

A SURVEY OF HISTORICAL ASTROLABES OF DELHI*

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Astrolabe is better known than all the measuring instruments which have come down to us from antiquity. Even today it may still be found in use. The astrolabe has long history at its credit. Astrolabe is a versatile scientific instrument with wide applications in Astronomy, Geography, Surveying and Astrology and played an important role in the scientific investigations of the Medieval times in the Middle East, Latine Europe and India. There are two most important types of astrolabes, i.e. the *Armillary*—which consisted essentially of three rings arranged at right angles to each other and the planisphere—which carried a stereographic projection of the heavens on a circular plan surface. The knowledge of astrolabes entered in India through Harran in Syria during seventh century and later on the Indian developed the science. An attempt has been made to highlight the following: (a) to trace out the history and utility of the astrolabes during the medieval period; (b) the main components of astrolabes; (c) the typological variations of astrolabes with reference to their material, size, longitudinal and latitudinal positions and utility; (d) the significant astrolabes of Delhi with their salient features; (e) the astrolabe makers and astrolabe making centres in India; and (f) problems and some suggestions relating to the study, conservation and deciphering of the damaged historical astrolabes.

Astrolabe is a versatile scientific instrument with wide applications in astronomy, geography, surveying and astrology; and played an important role in the scientific investigations of the medieval times, in the Middle East, Latin Europe and India. It appears that the Alexandrian Greeks were acquainted with instruments of this type; in the sixth and seventh centuries John Philoponus and Severus Sebokht

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wrote treaties on the instrument. Further perfection and development of astrolabe were without doubt due to the Arab astronomers and scientifically trained master craftsmen. In Europe, its brilliant period coincided with the Renaissance until it was superseded by telescopes and their varied applications in astronomy and other fields. In the Middle East, India and elsewhere where the introduction of telescopes and related instruments was delayed, astrolabe continued to remain the versatile instrument that it was, till the end of the eighteenth century. In India, the majority of astrolabes that have so far come to light belong to the seventeenth and the eighteenth centuries, although a few pieces of much older date and those constructed as late as the nineteenth century are known.

Astrolabes are mainly of three types: planisphaerum or flat, spherical and linear. The commonest is the first type which represents the projections of the celestial sphere on a flat surface. The second is the representation of the sphere itself, while the third is the projection on a straight line of the projections of the sphere on a plane. The majority of astrolabes of Delhi are flat; a few spherical examples are recorded; but representatives of the last type have not yet been met with in India.

I. *Astrolabes of the National Museum, Delhi*

In all six pieces of Astrolabes both dated and undated are found in the National Museum. They are as follows:

1. Vuhlomalla's, undated Astrolabe
2. Dharam Chand's undated Astrolabe
3. Gulam Qadir of Kapurthala, a student of Ballumal, Astronomer of Lahore (1278 A. H.)
4. Unnamed, undated Astrolabe
5. Unnamed, undated Astrolabe
6. Unnamed, dated 1129 A.H. Astrolabe.

II. *Astrolabes of Red Fort Museum, Delhi :*

The following astrolabes deserve special mention:—

1. Zia-ul-Din Muhammad Ibn Mulla, 1087 A.H., 1676 A.D.
2. Muhammad Salih of Tatta, 1070 A.H., 1660 A.D.
3. Unnamed, undated.
4. Unnamed, undated.
5. Unnamed, undated (thirteenth century).
6. Unnamed, undated (seventeenth century).
7. Muhammad Muqim Ibn Mullah, Isa Ibn al-Haddad, Usturlabi Lahori Humayuni, 1034 A.H., 1625 A.D.
8. Muhammad Muqqim Ibn Isa Ibn al-Haddad Usturlabi Humayuni Lahori, 1047 A.H., 1637 A.D.

Now we may discuss about the constructional details of the above mentioned astrolabes.

