10

	Place Name (<i>al-bilād</i>)	L (al-ţūl)	Ф (al- ^c arḍ)
24	Shīrāz	88;0	29;36
25	Yazd	89;0	32;0
26	Saharward	82;20	32;30
27	Hamadān	83;0	35;10
28	Sāwa	85;0	35;0
29	Qazwīn	85;0	36;0
30	lşfahān	86;40	32;25
31	Kāshān	86;0	35;0
32	Qumm	84;40	35;45
33	Ţāliqān	85;45	36;10
34	Astarābād	89;35	36;50
35	Jurjān	90;0	36;50
36	Bisțām	89;30	36;10
37	Sabzawār	91;30	36;5
38	Nishābūr	91;30	36;21
39	Ţūs	92;30	37;0
40	Tūn	92;30	34;30
41	Harāt	94;20	34;30
42	Balkh	81;0	36;41

	Place Name (<i>al-bilād</i>)	L (al-țūl)	Ф (al- ^c arḍ)
43	Badakhshān	84;25	37;10
44	Balūr	88;0 !	37;0
45	Bukhārā	97;30	39;50
46	Samarqand	99;36	39;37
47	Khujand	105;35	41;15
48	Kāshghar	106;30	44;0
49	Khutan	107;0	42;0
50	Mahrī	140;0	30;0
51	Hurmūz	92;0	25;0
52	?	94;0	28;30
53	Mīmand	101;55	33;20
54	Rabāț Amīr	105;0	34;0
55	Nahalwāra	102;30	22;0
56	Mūltān	107;25	29;40
57	Qandahār	107;40	33;0
58	Lahāwar	109;20	31;50
59	Qannawj	115;50	26;35
60	Bānārasī	117;20	26;15
61	Sarāndīb	130;0	10;0

	Place Name (<i>al-bilād)</i>	L (al-țūl)	Ф (al- ^c arḍ)
62	Tubbat	110;0	40;0
63	Kashmīr	108;0	35;0
Inn	er Annulus		
64	Kābul	104;40	34;30
65	Haḍrat Dihlī	113;35	28;15
66	Akra	114;0	27;13
67	Marw	100;0	27;15
68	Jawnpūr	119;6	26;36
69	Ajmīr	111;5	24;30
70	Kawāliyār	115;0	26;29
71	Aḥmadābād	108;40	23;15
72	Aḥmadānakar	107;0	19;0
73	Ujain	102;0	22;30
74	Dawlatābād	111;0	20;30
75	Kūpāmayū	116;33	26;45
76	Hānsī	102;25	29;15
77	Karah	117;6	26;36
78	Darband Jīn	148;40	23;0
79	Manikpūr	108;10	26;49

	Place Name (<i>al-bilād)</i>	L (al-țūl)	Φ (al- ^c arḍ)
80	Kūlkanda	114;19	28;4
81	Jadda	76;0	21;0
82	Qila Rājkarī	89;15	33;20
83	Sewāta	117;10	32;50
84	Amarkot	105;0	25;0
85	Baran	114;0	28;38
86	Sanām	114;25	30;30
87	Badāwan	114;59	26;32
88	Chānpānīrī	108;45	22;30
89	Kanbāyat	109;4	22;20
90	Sanhbal	115;0	28;4
91	?	108;40	21;10
92	Awadh	118;6	27;22
93	Pijāpūr	105;30	17;20
94	Burhānpūr	103;0	21;30

BACK

There are some scratches and pit marks on the surface of the back. The rim of the upper half is divided in 3° , 1° , $1/3^{\circ}$ as on the front, but numbering starts with 3 at the east and west points and reaches to the south point at the top with 90. The rim of the lower half carries cotangent scales.

Trigonometric Quadrant on the Upper Left

The trigonometric quadrant on the upper left is filled with 60 horizontal and 60 vertical lines, where every fifth line is dotted. These lines are not numbered.

Solar Quadrant on the Upper Right

In the solar quadrant the vertical and the horizontal radii are divided into 6 parts each. On these parts are written the serial numbers of the zodiac signs. On the vertical radius are written, starting from the centre, 3 (= Cancer), 4 (Leo), 5 (Virgo), 6 (Libra) 7 (Scorpio) and 8 (Sagittarius), i.e., from summer solstice to winter solstice. On the horizontal radius are written, starting from the outer periphery, 9 (Capricorn), 10 (Aquarius), 11 (Pisces), 0 (Aries), 1 (Taurus) and 2 (Gemini), i.e., from winter solstice to summer solstice. From the points of division of the vertical radius up to the points of division on the horizontal radius, quarter circles are traced for every 30° of solar longitude. Superimposed on these quarter circles are three curves to show the sun's midday altitude, but only the lowermost one is labelled as *khait nisf al-nahār 32*, which pertains to Lahore with the latitude of 32° .



Figure A017a.7 – Back of the Astrolabe (© photo curtesy the owner)

Shadow Squares

In the lower half are drawn two shadow squares. On the left of the vertical diameter (i.e., the meridian) is the square for shadows thrown by a gnomon of 7 feet. Here the vertical and horizontal scales are divided in 7s and numbered appropriately. Below the horizontal scale is the label *zill aqdam mustawī* (umbra recta in feet); to the left of the vertical scale is the label *zill aqdam ma^ckus* (umbra versa in feet). In the inner corner on the left is engraved *zill sullam aqdām* (scale of shadows in feet).

To the right of the meridian is the square for shadows thrown by a gnomon of 12 digits. Here the vertical and horizontal scales are divided in 12 and numbered accordingly. Below the horizontal scale is the label *zill aṣābi^c mustawī* (umbra recta in digits); to the right of the vertical scale is the label *zill aṣābi^c* (umbra versa in digits). In the inner corner on the right is the label *zill sullam aṣābī^c* (scale of shadows in digits).

The horizontal scales of the two shadow squares are projected on to the rim of the lower half to produce cotangent scales for the bases 7 and 12 respectively. These are labelled *zill aqdām* just below the horizontal diameter on the left and as *zill aṣābī*^c on the right. The divisions on these cotangent scales are further subdivided into 5 parts in an inner semicircle. These are followed by two scales carrying the names of the 12 zodiac signs and of the 28 lunar mansions in order to show graphically their mutual relation.



ALIDADE

Figure A017a.8 - Alidade, Pin and Horse (© photo curtesy the owner)

The straight bar alidade has ornate ends and an ornate centre piece. The left-hand side is divided in 12 parts and numbered in *Abjad* numerals 5,10, 15, ... 50, 55, 60, starting from the centre and proceeding towards the end. Each part is subdivided into 5s on the sloping edge. On the right-hand side are drawn 6 arcs corresponding to the declination arcs on the upper right quadrant; the arcs are marked with the serial numbers

of the zodiac signs but are too faint to decipher. The rectangular sighting plates have two holes each, one larger and another smaller. The pin is plain; the horse is shaped nicely with its mane on the neck and left eye.



INSCRIPTION ON THE FRONT OF THE THRONE

Figure A017a.9 – Inscription on the front of the kursī (© photo courtesy owner)

This inscription, engraved in 6 lines inside an ornate border with embossed letters against a hatched background, reads thus:³

dar tārīkh māh urdibahisht īlāhī sanah e Jāhāngīrī mutābiq shehr Rabic 'al- awal sanah 1021 dar dār 'al salṭanat Lāhore ḥasb 'al farmūdah bandgān iqbāl panāh ayālat dastgāh āqā Afẓal keh ayām ḥukūmat w cadalat īshān būdah īn aṣṭurlāb e tām bā tamām rasīd. 'This perfect astrolabe was completed in the capital city of Lahore on the order of [one of] the servants [of God], the asylum of felicity [and] one who has the power of Government, $\bar{A}q\bar{a}$ Afzal, [on] the Jahangiri Ilahi month Ordibehest, corresponding to Rabic I, the year 1021 [= May 1612], which was [in] the period of his administration and justice.'⁴

Here the expression usțurlāb e tām does not merely mean 'a perfect astrolabe' in the sense of a flawless or impeccable piece but has also a technical connotation of an astrolabe in which latitude plates carry 90 almucantar circles, thus it is a 'complete' astrolabe.

INSCRIPTION ON THE BACK OF THE THRONE



Figure A017a.10 - Inscription on the back of the kursī (© photo courtesy owner)

Unlike the inscription on the front, this inscription carries letters which are deeply cut into the surface, but which are nevertheless very elegant. The inscription reads thus:

tam al-^camal bi-yadī aḍ^cafī al-^cbād qā'im muḥammad wa muḥammad muqīm ibnī mullā ^cīsā bin Allāhdād asṭurlābī humāyūnī lāhūrī

'The work was achieved by the hands of the weakest of the servants [of God], Qā'im Muḥammad and Muḥammad Muqīm, the two sons of Mullā 'Īsā, the son of Allāhdād of Lahore, the astrolabe maker of [the emperor] Humāyūn.'