ASTROLABES OF THE NATIONAL MUSEUM¹, NEW DELHI

1. *Vuholmalla's undated² Astrolabe* :

It consists of a single brass disc of diameter 9.3 cm and thickness 1.40 mm, inscribed in *Devanagari* script and numerals. The face consists of eleven concentric rings. The first three rings are blank; the next divided into twelve spaces contain the names of the twelve signs beginning with *Meṣa* at the vertical line and ending with *Mina*. In the next two rings, each sign is divided into 30 degrees at intervals of two degrees and marked at the intervals of six degrees (three divisions). The same is repeated in the next three rings. The two rings at the periphery are graduated into 360 degrees and marked at the intervals of six degrees, e.g. 1, 2, 3, ... 60. The central region is marked 'latitude 36° 68'. The back is divided into four quadrants, each graduated into 90 degrees from the horizontal to the vertical line and marked at the intervals of 6 degrees, e.g. 6, 12, 18 ... 90. Immediately below the graduations at the periphery, there are five annular rings running through the four quadrants and marked with numerals.

2. *Dharma Chand's undated Astrolabe³*

It is a flat brass astrolabe inscribed in Arabic script (*Naskhi*) and numerals. It consists of the mater and the dioptra (*al idāde*) fixed at the back. The mater is of dia. 10.5 cm and thickness 2.50 mm and is fitted at the centre with an annular ring of outer dia 5.5 cm and inner dia. 4.2 cm and a circular disc within the annulus, of dia. 4.2 cm. Both the ring and the central disc can be rotated with the help of a raised pin attached to each of the pieces. The face is engraved with six annular rings of varying widths. The first two rings starting from the periphery are divided into eight spaces by radial lines. These spaces are engraved with month names in the following order starting from top and proceeding anti-clockwise:

1st ring :	September	June	March	February	August	May	October	July
	December		November					April
								January
2nd ring :	July	September	June	March	November	August	March	January
	April	December			February			October

The following rings are engraved with the names of the seven days of the week and of Indian months. The rim contains the legend that the upper disc should be moved after four years because in this above mentioned year the month of February has 29 days. The back is marked with a number of annular rings. The inner ring contains the names of twelve signs of the zodiac. In the next ring each zodiac is divided into 30 degrees marked at the intervals of 6 degrees. The next ring contains 60 divisions marked by Arabic numerals 1, 2, 3 ... 60. The use of this astrolabe was primarily calendrical.

3. *Gulam Qadir's Astrolabe of 13th century*⁴

It is dated in A.H. 1273 samvat 1918. It was constructed by Gulam Qadir of Kapurthala, a student of Ballumal, astronomer of Lahore under the orders of Rajjada Shankerdas Harbanspuri. It is a flat brass astrolabe inscribed in Arabic numerals and script (*Naskhi*). The instrument includes the mater of dia. 33.6 cm, the *'ankabut'* of dia. 27.6 cm, two tablets of dia. 27.6 cm each and the dioptra (*al-idade*) of length 29 cm. The tablets are fixed by a pin. The mater has no raised rim unlike most flat astrolabes. There are four rings in the periphery, the first three containing the names of places and their latitudes and longitudes and the fourth innermost ring containing graduations into 360 degrees marked at intervals of 6 degrees. The central space immediately after the rings is engraved with the projections of the two tropics, the *almucantarats*, azimuth circles, hour circles etc. for the latitude 32°. The *almucantarats* are given at intervals of 3 degrees, that is, the astrolabe is a tripartite (*thulthi*). In the back, the upper quadrants contain the usual sine graph and the lower quadrants the shadow scales in digits and feet. The *ankabut* contains the ecliptic circle engraved at its rim with the names of signs of twelve zodiacs, each sign being graduated into 30 degrees marked at the intervals of 6 degrees. The indicators carry the names of 22 stars,—8 outside the ecliptic circle and 13 within it. One tablet contains the projections of horizons on both sides and the other contains *almucantarats* etc. for latitude 36° on one side only. The astrolabe is a specimen of fine workmanship.

4. *An unnamed undated Astrolabe*⁵

The piece consists of one brass disc of diameter 13.2 cm with a circular cut at the centre fitted with a glass piece of diameter 3 cm. The face has engraved on it a circle of diameter 6.3 cm. The back is fitted with a fixed *al-idiade* of length 13.2 cm. The dioptra has at its two ends two plates at right angles to its face, provided with sighting holes and slots. The instrument is incomplete in its parts.

5. *An unnamed and undated Astrolabe*⁶

It is a flat astrolabe made of brass and inscribed in Arabic numerals and scripts (*Naskhi*). It consists of the mater of dia. 14 cm, the *ankabut* of dia. 12.2 cm, all fitted together by a pin passing through a central hole in each piece. The mater has no raised rim. The periphery of the face is graduated into 360 degrees in an inner circle and 60 degrees in an outer circle where it is marked as 1, 2, 3 ... 60. The rest of the face within the circular scale is engraved with projections of the altitude circles (*almucantarats*) at intervals of 6 degrees (that is, the astrolabe is a *sudsi*), the azimuth circles, the two tropics, the equator, the hour circles, with the two extremities of the horizon marked 'east' (*mashriq*) and 'west' (*maghrib*). The back is divided into four quadrants of which the two upper ones have their peripheries graduated into 90 degrees marked at the interval of 6 degrees. The upper right contains the sine graph and the upper left is kept blank. The lower quadrants contain the rectangular shadow scale; the rim

is divided into 15 divisions in each of the lower quadrants, but not marked, giving the impression that the astrolabe was not completed. The *ankabut* contains the ecliptic divided into twelve horizons with their names engraved; each sign is subdivided into five parts and marked 6, 12, 18, 24 and 30. Eleven stars are engraved on the indicators (*shaziva*) of the spider.

6. *An unnamed and undated Astrolabe*⁷

The astrolabe is made of brass and is engraved in *Naskhi* character and Arabic numerals. Its component parts are: the mater of dia. 15.3 cm (length of the suspension system—5.5 cm); the *ankabut* of dia. 13.3 cm; 3 tablets of dia. 13.3 cm each; and the dioptra (*al idade*) of length 13.6 cm. The different pieces are fixed in the mater by a pin passing through a central hole in each piece. The rim of the mater is graduated in an outer circle into 60 divisions, each division being further subdivided into 6 degrees in the next inner circle. The venter is engraved with three groups of rings each containing the names of places and their latitudes and longitudes. The back contains the sine table on the upper right quadrant and the shadow scales in the two lower quadrants. The remaining space is left blank. The *ankabut* contains the graduated ecliptic with the names of the twelve signs of the zodiac engraved. A few stars are engraved on the pointers. Other tablets contain the *almucantarats* drawn at the intervals of 6 degrees, the azimuth and hour circles etc. The astrolabe is sexpartite (*sudsi*). The workmanship is ordinary.

7. *An unnamed dated Astrolabe of A.H. 1189*⁸

It is a flat astrolabe made of brass. It consists of the mater (*umm*) of dia. 15.1 cm (length of the suspension system with *kursi* and *halq* 9.1 cm), the spider (*ankabut*) and seven tablets, each of dia. 13.5 cm. The dioptra is missing. The astrolabe is inscribed in *Naskhi* character and *abjad* notation for numbering. The raised rim of the mater is graduated into 90 degrees in each quadrant in the anti-clockwise direction, being marked at the intervals of 5 degrees. The venter is engraved with three groups of concentric rings, each group containing the names of places and their latitudes and longitudes. The back is engraved with the sine table (upper left), declination circles (upper right) and the shadow scales, both circular (at the periphery) and rectangular (symmetrically at the two lower quadrants). The shadow scales are given in both feet and digits. The *ankabut* contains the usual ecliptic circle, divided into twelve parts, each graduated into 30 degrees and marked by the name of a sign of the zodiac. The indicators of the spider are engraved with the names of 24 stars. One of the seven tablets contains the projections of horizons (*afaqsiyah*) on both sides. The remaining tablets contain projections of the two tropics, the *almucantarats*; the hour circles, temporal lines etc. for different latitudes. The *almucantarats* are given at the intervals of 3 degrees, that is the astrolabe is a tripartite (*thulthi*) one.