This inscription is the same as that on A017 with a minor difference; while A017 has *ibn*, A018 has *bin*.

⁴ The translation is by Dr Manijeh Bayani-Wolpert.

A054 ASTROLABE ATTRIBUTABLE TO MUHAMMAD MUQĪM (REVISED)

Not dated, 17th century

Diameter 204 mm

PLU (ex-Sotheby's 2023 April 26, Lot 79)

This large and well-crafted astrolabe is not signed, nor dated, but can be attributed to Muḥammad Muqīm. Two different styles of calligraphy can be seen in this astrolabe. First, letters and words are engraved in continuous curves on the front and back. Second, the star names on the rete and the place names in the geographical gazetteer are represented by deeply cut inelegant strokes; these may have been engraved by an assistant and not by Muqīm himself. Especially in the gazetteer, the cells become progressively smaller towards the centre. Without the dots below or above, the names engraved here are difficult to decipher.

An unusual feature of this astrolabe – not seen in any other Indo-Persian astrolabe – is that at the centre of the geographical gazetteer, there are names of several fixed stars and two types of numerical data related to them (see Figure A054.5 below).

COMPONENTS

Mater (d. 204, h. 306) with *kursī*, shackle and ring; rete and 5 plates. The alidade, pin and horse are later additions.

Front

The mater, $kurs\bar{i}$ and the rim are cast as one piece. The degree scale on the limb is divided in 1° and 5° and numbered in 5s from 5 to 360, starting from the south point at the top and proceeding clockwise.

The *kursī* with multi-lobed profiles is elaborately reticulated, with a cartouche resembling a casket with a triangular base and a lid with a long oval handle. The finial imitates the form of the cartouche. The surface on both sides is engraved with decorative lines.



Figure A054.1 – Front of the Astrolabe (Sotheby's London, 26 April 2023, 79 ; © Photo courtesy Sotheby's, 2023)

Rete

The Capricorn ring is very slender compared to the much wider ecliptic ring. These two rings are held together by a slender equinoctial bar which has a counter change at the centre. The ecliptic ring is divided into the 12 signs and labelled with their names; each sign is divided into units of 2° and numbered accordingly; these units are further subdivided in 1°. There is a handle at the western end of the equinoctial bar. Probably there was another in the east within a part of the tracery, but it is now missing; there is just an empty hole. The Capricorn index with a pointed tip is situated at the uppermost point of the ecliptic ring. About 53 names of fixed stars are engraved on the rete.



Figure A054.2 – Rete, wedge, pin and alidade (Sotheby's London, 26 April 2023, 79 ; © Photo courtesy Sotheby's, 2023)

PLATES

There are five plates stacked below the rete. On all plate faces, except 4b, 5a, 5b, equal altitude circles are drawn for every degree and numbered in 2s on the right and left. Azimuth circles are traced above and below the horizon for every 6°. Lines for both equal and seasonal hours are drawn below the horizon.

	φ	Longest Day
1a	22°	13;22 hours
1b	25°	13;25 hours
2a	29°	13;53 hours
2b	32°	14;8 hours
3a	34°	14;19 hours
3b	37°	13;16 hours!
4a	36°	14;30 hours
4b	Horizons	
5a	Ecliptic Coordinates	
5b	Triple projection	

Table A054.1 – Plates

On 4b, the plate of multiple horizons, four sets of half horizons are drawn for latitudes 1° to 64° . Scales of declination are marked along each radius, for both south and north, and labelled as 2, 4, 6, ... 22, 24. The name of the plate *şafīḥā al-āfāqiya* is engraved at the bottom. On the plate for ecliptic coordinates are drawn latitude circles for each 1° and longitude circles for each 6° . The name of plate *mīzān al-cankabūt* is likewise engraved at the bottom. Finally, 5b carries projections for three latitudes.



Figure A054.3 – Plate for Ecliptic Coordinates (Sotheby's London, 26 April 2023, 79 ; © Photo courtesy Sotheby's, 2023)



Figure A054.4 – Geographical Gazetteer (Sotheby's London, 26 April 2023, 79 ; © Photo courtesy Sotheby's, 2023)

GEOGRAPHICAL GAZETTEER

On the inner side of the mater, an elaborate geographical gazetteer is engraved, in 3 circles, bearing the names, longitudes and latitudes of as many as 285 (95 x 3) places.

In the fourth circle there are the names of 47 fixed stars (*kawākib*) and two types of numerical data related to them. The star names include *Muqaddam Sharaṭayn* (β Arietis), *Mu'akhir Sharaṭayn* (α Arietis), *Rijl Musalsalah* (γ Andromedae), *Rās al-Ghūl* (β Persei), and so on. In the fifth circle the argument is given in one cell, but the rest of the 47 cells are blank. In the sixth circle there is some writing in two lines.

The significance of this star table eludes us, so too the purpose of inserting it at the centre of the geographical gazetteer.



Figure A054.5 – Centre of the Gazetteer with the star names (Detail of Figure A054.4)

BACK

On the back, the rim of the upper half is divided in 1° and 5° and numbered in 5s, starting at the west and east points, and reaching the south point. The upper left quadrant carries a sexagesimal sine graph, consisting of 60 horizontal lines, with each fifth as a dotted line. The lines are not numbered.

In the solar quadrant on the upper right, the vertical and the horizontal radii are divided into 6 parts each. On these parts are written the names the 12 zodiac signs. On the vertical radius are written, starting from the centre, *Sarațān* (Cancer), *Asad* (Leo), *Sunbulah* (Virgo), *Mīzān* (Libra), *Aqrab* (Scorpio) and *Qaws* (Sagittarius), i.e., from summer solstice to winter solstice. On the horizontal radius are written, starting from

the outer periphery, $Jad\bar{i}$ (Capricorn), Dalw (Aquarius), $H\bar{u}t$ (Pisces), Hamal (Aries), Tawr (Taurus) and $Jawj\bar{a}$ (Gemini), i.e., from winter solstice to summer solstice. From the points of division of the vertical radius up to the points of division on the horizontal radius, quarter circles are traced for every 30° solar longitude as dotted arcs. Between these quarter circles are traced for every 3°.

Superimposed on these quarter circles are five curves. Of these, three upper curves are labelled as *khaṭṭ niṣf al-nihār ^carḍ 27* (sun's midday altitude at latitude 27°), *khaṭṭ niṣf al-nihār ^carḍ 32* (sun's midday altitude at latitude 32°); *khaṭṭ niṣf al-nihār ^carḍ 36* (sun's midday altitude at latitude 36°). The two lower curves mark presumably the beginning of the afternoon prayer, and the end of the midday prayer at Lahore which lies on latitude 32° .



Figure A054.6 – Back of the Astrolabe (Sotheby's London, 26 April 2023, 79 ; © Photo courtesy Sotheby's, 2023)

In the lower half, immediately below the horizontal diameter are the shadow squares. On the left is the square for 7 feet. Here the horizontal and vertical scales are

divided into 7 parts each and numbered accordingly. The horizontal scale carries the label *zill aqdām mustawī* and the vertical scale *zill aqdām ma*^ckūs. On the right is the square for 12 digits. The horizontal and vertical scales are divided into 12 parts; each division is further divided into 5 sub-divisions in an adjacent scale. The horizontal scale is labelled *zill sittayinī al-mustawī* and the vertical scale *zill sittayinī ma*^ckūs.

The outer periphery carries cotangent scales and their subdivisions: on the left for 7 feet with the label *zill aqdām* and on the right for 12 digits with the label *zill aṣābi*^c. These are followed by two semi-circles engraved with the names of the 28 lunar mansions and the corresponding 12 zodiac signs respectively. Beyond these there are several semi-circles with astrological tables, also inside the two shadow squares.

ALIDADE

The alidade, pin and horse are not original; they are added alter.

PROVENANCE

Brieux, Paris, 1969.

Ex-private collection, France, acquired late 1970s.

BIBLIOGRAPHY

Alain Brieux, Histoire des Sciences: Livres, Autographs, instruments, astrolabes, Paris, 1969, no. 5819.

Sotheby's Auction Catalogue, London, 26 April 2023, Lot, 79.
C019 SANSKRIT ORNITHOMORPHIC ASTROLABE, NOT SIGNED, NOT DATED (REVISED)⁵

17th Century, Gujarat

Diameter 290 mm

Moscow, PC



Figure C019.1 – Front of the Astrolabe (photo by Dr Alexander Walland)

⁵ In 1995 Dr Wailand (Ingelheim, Germany) saw this astrolabe in a shop at Jodhpur and sent me a few photographs. On their basis, I made an entry in the Catalogue. Some 27 years later, the astrolabe reached Moscow where the present owner acquired it in an antique shop in 2022. The owner, very kindly, sent me detailed photographs. These enabled me to write this more comprehensive description of the astrolabe.

This is a highly unusual astrolabe. First, the rete is ornitho-morphic with the star pointers shaped like various kinds of birds. It is also remarkable that the legends on the four sides of the two plates mentions not just the latitude (φ), but also the midday equinoctial shadow (*chāyā*, tan φ), the hypotenuse of the right-angled triangle formed with the gnomon and the equinoctial midday shadow (*karṇa*), the duration of the longest day (*paramadina*), the oblique ascensions or the rising times (*svodaya*) of the zodiac signs at this latitude, ascensional differences of the zodiac signs (*cara-khaṇḍa*), and the names of several other localities with approximately the same latitude where this plate face can be used for observation and computation. No other Sanskrit astrolabe is known where the plates contain so many parameters. The plates in the astrolabe C016 mention some of these parameters, viz., the latitude, equinoctial shadow, duration of the longest day and the oblique ascensions.⁶

However, there are also some lacunae in this astrolabe. There is no geographical gazetteer on the inner side of the mater; it is completely blank. The back of the mater does not carry the usual scales in the four quadrants. Instead, altitude circles are drawn, eight above the horizon line and eight below it, whose purpose is not known. Furthermore, the limb on the front of the mater is numbered in the same manner as on the back, which is not quite appropriate.

Moreover, the astrolabe is heavily damaged. In the rete, almost the entire eastern half of the outer circle constituting the Tropic of Capricorn is broken, so too probably some star pointers in the vicinity. In Plate 1, the edge of the upper left-hand corner is broken at places as if a rat had nibbled it; but rats cannot nibble at brass sheets.

Even so, the astrolabe is an important specimen, because of the design of the rete and the detailed engravings on the plate faces. The Devanagari letters and numerals are clearly and neatly engraved. The style of the numerals suggests that the astrolabe was made in Gujarat, possibly in the seventeenth century.

⁶ A few other astrolabes, such as C007, C012, C017 etc., mention the longest day, midday equinoctial shadow (also called *aksabhā*, or simply *bhā*) or the hypotenuse (*karna*).

COMPONENTS

Mater (d. 290, h. 303, t. 5) with a shackle and ring, two plates, rete, alidade (length 263); pin and wedge are missing.

FRONT

The crown is very small and low, with an inscription śrīmahāgaṇapataye namaḥ, 'salutation to glorious great Gaṇapati, i.e., Gaṇeśa.' The limb is neatly divided in 1° and 5°. However, groups of 5° are numbered serially from 1 to 15, separately in each quadrant, starting from the east and west points and proceeding to the north and south points (1-15; 15-1; 1-15; 15-1). This is usually how the limb is numbered on the back for measuring the altitudes of the heavenly bodies. But in the front, the numbering ought to be continuous from 5 to 72, starting at the south point at the top and proceeding clockwise. The inner surface of the mater is blank.

Rete

The design of the rete is very interesting and unusual. Here the star pointers are constituted by the beaks⁷ of peacocks and cranes, and a few tips of leaves or flowers. The solstitial bar, slightly counter-changed at the centre, and the equinoctial bar, without counter change, are formed by densely joined lozenges with holes in the middle. Two large segments of the equator are shown, one above the ecliptic and the other inside the ecliptic. The ecliptic is fully represented; it is divided into the 12 signs of zodiac and labelled with the names of the signs together with their serial numbers, starting in the east above the equinoctial bar, and proceeding clockwise: me[sa]1 (Aries), vr[sa] 2 (Taurus), mi[thuna] 3 (Gemini), ka[rka] 4 (Cancer), sim[ha] 5 (Leo), $ka[ny\bar{a}] 6$ (Virgo), $tu[l\bar{a}] 7$ (Libra), vr[scika] 8 (Scorpio), dha[nuh]9 (Sagittarius), ma[kara] 10 (Capricorn), kum[bha]11 (Aquarius) and $m\bar{v}[na]12$ (Pisces). Each sign is further subdivided into ten divisions of 3° and numbered in 3s in an anticlockwise direction. On the reverse side also the ecliptic ring is divided and marked in the same manner.

Perched on these rings are some 11 peacocks, cranes and other birds whose beaks constitute the star pointers; likewise, there are about 10 leaf-clusters carrying star

⁷ In fact, the Sanskrit word for star pointer is *cañcu*, lit. bird's beak

pointers at their tips. Some 40 star names appear to be engraved in abbreviated form. It is difficult to decipher the full names in most cases.



Figure C019.2 – Rete (photo by the owner)

PLATES

There are two plates, with projections engraved on both sides, with calibrations for the latitudes 20° , 23° , 26° , and $29;34^{\circ}$. The plate for 20° and 23° is heavily damaged.



Figure C019.3 – Plate 1 Front for the Latitude of 20° (photo by the owner)

On all the four sides of the plates there are full circles of the tropics of Capricorn and Cancer, the equator and the prime meridian. Altitude circles are drawn for each 2° and labelled on the left-hand side as well as on the right as 2, 4, 6 and so on. Below the oblique horizon are drawn unequal hour lines; these are numbered as 1, 2, 3 ... 12, starting from the western horizon.

On plate 1, one side is calibrated for the latitude of 20° . Here within the circle of the Tropic of Cancer, just below the oblique horizon, there is a Sanskrit inscription in four lines. It reads as follows:



Figure C019. 4 – Inscription on the Plate for the Latitude of 20° (photo by the owner)

akṣāh 20 bhā 4/35 karṇa[ḥ] 12/50 paramaṃ dinaṃ 33/11 svodayāḥ || me 231 vṛ 262 mi 308 ka 338 siṃ 336 ka 325 carakhaṇḍāni me 47 vṛ 37 mi 15 ahamadānagare makkāḥ devagirau vidyānagare buhrānapure hāvase phiraṃga yatraite [']kṣās tatredam ||

⁽[Degrees of] latitude (*akṣa*) 20; [midday equinoctial] shadow (*bhā*) 4;35; hypotenuse (*karṇa*) 12;50; longest day (*parama-dina*) 33;11. Oblique ascensions (*svodaya*): Aries 231, Taurus 262, Gemini 308, Cancer 338, Leo 336, Virgo 325. Ascensional differences (*cara-khaṇḍa*): Aries 47, Taurus 37, Gemini 15. At Ahamadanagara, Makkā, Devagiri, Vidyānagara, Buhrānapura, Hāvasa, Phiraṃga,⁸ [and] wherever these [degrees of] latitude [prevail], this [latitude plate is to be used].'

OBLIQUE ASCENSIONS AND RIGHT ASCENSIONS

The inscription enumerates the oblique ascensions (*svodaya*) and the ascensional differences (*cara-khaṇḍa*) at latitude 20°. The former are given for the first 6 zodiac signs and they apply also to the next 6 signs in the reverse order. By the addition or subtraction of the oblique ascensions and the ascensional differences, the right ascensions or the rising times of the signs at the equator are obtained as shown in the table below. The values mentioned here are in *palas* (= 24 seconds). The longest day is measured in *ghațīs* and *palas*.

⁸ These localities have roughly the same latitude 20°. Their modern names and exact latitudes are as follows: Ahmedanagar (19;08°), Mecca (21;25°), Daulatabad (19;57°), Vijayanagar/ Hampi (15;20°), Burhanpur (21;18°). Phiranga may refer some European settlement; Daman and Diu have a latitude of 20;42°. Hāvasa cannot be identified.

S	igns	Oblique Ascensions	Ascensional Differences	Right Ascensions
Aries	Pisces	231	+ 47	278
Taurus	Aquarius	262	+ 37	299
Gemini	Capricorn	308	+ 15	323
Cancer	Sagittarius	338	- 15	323
Leo	Scorpio	336	- 37	299
Virgo	Libra	325	- 47	278

Table C019-1Oblique and Right Ascensions at Latitude 20°



Figure C019.5 – Plate 1 Reverse Side for the Latitude of 26° (photo by the owner)



Figure C019.6 – Inscription on the Plate for the Latitude of 26° (photo by the owner)

41

āšāpalyām raivatakācale mamgalaure dvārakāyām ujjayinyām akşāh 23 bhā 5;15 karņah 13;7 paramadinam
33;40 carakhandāni me 52 vr 42 mi 17 svodayāh me 226 vr
257 mi 306 ka 340 sim 341 ka 330
bagālā
'At Āśāpallī, Raivatakācala, Mangalore, Dvārakā and Ujjayinī,⁹ [the degrees of] latitude (akşa) are 23; [midday equinoctial] shadow (bhā) 5;15; hypotenuse (karņa) 12;50; longest day (parama-dina) 33;40. Ascensional differences (cara-khanda): Aries 52, Taurus 42, Gemini 17. Oblique ascensions (svodaya): Aries 226, Taurus 257, Gemini 306, Cancer 340, Leo 341, Virgo 330.