ASTROLABES OF THE ARCHAEOLOGICAL MUSEUM, RED FORT, DELHI⁹1. *Zia-al-Din Muhammad Ibn Mulla's Astrolabe, A.H. 1087, A.D. 1676*:¹⁰

It is a mounted brass sphere fitted with a horizontal and a vertical ring within which the sphere is placed and is capable of rotation about any axis. The dia. of the sphere is 6.8 cm. The inner and outer diameters of the two rings are 6.9 cm and 8.7 cm (horizontal ring) and 8 cm (vertical ring). The horizontal ring is graduated and is marked with four cardinal points. The sphere is engraved with the ecliptic and the equator circles. The ecliptic is divided into twelve spaces each containing the name of a sign, e.g. *Hamal* (Aries), *Thaur* (Taurus), *Jauza* (Gemini), *Saratan* (Cancer), *Asad* (Leo), etc. Each zodiac is subdivided at intervals of two degrees and marked 6, 12, 18, 24 and 30. The positions of a large number of stars, each indicated by a dot enclosed in small circle are given, and the names of most of them are clearly engraved in *Naskhi* characters. Kaye has given the names of 70 of these stars, together with their latitudes and longitudes, their modern equivalents. By a comparison of the longitudes as given on the sphere with those given in Ulegh Beg's Star Catalogue after taking into account the procession of the equinoxes, Kaye determined the age of the spherical astrolabe as A.D. 1664, which compares well with the date inscribed on the astrolabe itself.

2. *Muhammad Salih of Tatta's Astrolabe, A.H. 1070, A.D. 1660*:¹¹

This is a brass celestial sphere without stand. The stand with the mounting arrangement is probably lost. The diameter of the sphere is 21.2 cm. Arabic (*Naskhi*) script is used in the engravings. Longitudes are engraved, as also a few star names and constellations.

3. *An unnamed, undated Astrolabe*:¹²

It is a brass sphere mounted on a stand. The stand is provided with rings, one horizontal and the other vertical within which the sphere just fits and is capable of rotating in any direction. The diameter of the sphere is 16.2 cm; the inner and the outer diameters of the horizontal rings are 16.3 cm and 18.7 cm respectively. Both the rings are graduated. The vertical ring can be fixed in any position with respect to the horizontal one by means of two pins. The sphere is engraved with ecliptic and equator circles. The ecliptic is engraved with zodiacal signs, each sign being subdivided into 30 degrees and marked at the interval of 5 degrees. The equator is also graduated. Constellation figures are engraved.

4. *An unnamed, undated Astrolabe*:¹³

It is a brass astrolabe consisting of the mother or mater (*umm*), the spider (*ankabut*), five discs (*safiha*), inscribed in Arabic (*Naskhi*) characters. The dioptra (*al-idade*) is missing. The diameter of the mother is 24.1 cms; the length of the *kursi* and *halqa*, taken together, is 7.2 cm. The *ankabut* and the discs have a diameter of 22 cm each. The rim of the mother is divided into four quadrants, each being graduated into 90 degrees and marked at the intervals of 3°. The vector is

divided into three annular zones, each zone containing three annular concentric rings engraved with the names of places and their geographical latitudes and longitudes. The back (*zahar*) has a graduated scale at the rim in the four quadrants, the upper two being similar and divided into 90° at intervals of 3° . The two lower scales are for measuring shadows and graduated from 1 to 60 feet or digits. The left upper quadrant contains the graphic sine table and the right the declination circles. The lower quadrants contain the names of 12 zodiacs, 28 lunar mansions, shadow scales and astrological tablets and decans and their lords. Of the five discs, one contains the projections of horizons and the measures on the '*ankabut*', and the others are engraved with *almucantarats* for different latitudes. The astrolabe is of the class of *tamm* (complete) as 90 *almucantarats* are engraved and marked at the intervals of 2 degrees. The duration of the longest day corresponding to the latitude is inscribed in the discs.