The word ' $Bag\bar{a}l\bar{a}$ ' in the last line cannot be identified.

Signs		Oblique	Ascensional	Right
		Ascensions	Differences	Ascensions
Aries	Pisces	226	+ 52	278
Taurus	Aquarius	257	+ 42	299
Gemini	Capricorn	306	+17	323
Cancer	Sagittarius	340	- 17	323
Leo	Scorpio	341	- 42	299
Virgo	Libra	330	- 52	278

Table C019-2 Oblique and Right Ascensions at Latitude 23°

 ⁹ These places have roughly the same latitude 23°. Their modern names and exact latitudes are as follows:
 Ahmedabad (23;01°), Girnar (21;29°), Mangaluru (12;52°!), Dwaraka (22;14°), and Ujjain (23;17°).



Figure C019.7 – Plate 2 Front for the Latitude of 26° (photo by the owner)



Figure C019.8 – Inscription on the Plate for the Latitude of 26° (photo by the owner)

akṣāḥ 26 bhā 5;58 karṇaḥ 13;24 paramadinaṃ 34;10 carakhaṇḍāni me 59 vṛ 47 mi 20 svodayāḥ me 219 vṛ 252 mi 303 ka 343 siṃ 346 ka 337 ajamerau vārāṇasyāṃ kanyakubje nāgaura rūma yatraite[']kṣāḥ statredaṃ '[Degrees of] latitude (akṣa) 26; [midday equinoctial] shadow (bhā) 5;58. hypotenuse (karṇa) 13;24; longest day (parama-dina) 34;10. Ascensional differences (cara-khaṇḍa): Aries 39, Taurus 47, Gemini 20. Oblique ascensions (svodaya): Aries 219, Taurus 252, Gemini 303, Cancer 343, Leo 346, Virgo 337. At Ajmer, Benares, Kānyakubja, Nāgaur, Rūma,¹⁰ [and] wherever these [degrees of] latitude [prevail], this [latitude plate is to be used].'

Signs		Oblique	Ascensional	Right
		Ascensions	Differences	Ascensions
Aries	Pisces	219	+ 39	258
Taurus	Aquarius	252	+ 47	299
Gemini	Capricorn	303	+ 20	323
Cancer	Sagittarius	343	- 20	323
Leo	Scorpio	346	- 47	299
Virgo	Libra	337	- 39	298

Table C019-3Oblique and Right Ascensions at Latitude 26°

¹⁰ These towns have roughly the same latitude 26°. Their modern names and exact latitudes are as follows: Ajmer (26;45°), Banaras / Varanasi (25;15°), Kannauj (27;07°), Nagaur / Nagore / Nagor (27;02°). Rūma or Rome could be Alexandia, but its latitude is 31;12°.



Figure C019.9 – Plate 2 Reverse for the Latitude of $28;39^{\circ}$ (photo by the owner)



Figure C019.10 – Inscription on the Plate for the Latitude of 28;39° (photo by the owner)

akṣāḥ 28;39 bhā 6;40 karṇaḥ 13;44 paramadinaṃ 34;34 carakhaṇḍāni me 66 vṛ 53 mi 22 syodayāḥ me 212 vṛ 246 mi 301 ka 345 siṃ 352 ka 344 śrī-yoginīpure uccanagare kaṃpilāyāṃ kurukṣetre hisāre yatraite [']kṣās tatredaṃ ||

⁽[Degrees of] latitude (*akṣa*) 28;39; [midday equinoctial] shadow (*bhā*) 6;40; hypotenuse (*karṇa*) 13;44; longest day (*parama-dina*) 33;11. Ascensional differences (*cara-khaṇḍa*): Aries 66, Taurus 53, Gemini 22. Oblique ascensions (*svodaya*): Aries 212, Taurus 246, Gemini 301, Cancer 345, Leo 352, Virgo 344. At the illustrious Yoginīpura (Delhi), Uccanagara, Kaṃpilā, Kurukṣetra,¹¹ [and] wherever these [degrees of] latitude [prevail], this [latitude plate is to be used].'

Signs		Oblique	Ascensional	Right
		Ascensions	Differences	Ascensions
Aries	Pisces	212	+ 66	278
Taurus	Aquarius	246	+ 53	299
Gemini	Capricorn	301	+ 22	323
Cancer	Sagittarius	345	- 22	323
Leo	Scorpio	352	- 53	299
Virgo	Libra	344	- 66	278

Table C019-4Oblique and Right Ascensions at Latitude 28;39°

¹¹ These places have roughly the same latitude 28,39°. Their modern names and exact latitudes are as follows: Delhi (28;36°), Kampil (27;62°) and Kurukshetra (29,97°). Uccanagara cannot be identified.



Figure C019.11 – Back of the Astrolabe (photo by the owner)

BACK

On the back, the narrow and low crown is engraved with *jagaccakṣuṣe namaṣ* (Salutation the eye of the Cosmos, i.e., the Sun).

The rim is neatly divided in 1° and 5° ; groups of 5° are numbered serially from 1 to 15, separately in each quadrant, starting from the east and west points and proceeding to the north and south points (1-15; 15-1; 1-15; 15-1).

Inside the rim, there is another circle at some distance. The intervening space is divided, in each quarter, into four parts. Its purpose is not known. At the centre, there is the circle of Cancer.

In the middle of the back, altitude circles are engraved, eight each above and below the horizon. These are numbered, on the left as well as on the right, as 90, 70, 60, 50, 40, 30, 20, 10 and the same in reverse order. Each of these circles is divided between the rim and the centre in gradually decreasing intervals and numbered as 4, 5, 6, 12, 13, 14, on both sides of the centre. The purpose of the circles is again unknown.

However, because of these circles, the back does not carry the usual scales and parameters in the four quadrants are to be found on the back of the other astrolabes.



Figure C019.12 – Alidade (photo by the owner)

ALIDADE

The alidade is 263 mm long. It has pointed tips, and an exaggerated centre piece with a large circle. The length of the alidade is divided into two halves. The upper half is divided into 30 parts on either side of the centre and numbered accordingly starting from the centre. The sighting plates are however unusual; their width is twice that of the alidade. Consequently, one half of the sighting plates rests beyond the surface of the alidade. Each sighting plate has two apertures. The larger aperture is correctly placed above the inner edge of the alidade which coincides with the diameter of the astrolabe. The smaller one is placed in that half which is jutting out. Consequently, the line joining the two smaller apertures does not pass through the centre of the astrolabe.

D062 © ASTROLABE FOR LATITUDE 28;16°, DESIGNED BY KASTŪRĪCANDRA, MADE BY SŪTRADHĀRA SŪRYAMALLA, NOT DATED (REVISED)

19th century, Bikaner, Rajasthan

Diameter 273 mm

Cologne, PC



Figure D062.1 – Front of the astrolabe (photo by S. R. Sarma)

The inscription on the back states that this astrolabe was made by Sūryamalla according to Kastūrīcanda's instruction (*upadeśa*) for the latitude of $28;16^{\circ}$. Probably Kastūrīcandra did not merely give oral instructions; he must have prepared the technical designs for the astrolabe and also drafted the text of the inscription on the back, where Sūryamalla receives the title *sūtradhāra*; the term, among others, denotes architect; here it is used in the sense of 'master craftsman' or 'artisan'¹².

The plate is actually designed for latitude 27°, but can be used at 28;16° as well. It is likely that the astrolabe was made at the princely city of Bikaner (28;01° N, 73;19° E) in Rajasthan which is situated roughly on this latitude. The distinguishing feature of this astrolabe is the large flamboyant peacock perched on the central ring of the rete, its beak pointing to the star α Coronae Borealis. The raised neck and the feathers in the wings are depicted nicely with a series of parallel strokes.

Sūryamalla appears to have fabricated many specimens, four of which are known at present, viz. this and the next three astrolabes. These are almost identical: all have about the same size, the same design of the rete with the peacock motif, the same projections on the front of the plate and the same inscription on the back. There is a fifth one D066, identical in all respects, but without the inscription.