5. *An unnamed, undated Astrolabe (thirteenth century A.D.)*¹⁴ :

The astrolabe is made of brass and is engraved in *Kufic* characters. It consists of the mother or mater (*umm*), the spider ('*ankabut*) and the dioptré (*al-idade*). The diameter of the mother is 14.3 cm, and with the *kursi* and *halqa*, 18.4 cm. The spider's dia. is 12.6 cm. The *al-idade* is 12.9 cm in length. All the parts are fixed in the mother with a pin. The ventor of the mother is engraved with a projection of the celestial sphere and its rim is graduated in degrees in groups of five upto 360. The back (*Zahar*), divided into four quadrants, the upper two engraved with *Zarqali* projections and the lower left with a graphic sine table and the edge of the lower right with a shadow scale. The '*ankabut*' has 29 star names engraved. From the star catalogue and the precession of the equinoxes, Kaye determined the age of the astrolabe to be around A.D. 1308 or A.D. 1287, that is *c.* thirteenth century A.D.

6. *An unnamed, undated Astrolabe (c. seventeenth century A.D.)*¹⁵ :

It is a brass astrolabe engraved in *Devanagari* characters. It consists of the mother, 17.2 cm in dia. and 29.2 cm including the suspension system, the spider, 15.9 cm in dia. and two plates, each 15.9 cm in diameter. The dioptré is 15.5 cm in length. The spider contains the usual ecliptic circle with 12 divisions of the zodiac engraved with their Sanskrit names, e.g., *Meṣa* (Aries), *Vṛṣa* (Taurus), *Mithuna* (Gemini), *Karkaṣa* (Cancer), *Siṃha* (Leo), etc. The spider has 25 indicators but not all of which are engraved with star names in *Devanagari*, e.g. *Citrā* (Spica), *Svātī* (Arcturus) *Viśākhā* (Librae), *Abhijit* (Vega), *Śravaṇa* (Altair), *Pūrva Bhādrapada* (Pegasi), *Rohiṇī* (Aldebaran) to mention a few. The ventor of the mother is blank, but the back divided into four quadrants contains the graphic table of sines (upper left), declination circles (upper right) and the shadow scales (two lower quadrants). The two plates contain projections of altitudes (*almucantarats*), temporal hour lines and latitudes with their corresponding longest days (*paramadina*) in *ghaṭis* and *palas* and the lengths of *chāyā* (shadow) and *karṇa*

(hypotenuse). One face of one of the two tablets contains the projections of horizons. After the conversion of the time units into hours and minutes, the longest day for the latitude of Ahmedabad, 22° is 13 h 24 min. and that of Ujjain, 23° is 13 h and 32 min.

7. *Muhammad Muqim ibn Mullah 'Isa ibn . al-Haddad usturlabi Lahori Humayuni's Astrolabe (A. H. 1034, A.D. 1625)¹⁶ :*