But each one has a different style of crown. There are other minor differences. Broadly speaking, the pair D062 and D063 differs from the pair D064 and D065 in three respects. First, in D062 and D063, the outer band of the degree scale on the rim is divided in 6° and numbered serially from 1 to 60. In the inner band, these divisions of 6° are subdivided, not into 6 units of 1° as is the common practice, but into 5 units of $1;12^{\circ}$. The same error is repeated in the altitude scale at the back and in the degree scale on the edge of the ecliptic ring in the rete. But in D064 and D065 the scales are correctly divided in 1° and 6° .

Second, while there are 24 named star pointers in D062 and D063, the retes in the other pair have 27 star pointers. Third, in D062 and D063 declination arcs are engraved on the upper left quadrant on the back; in the other three the upper left quadrants are empty. While the workmanship is reasonably good in all the four specimens, the orthography is generally poor and there are serious errors in the star names. In all the five specimens *Kukkutapuccha* (α Cygni) is wrongly labelled as *Śatabhiṣā* (λ Aquarii) and *Kartitakara* (β Cassiopeiae) is

¹² Cf. Sūtradhāra Māyārāma who made C026 and C027 in 1810. An analogous title is *Ustād* (derived from Arabic) in D035, D036, D037 and D038.

wrongly placed in the northern hemisphere. *Dhanakoți* and *Sarpadhārī*, or more correctly *Dhanuhkoți* and *Sarpadhārīśira*, are alternative names of the same star α Ophiuchi. In all the five specimens these two names are engraved on the solstitial bar as if there are the names of two different stars situated on either side of the meridian. While a pointer is provided for *Dhanuhkoți* to the right to the solstitial bar, no pointer is provided for the other name.

Now the description of the present astrolabe D062.

COMPONENTS

Mater (d. 273, h. 319, t. 1.8) with ring and shackle, rete (d. 241) for 23 stars, alidade (244) with a sighting tube, pin and wedge.

Front

Simple ring and shackle; the crown is lobed. The rim is divided in 6° and numbered in 6s from 1 to 60. But each unit of 6° is wrongly divided in 5 parts each measuring 1:12° and not 1°, and this error is repeated is on the edge of the ecliptic ring in the rete and in the altitude scales on the back.

Altitude circles are drawn for every 3° , these are numbered on both sides of the meridian. Azimuth arcs are drawn above and below the horizon for every 10° , but their intervals are not uniform. In the lower half are lines for seasonal hours and lines for equal hours which commence from the western horizon. The azimuth arcs and the two kinds of hour lines are not numbered.



Figure D062.2 – Rete of the astrolabe (photo by S. R. Sarma)

Rete

The rete consists of the Capricorn ring, fully represented equator ring and a much wider ecliptic ring; these three are held together by the equinoctial and solstitial bars which are fully represented without any counter change. The equator ring, however, has counterchanges at the two equinoxes where it intersects with the ecliptic ring. The ecliptic is ring is divided in the 12 signs of the zodiac and labelled with their names. There are 24 dagger-shaped star pointers. The proper sequence of the stars is not always correctly maintained.

Table D062 1 Stars on the Rete

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	Star Name as engraved	Full/Correct Form	Identification
1	Samudrapakṣī	Samudrapakṣī	βCeti
2	Kārtikabhaja ¹³	Kartitakara	β Cassiopeiae
3	Madasāra	Matsyodara	β Andromedae
4	Pretapūra	Pretaśira	β Persei
5	Pretapārśva		a Persei
6	Rohiņī		α Tauri
7	(not named)	Brahma-hṛdaya	α Aurigae
8	Mithuna	Mithuna-vāma-pāda	βOrionis
9	Mithana-skandha	Mithuna-vāma- skandha	γ Orionis
10	Ladhşaka	Lubdhaka	α Canis Majoris
11	Ladhşakavadhu	Lubdhaka-bandhu	α Canis Minoris
12	Maghā		α Leonis
13	Hasta		δ Corvi
14	Marīci		η Ursae Majoris
15	Citrā		α Virginis
16	Svāti		α Bootis
17	Viśyā	Viśākhā-mātṛ- maṇḍala	α Coronae Borealis
18	Dhanakoți ¹⁴	Dhanuḥkoṭi	α Ophiuchi
19	Sarpadhārī	Sarpadhārīśira	α Ophiuchi
20	Abhijata	Abhijit	α Lyrae

¹³ Wrongly placed in the northern hemisphere.

¹⁴ Nos 17 and 18, viz., *Dhanuḥkoṭi* and *Sarpadhārīśira*, refer to the same star α Ophiuchi.

	Star Name as engraved	Full/Correct Form	Identification
21	Śrava <u>ņ</u> a		α Aquilae
22	Śatabhiṣā ¹⁵	Kukkuṭapuccha	α Cygni
23	Pūrvā Bhādapada	Pūrvā Bhādrapadā	β Pegasi
24	Asamukha	Aśvanābhi	δ Pegasi

¹⁵ Kukkutapuccha (α Cygni) is wrongly labelled as Śatabhiṣā (λ Aquarii).



Figure D062.3 – Back of the astrolabe (photo by S. R. Sarma)

BACK

The rim of the upper half carries altitude scales which are divided in 6° and numbered as 6—90; 90—6. As in the front, here also the units of 6° are wrongly divided in 5 parts. The rim of the lower half is blank.

The upper right quadrant is filled with 30 horizontal and 30 vertical parallel lines. The 30 horizontal lines in this quadrant are extended into the left quadrant to form 30 declination circles. But there are no numbers or labels in these two quadrants.

In the lower half are shadow squares. The square on the left is for a base of 12; the vertical and horizontal scales are divided in 12 units and numbered from 1 to 12. In the middle of the square is engraved $dv\bar{a}das\bar{a}ngula-ch\bar{a}y\bar{a}$ 12 (shadow of [the gnomon of] 12 digits). The square on the left is drawn for a base of 7. Here the vertical and horizontal scales are divided in 7 units and numbered from 1 to 7. In the middle of the square is the label stating *saptāngula-chāyā* 7 (shadow of [the gnomon of] 7 digits).

ALIDADE

The alidade is equipped with a sighting tube. The end of the wedge is nicely shaped as a horse's head.

INSCRIPTION

Below the shadow squares is the inscription engraved on both sides of the vertical diameter, with many errors in orthography.

|| akṣāmśa 28|16 ||akṣabhā 6|30

|| idam patram kastaraca 6 syīpadeśena sūtradhāra sūryamalle-na krttā || 1||

The correct version should be:

akṣāmśāh 28 16, akṣabhā 6 30

idam patram kastūrīcandrasyopadeśena sūtradhāra-sūryamallena krtam.

'Latitude 28;16 [degrees]. Midday equinoctial shadow 6;30 [digits].

'This plate was made by Sūtradhāra Sūryamalla according to Kastūrīcandra's instruction.'

D065A SANSKRIT ASTROLABE ATTRIBUTABLE TO KASTŪRĪCANDRA & SŪTRADHĀRA SŪRYAMALLA, NOT DATED

19th century, Bikaner

Diameter 275 mm

Brussels, PC

This astrolabe carries no signature, but it is identical in all other respects to the preceding four astrolabe. Therefore, this one also must have been designed by Kastūrīcandra and fabricated by Sūryamalla.



Figure D065a.1- Front of the Astrolabe (Photo by Dr van der Linden)

COMPONENTS

Mater (d. 275, h. 320, t. not known) with ring and shackle, rete for 17 stars, alidade (245) with a sighting tube, pin and wedge.

Front

Simple ring and shackle. The crown is solid with lobed profiles and peak-like projections on either side at the base. The rim is divided in 6° and numbered in 6s from 1 to 60. Each unit of 6° is subdivided into 6 parts of 1° each.

Altitude circles are drawn for every 3° , these are numbered on both sides of the meridian. Azimuth arcs are drawn above and below the horizon for every 10° . In the lower half are lines for seasonal hours and lines for equal hours which commence from the western horizon. The azimuth arcs and the two kinds of hour lines are not numbered.



Figure D065a.2 – Rete (Photo by Dr van der Linden)

Rete

The rete consists of the Capricorn ring, fully represented equator ring and a much wider ecliptic ring; these three are held together by the equinoctial and solstitial bars which are fully represented without any counter change. The equator ring, however, has counter-changes at the two equinoxes where it intersects with the ecliptic ring.

The ecliptic is ring is divided in the 12 signs of the zodiac and labelled with their names, *meşaḥ, vṛṣaḥ, mithunaḥ ... mīnaḥ*. Each sign is divided in 5 parts of 6° each and numbered 6,12, 18, 24, 30. Again each unit of 6° is subdivided in 6 parts of 1° each. There are 23 dagger-shaped star pointers.



Figure D065a.3 – Detail of the Rete (Photo by Dr van der Linden)

Table	Table D065.1 Stars on the Rete				
	Star Name as engraved	Full/Correct Form	Identification		
1	Samudrapakṣī		β Ceti		
2	Kartitabhaja	Kartitakara	β Cassiopeiae		
3	Matvodara	Matsyodara	β Andromedae		
4	Pretaśira		β Persei		

	Star Name as engraved	Full/Correct Form	Identification
5	Pretapāśva	Pretapārśva	α Persei
6	Rohiņī		α Tauri
7	Brahmahadaya	Brahmahṛdaya	α Aurigae
8	Ārdrā		α Orionis
9	Mithuna-vāma-pāda		β Orionis
10	Lubdhaka		α Canis Majoris
11	Lubdhaka-bandhu		α Canis Minoris
12	Maghā		α Leonis
13	Uphā	Uttarā Phālguņī	β Leonis
14	Hasta	Hastā	δ Corvi
15	Marīci		η Ursae Majoris
16	Citrā		lpha Virginis
17	Svāti		α Bootis
18	Viśaṣā	Viśākhā Mātṛmaṇḍala	α Coronae Borealis
19	Dhanukoți	Dhanuḥkoṭi	α Ophiuchi
20	Abhijit		α Lyrae
21	Śravaṇa		α Aquilae
22	Śatabhiṣā	Kukkuṭapuccha	α Cygni
23	Pūvābhadra	Pūrvā Bhādrapadā	β Pegasi



Figure D065a.4 – Back of the Astrolabe (Photo by Dr van der Linden)

BACK

The rim of the upper half carries altitude scales which are divided in 6° and numbered as 6—90; 90—6. Each unit of 6° is subdivided into 6 parts of 1° each.

The upper right quadrant is filled with 30 horizontal and 30 vertical parallel lines, but these are not numbered. The upper left quadrant is blank.

In the lower half are shadow squares. The square on the left is for a base of 12; the vertical and horizontal scales are divided in 12 units and numbered from 1 to 12. In the middle of the square is engraved $dv\bar{a}das\bar{a}ngula-ch\bar{a}y\bar{a}$ 12 (shadow of [the gnomon of] 12 digits). The square on the left is drawn for a base of 7. Here the vertical and horizontal scales are divided in 7 units and numbered from 1 to 7. In the middle of the square is the label stating *saptāngula-chāyā* 7 (shadow of [the gnomon of] 7 digits).

Below the square on the left is written aksam is a 28/16 (Latitude 28;16 [degrees]). Below the square on the right is written aksabha 6/30 (Midday equinoctial shadow 6;30 [digits]).

ALIDADE

The alidade is equipped with a sighting tube. The end of the wedge is nicely shaped as a horse's head.



Figure D065a.5 – Alidade (Photo by Dr van der Linden)

F032A CELESTIAL GLOBE ATTRIBUTABLE TO DIYA' AL-DIN MUHAMMAD

Not dated, 17th Century Diameter ca. 240 mm PLU (ex- Sotheby's, 27 October 2021, Lot 205)



Figure F032a.1 – Celestial Globe with Stand (Sotheby's London, 27 October 2021, 205 ; © Photo courtesy Sotheby's, 2023)

This brass globe carries no signature or date, but the iconography of the constellation figures clearly suggests that it was made by Diyā' al-Dīn Muḥammad or at his workshop. There is a close resemblance with the unsigned celestial globe at the Rampur Raza Library (F027) and, to some extent, also with the Smithsonian globe (F028). A remarkable feature of this globe is the nomenclature of some constellation figures and stars. This is the only specimen where the constellation figure Virgo (Figure F032a.8) is named *sūrat °Adhrā* (figure of the maiden), while all the other known specimens carry the name of *Sunbulah* (ear of wheat).¹⁶ Moreover, three stars β Persei (Figure F032a.6), η Bootis (Figure F032a.11) and β Piscis Austrini (Figure F032a.12) are given unusually long names.¹⁷

This globe is cast as a single hollow sphere by the lost wax method. Three rectangular plugs were inserted; one on the celestial equator slightly to the west of the vernal equinox, the second just below the equator where the figure of Hydra crosses the equator, and third within the figure of Argo Navis. The first two plugs are now lost, there remain just the holes; in the hole near Hydra cracks have developed at two opposite corners; the third one inside Argo Navis is intact. There are three large dents in the globe obviously caused by careless handling. The first one is near the northern equatorial pole between the figures of Ursa Major and Ursa minor (Figure A076.2), the second below the figure of Argo Navis covering the two rudders, and the third near the southern equatorial pole. There are several pit marks all over the surface of the globe.

CIRCLES

The celestial equator and the ecliptic are represented by double bands. In the celestial equator, the inner band is divided in 1° and the outer band in 5°. The outer band is numbered in 5s from 5 to 360 in *Abjad* notation. In the ecliptic the inner band is divided in 1° and the outer band in 5°. In the outer band each zodiac sign is numbered separately from 5 to 30. The names of the zodiac signs are not engraved immediately above the ecliptic, but several degrees to the north, in very large letters, with the epithet *burj* (sign). The Tropic of Capricorn and Tropic of Cancer are drawn to the north and

¹⁶ Cf. Savage-Smith, 1985, p. 174.

¹⁷ Dr Pouyan Rezvani has kindly transliterated and translated the three names.

south of the equator. Six ecliptic latitude circles are drawn at right angles to the ecliptic which converge at the ecliptic poles in the north and in the south. Some of these are marked as $d\bar{a}$ 'irat ^card. At the two poles of equator holes are made for the axis; next to the hole at the north pole is engraved *qutb shumālī* and next to the hole at the south pole is engraved *qutb shumālī*.

CONSTELLATION FIGURES AND STARS

The globe appears to have been engraved with the figures of all the forty-eight Ptolemaic constellations along with their Arabic names with the prefix $s\bar{u}rat$. Moreover, the positions of some 1020 fixed stars are marked with inlaid silver points of three different magnitudes. Many of these silver points lost their lustre, but there are still some which retain the sparkle. Some of these are accompanied by their Arabic names.

Starting from the point of the vernal equinox, the figures of the zodiac signs are engraved on the ecliptic from left to right, in the conventional manner.

Interestingly all the animate figures are endowed with eyes like the human eyes, with almond-shaped eyes with eyebrows above and round pupils inside, whether it is the Great Bear, or the reptile Serpens, or the fish Piscis Austrinus. In Ursa Major, its mane is drawn with a series of oblique strokes and the claws in all its four paws are drawn clearly. In Pegasus, great care is shown in drawing its long mane and the right wing.

In reptile figures like Draco, Hydra and Serpens, innumerable tiny scales are meticulously engraved on their long bodies. More interesting are their heads; in the case of Serpens, a long forked tongued issues out its gaping mouth; its eye is like the human eye, and it has even an ear. The head closely resembles the same on the Smithsonian globe.



Figure F032a.2. Ursa Minor and Ursa Major (Sotheby's London, 27 October 2021, 205; © Photo courtesy Sotheby's, 2023)

In the constellation Ursa Major, the figure of a quadruped animal is drawn as on other globes, with elongated claws in all the four paws. The title of the constellation is written on the body as $s\bar{u}rat Dubb Akbar$. Several star positions are marked with inlaid silver nails; some of these are named. The star on the back is labelled as Zahr Dubb Akbar, 'back of the Great Bear' (α Ursae Majoris); that on the loin is named *Mirāq Dubb Akbar*, 'loin of the Great Bear' (β Ursae Majoris); that on the upper part of foremost hind leg *Fakhd Dubb Akbar*, 'thigh of the Great Bear' (γ Ursae Majoris). The three stars on the tail carry the names *Jawn*, 'black horse' (ε Ursae Majoris), '*Anāq*, 'goat' (ζ Ursae Majoris) and *Qā'id*, 'leader' (η Ursae Majoris) respectively. The pair of the stars on the

rear paw are labelled as *al-Qafzah al-Ulā*, 'first leap' ($v\xi$ Ursae Majoris), those on the middle paw *al-Qafzah al-Thānī*, 'second leap' ($\lambda\mu$ Ursae Majoris) and those on the lower front paw *al-Qafzah al-Thālithah*, 'third leap' ($\iota\kappa$ Ursae Majoris).

We may now consider the iconography of some anthropomorphic figures. The constellation figure **Cepheus** engraved on the present globe resembles to a large extent the same on the Rampur globe. He wears a conical cap with a triple plume, a long tunic tied at the waist by a thin sash, and elaborately patterned knee-high boots. His face is in profile, nose, mouth, and chin are clearly drawn, so also the eye and the ear. The beard is indicated by a series of oblique strokes. By bending his left knee and raising his right arm, he seems to be remonstrating to his wife against her audacity.



Figure F032a.3 – Cepheus, next to him the coils of the serpent Draco (Sotheby's London, 27 October 2021, 205; © Photo courtesy Sotheby's, 2023)

Cepheus's wife **Cassiopeia** is shown as seated on a chair to the south of the kneeling Cepheus. This constellation also closely resembles the same on the Rampur globe with a minor variation. The chair is highly ornate, the short legs are shaped like hour glasses; the side of the seat and the back are decorated with a floral pattern; the two backrests are topped with trifoliate ornaments.


Figure F032a.4 – Cassiopeia (Sotheby's London, 27 October 2021, 205 ; © Photo courtesy Sotheby's, 2023)

Cassiopeia is shown in front view. Her eyebrows, almond shaped eyes and nose are well drawn. The curly strands of hair fall on either side of the face up to the chin. The sleeves of the tunic are indicated by two parallel lines at the wrists, but no other outlines. While the Rampur globe shows the outlines of her long tunic, here this detail is omitted. There is just a long sash falling down her legs, with two elaborate loops below the waist. Her feet are clad in shapely boots. With her left hand she is holding the back post of her chair and with the right hand she is pointing towards her daughter Andromeda.

The name of the constellation is engraved as $s\bar{u}rat Dh\bar{a}t al-Kurs\bar{v}$ to the right of her face. The star on her raised elbow is entitled *Kaff al-Khadīb* (β Cassiopeiae). The star above the knee is named *Rukbat Dhāt al-Kursī* (δ Cassiopeiae).



Figure F032a.5 – Andromeda and Pisces (Sotheby's London, 27 October 2021, 205; © Photo courtesy Sotheby's, 2023)

Andromeda is also shown in front view, but her face is not well drawn. The eyebrows and the eyes are neatly drawn, but not the nose. As in the case of Cassiopeia, strands of curly hair fall on either side of the face. She is draped in a long tunic which reaches up to her calves. The sleeves are indicated by parallel lines at the wrists and at the upper arms; a sash is tied at the waist; its patterned ends hang down vertically. The

lower part of tunic is flared. Below the tunic, the legs and feet are bare. A bead necklace adorns her neck.

Her posture is very dramatic. She stands with outstretched hands, right arm pointing upwards and the left arm down words, as if she is asking to be rescued from the monster Cetus. Across her upper body, the title of the constellation is written as decorative element of the tunic: *sūrat Marāh al-Musalsalah*.

The star on the right side of her waist is named *Janb Musalsalah* (β Andromedae). The star on her right ankle (γ Andromedae) carries two names: *Rijl al-Musalsalah wa samī* and also the traditional Bedouin name ^{*c*}*Anāq al-arḍ azyā* (the wild lynx).



Figure F032a.6 – Perseus (Sotheby's London, 27 October 2021, 205 ; © Photo courtesy Sotheby's, 2023)

Perseus, who comes to rescue Andromeda, strikes a heroic pose, holding a long sword aloft with the left hand and the Gorgon's head with the right hand. He wears a long tunic, knee-length boots with spurs, but with a pattern that is different from the

boots of Cepheus. On the right side of his body is engraved the designation $s\bar{u}rat$ Barsā'us.

His head and that of Gorgon are clearly drawn with eyebrows, eyes, nose, mouth and beard. The star on his chest usually carries two names: *Janb Barsā'ūs*, 'side of Perseus', and *Mirfaq al-Thurayyā*, 'elbow of *Thurayyā*' (β Persei, Algenib / Mirfaq). But here the two names are combined thus: *wa yusammā janb Barshāwus* {*wahuwa*} '*alā mirfaq yad al-Thurayyā yumnā*, 'and it is called the side of Perseus, {which is} on the elbow of the right hand of *Thurayyā*'. Next to the Gorgon's head is written the name *Rās al-Ghawl*, 'ghoul's head' (β Persei, Algol).

To the lower right of Perseus is the figure of **Auriga** who is depicted as sitting with his left leg crossed over the right leg. His face in three-quarters profile; on the top is a turban, the long end of which floats towards the patterned boot of Perseus. Auriga is clothed in a long tunic; its collar, the opening in the front and the sleeves are clearly marked. The two ends his sash hang down over his thigh. His legs are bare. In his left hand is a long ornate horse whip.



Figure F032a.7 – Auriga

(Sotheby's London, 27 October 2021, 205 ; © Photo courtesy Sotheby's, 2023) The title of the figure *şūrat Mumsik al-A^cinnah* (he who holds the reins) is written vertically on the left side of his body. On his right shoulder is a large star named *cAyyūq* (α Aurigae, Capella) and on his left shoulder is a star named *Mankib dhī al-cinān*, 'shoulder of one having the reins' (β Aurigae). On his right foot is a star named *Kacb dhī al-cinān*, 'ankle or heel of one having the reins', (γ Aurigae). This star is common to Taurus (β Tauri). The name of the zodiac house Gemini is written in large letters across his knees as *Burj Jawzā*.



Figure F032a.8. Virgo (Sotheby's London, 27 October 2021, 205 ; © Photo courtesy Sotheby's, 2023)

Among the zodiac figures, the anthropomorphic figure of **Virgo** deserves mention. Her face is in three-quarters profile. Eyebrows, eyes, pupils, and nose are well drawn, but the mouth is represented by two small horizontal strokes. The hair is represented by a series of wavy lines. Her tunic is like that of Auriga mentioned above. Around her waist is tied a sash, the two ends of which hang down. Her left wing is represented fully. The lower part of the right wing is obscured by the intersection of the two graduated bands of the equator and ecliptic at the autumnal equinox, which is labelled as *citidāl kharīfī*. The title of the figure is written as *sūrat cAdhrā* (figure of the maiden). This is a rare case which follows the Greek nomenclature, but which is usually suppressed by the Boudoin name *Sunbulah* (ear of wheat).

Her right arm is largely obscured by the bands of equator and ecliptic. In the middle of the right palm is the star with the name *Simāk* A^czal , 'unnamed Simāk' (α Virginis, Spica). With the left hand she holds an ear of wheat. In the Rampur globe and in the Smithsonian globe, the hand is bare. Near the hand is a star named *Min ā* $A^cww\bar{a}$; this name is also rare. Two stars on the hemline of the skirt are named *Min al-Ghafr*, also a rare case.



Figure F032a.9 – The 'Feminine' Hercules (Sotheby's London, 27 October 2021, 205 ; © Photo courtesy Sotheby's, 2023)

As on the three globes F019 at Hyderabad, F020 at Edinburgh, and F027 at Rampur, **Herculus** is depicted here with feminine breasts. The figure here closely resembles the same on F027 with minor variations. The posture and the facial features are exactly the same. He bends on his left knee, the left arm holding a sickle is raised high, while the right arm is slanted downwards. Long strands of curly hair stretching on either side of the face, eyebrows, eyes, pupils, nose and the left ear are carefully drawn. The mouth is indicated by a short horizontal stroke. Sleeves are suggested by lines at the two wrists, otherwise the upper part of the body is entirely bare. The lower part is covered by a very short skirt. The skirt here differs from that on the Rampur globe. Here it is with many vertical folds and a wavy hemline.

The title of the constellation is engraved vertically between the breasts $s\bar{u}rat J\bar{a}th\bar{i}$ (figure of the kneeling one). The star on his forehead is named $R\bar{a}s al-J\bar{a}th\bar{i}$, 'head of the kneeling one' (α Herculis) and that on the right knee *Rukbat al-Jathi*, 'knee of the kneeling one' (τ Herculis).



Figure F032a.10 – Centaurus (Sotheby's London, 27 October 2021, 205 ; © Photo courtesy Sotheby's, 2023)

In the southern hemisphere, the prominent figure is that of **Centaurus**, the halfhorse and half-man. Both the halves, the rearing horse and the bearded and broadshouldered human wearing a jaunty hat are very powerfully drawn. The horse is realistically depicted with a long hair tail and hooves. The human torso is clothed in a tunic which is closed in the front, with a sash at the waist. The face is in profile. The ear is clearly drawn, and the beard is represented by a series of oblique strokes. On the head is a conical hat, with a bead at the top and an ornate brim around. With the right hand, he is holding vine leaves and with the left hand a wild beast by its rear legs. This wild beast named Lupus is the 45th constellation.

The designation of the constellation $s\bar{u}rat Qanturas$ is engraved across the equine body. A star on the hoof of the higher foreleg carries the name *rijl Qanturas*, 'foot of the centaur' (α Centauri); it is the third brightest star in the heavens and the nearest one to us. On the body of the wild beast is the designation of the constellation $s\bar{u}rat Sab^c$.

In the figure of Bootes, the star η Bootis on the forward leg, which is usually labelled as *Mufrad al-Rāmiḥ*, carries the following label.



 $\label{eq:Figure F032a.11-Label of the Star η Bootis$} (Sotheby's London, 27 October 2021, 205 ; © Photo courtesy Sotheby's, 2023)$

alladī 'alā al-sāq al-yusrā mufrad al-rāmiķ

wa al-ithnān allaḍān maʿahumā al-silāḥ

'[The star], which is on the left leg, is mufrad al-rāmih

and the two [stars] that the armament is together with them.'



Figure F032a.12 – Label of the star β Piscis Austrini (Sotheby's London, 27 October 2021, 205; © Photo courtesy Sotheby's, 2023)

The star β Piscis Austrini in the mouth of Piscis Austrinus carries the following label:

alladī ʿalā ākhir al-māʾ min kawkabih-ī, sākib al-māʾ, wa huwa al-difdaʿ al-awwal wa al-zalīm aydan 'The last star at the end of the mā' (water), sākib al-mā' (the pourer of water = Aquarius), that is al-difdaʿ al-awwal (the first frog) and al-zalīm (ostrich) as well.'

STAND

The stand consists of four ornate legs which rest on a circular ring and support the horizon ring. There is semi-circular arc below the globe, but the meridian ring is missing.

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K005A SANSKRIT HORARY QUADRANT

Ca. 1823 Radius 230 mm Cologne, PC

This quadrant, with a radius of 230 mm and thickness of 16 mm, is made of wood and is painted in reddish orange colour on which letters and numerals are written in black. Part of thickness is hollowed out, where a wooden index is stored when not in use. At the apex of the quadrant is a brass pin with a pointed tip to which the wooden index can be attached for taking observations.

From one of the radii project two vertical sights with sighting holes bored them. When the sun is viewed through these sighting holes, the wooden index on the observe side will show the current time in *ghațīs*. The *ghațī* has been the traditional standard unit of time in India. It is the one-sixtieth part of the nychthemeron and is equal to 24 modern minutes.

The numerals and letters are in Devanagari script and in Sanskrit language. The orthography of Sanskrit words is not always correct; sometimes short vowels are written as long vowels and vice versa. Moreover, vernacular influence can be seen in the phonology. The numerical fractions are represented in the following manner: a single vertical stroke stands for $\frac{1}{4}$ and slightly tilted horizontal stroke for $\frac{1}{16}$. Thus (29 ||-) stands for (29 + $\frac{2}{4}$ + $\frac{1}{16}$) or (29 + $\frac{9}{16}$).

The quadrant is in a perfectly well-preserved condition, except that some letters and numerals are slightly effaced on the right-hand side on both faces. As a result, two crucial words cannot be properly deciphered, viz. the name of the Mahārājā who caused this quadrant to be made and what appears to be the name of the maker.

Horary quadrants are latitude-specific, but no latitude is mentioned on this quadrant. The shape of the numeral 9 is peculiar to Rajasthan. If the Mahārājā who commissioned this quadrant could be identified, then the name of his capital and its latitude can be deduced, but unfortunately the Mahārājā's name cannot be properly deciphered. On the reverse side, the duration of the longest day in Cancer stated to be 33 *ghațīs* which is tantamount to 13 hours and 12 minutes. The two major centres where astronomical instruments were produced are Jaipur and Kuchaman, both considered to

be roughly on the latitude of 27° N. At Kuchaman, in particular, Sanskrit astrolabes were produced throughout the nineteenth century. Therefore, it is likely that the present horary quadrant may have been produced at Kuchaman.

OBVERSE SIDE



Figure K005a.1 – Obverse Side of the Quadrant (Photo by the Owner)

The horary quadrant is drawn on the obverse side. Here the arc of the quadrant is divided into units of 3° each and numbered in threes from 3 to 90 in anti-clockwise direction. Since this scale is used for measuring the altitude of the Sun at the time of observation, it carries the label *unnatāmsā* (altitude in degrees) on the left margin.

Above this arc are drawn 15 parallel scales. Radial lines, drawn from the centre to each of the 3° divisions of the arc, divide each of the 15 parallel scales into 30 cells

each. The first of the 15 scale shows the lengths of the shadow cast by a gnomon of twelve digits and the second scale the same by a gnomon on 7 digits.

The 13 scales above these pertain to the halves of zodiac signs with appropriate labels on both sides. On the left, the labels read upwards from below Gemini 15, Gemini 30, Cancer 15, Cancer 30 ... Scorpio 15, Scorpio 30, Sagittarius 15. On the right, the labels read, again upwards from below, Taurus 30, Taurus 15, Aries 30, Aries, 15, ... Capricorn 30, Capricorn 15, Sagittarius 30.

The cells are filled by appropriate values of times in *ghațīs* and their fractions.

Reverse Side



Figure K005a.2 – Reverse Side of the Quadrant (Photo by the Owner)

The reverse side carries a table with 12 rows 7 columns. Each row pertains to a zodiac sign listed from Aries (*meşa*) to Pisces ($m\bar{n}a$). The first column contains serial numbers from 1 to 12. In the second column, the rows are named respectively as *meşa*-

saṃkrāṃta-dina (days pertaining to Aries), *vṛṣa-saṃkrāṃta-dina* (days pertaining to Taurus), *mithuna-dina* (Gemini days) ... *mīna-dina* (Pisces days). The third column has what are apparently the days in each sign, which vary 33½ to 4. This variation is quite incomprehensible. In the fourth column, each row carries the phrase *dina-māna* which can only mean the day-measure or the length of the day. Does this imply the duration of the longest day in that particular zodiac? But the values in the next column do not show a gradual increase and gradual decrease. Probably some of the values are copied wrongly.

In the sixth column, each row is filled with the word *sesa*, which ought to be written correctly as *seṣa*. It means "rest" or "remainder". What does this imply? If the fifth column carries the duration of the longest day in *ghaṭīs* in a particular zodiac sign, then the word "rest" or "remainder" may refer to the shortest duration of the night in *ghaṭīs* in the same zodiac sign. Then the sum of the values in columns 5 and 7 ought to be 60 *ghaṭīs*, but that is not so in any of the 12 rows. Either there are errors in the numbers, or the word "rest" or "remainder" refers to something totally different. Moreover, some cells are left blank. I am unable to explain the purport of this table satisfactorily.

1	Aries days	10	day measure	31		
2	Taurus days	2*	day measure	32	rest	331/2
3	Gemini days	331/2	day measure		rest	
4	Cancer	27	day measure	33	rest	
5	Leo	10	day measure	32	rest	31½
6	Virgo	15	day measure	30	rest	291⁄2
7	Libra	18	day measure	28	rest	271⁄2
8	Scorpio	10	day measure	27	rest	26
9	Sagittarius		day measure	16½		
10	Capricorn	5	day measure	26	rest	271⁄2
11	Aquarius	17	day measure	28	rest	29
12	Pisces	4	day measure	29	rest	

INSCRIPTION

On the reverse side, below the table which has been discussed above, occurs the following inscription in three lines, mentioning the name of the instrument, the name of patron who commissioned this quadrant, date of manufacture, and finally the name of the maker. Unfortunately, the names of the patron and the maker cannot be fully deciphered. The patron is stated to be Mahārāja Jorāva**ga-jī. The maker is mentioned as redīlalaṣa; perhaps we should read it as redīlāla-ssa, i.e., of/byRedīlāl.



turī-jaṃtra māhārājā jorāva**īgajī karāpītaḥ saṃvat 1883 varṣe śāke 1745 || āśvina suda 15 śanī redīlalasā

Here the year is given in two eras, namely Vikrama Samvat 1883 and Saka 1745. Since the difference between these two eras is 135 years, one of the given values is wrong. If we accept Vikrama Samvat 1883, then the date translates to 16 October 1826, which is Monday. It is two days ahead of Saturday which is mentioned in the inscription.

On the other hand, Śaka 1745 yields 19 October 1823. It is a Sunday, i.e., just one day ahead of the given Saturday. Therefore, Śaka 1745 is preferable. By adjusting the date according to the weekday, we get Saturday, 18 October 1823.

Accordingly, the inscription may be rendered thus:

'[This] quadrant (*turī-jamtra*, correctly *turīya-yantram*) has been caused to be made (*karāpītah*, correctly *kārāpitam*) [by] Mahārājā Jorāva**īga-jī.

'[In] Vikrama era 1880 year (*saṃvat 1883*, correctly *1880*) in the *Śaka* era 1745 \parallel [lunar month] *Āsvina*, bright fortnight (*suda*, correctly *sudi*) [lunar day] 15, Saturday [.] Of/by Redīlāla.'







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