It is a brass astrolabe (plane) inscribed in Arabic (*Naskhi*) characters. It consists of the mother or mater, dia. 11.4 cm and 16.6 cm including the *kursi* and the *halqa*, the spider (*'ankabut*), dia. 12.2 cm, five tablets (*sufa'ih*), dia. 12.2 cm, each and the dioptré (*al-Idade*), 10 cm in length. The rim of the mother is graduated into 360 degrees marked at the intervals of 6 degrees, i.e. 6, 12, 18 etc. in *abjad* notations. The ventor is marked into two groups of three annular rings further divided into a number of annular spaces but radial lines. Each space is inscribed with the names of some important places and their latitudes and longitudes. The back (*zahar*) is divided into four quadrants. The rim of the two upper quadrants is graduated into 90 degrees from the horizontal line to the vertical and marked at the intervals of 6 degrees. The upper left is engraved with horizontal lines from the vertical line to the rim and serves the purpose of the sine table. The upper right contains the declination circles. The two lower quadrants are engraved with the shadow scales in feet and digits, the names of twelve zodiacal signs and twenty-eight lunar mansions (*manāzil*). The name of the maker and date are inscribed within the rectangular space in the centre of the lower quadrants. 33 stars are engraved on the indicators of the spider, in addition to the names of the zodiacal signs on the ecliptic circle. The tablet of horizons (*safihah-al-afaquiyah*) and the measures on the *'ankabut* (*safihah mizan 'ajkabut*) are engraved, one on each side of a tablet. Other tablets contain projections of parallels of altitudes (*almucantarats*) for altitudes 12, 18, 22, 24, 27 and 29 degrees as also the tropics, the equator, temporal hour lines, the longest day measures for the latitude etc. The *almucantarats* are drawn at intervals of 6 degrees, that is, the astrolabe is a *sudsi*.

8. *Muhammad Muqim ibn 'Isa ibn al-Haddad usturlabi Humayuni Lahori's Astrolabe (A.H. 1047, A.D. 1637)¹⁷ :*

It is a plane astrolabe made of brass and inscribed in *Naskhi* characters. It consists of the mother or mater (*umm*) of dia. 20.6 cm, the spider (*'ankabut*) of dia. 18.9 cm. The dioptré (*al-idade*) is 18.7 cm long. The rim of the mother is graduated into 360 degrees and is marked at the intervals of 5 degrees. The ventor is divided into four annular spaces, each further subdivided into three rings. Within these rings are engraved the place names and their latitudes and longitudes. The back (*zahar*) is divided into four quadrants. The rim of the upper two quadrants is each divided into 90 degrees from the horizontal to the vertical line and marked at the intervals of 5 degrees. The upper left is for the sine tables and the upper right is engraved with declination circles. The two lower quadrants contain

graduations at the rim and a rectangular scale for measuring shadows in feet (*zill-i-aqdam*), and shadows in digits (*zill-i-asabi'a*). Within the rectangular scale are engraved six semi-circular rings containing the names of 28 lunar mansions, 12 signs of the zodiac and table of Hudud with their decans and Lords. The 'ankabut is engraved with 37 star names in addition to the ecliptic with the names of the 12 zodiacal signs. Of the five discs, one is engraved on one side with the projections of the horizons and the other side with the measures on the 'ankabut to enable determination of the longitudes and latitudes of the 'ankabut stars. The remaining four tablets are engraved with *almucantarats* at intervals of two degrees (*nisfi*) for different latitudes, the two tropics, the equator, the temporal lines and the extent of the longest day in hours and minutes for the corresponding latitudes. The workmanship is excellent.

The foregoing account reveals the following :

1. That brass is the material which is applied in almost all kinds of astrolabes.
2. That there is no uniformity with regard to the diameter of the mater, the diameter of the 'ankabut and the thickness of the astrolabes.
3. That these astrolabes marked a distinctive typological uniformity within themselves.
4. That some of the astrolabes are inscribed in the Arabic, Kufic or *Naskhi* characters with *Abjad* numerals; while others are inscribed in the *Devanagari* script and numerals.
5. That some of the astrolabes are dated without makers' name; some are undated without makers' name; while some others are both dated with the maker's name.
6. That the details of their construction is available in some cases while only few of them are simply reported by the historians. Their details are not yet available.
7. That these astrolabes refer to different longitude and latitude of cities; star names; signs of zodiacs, names of days, weeks and months etc.
8. That the astrolabe-making in India could be traced out from the advent of the Arabs in India, and the tradition continued in the preceding centuries down to the nineteenth century.

The systematic study of these astrolabes in a historical perspective would be highly profitable in tracing out the gradual evolution of the technique of Astrolabe-making in India right from twelfth century onwards down to the early nineteenth century. But the task is not so easy as it amounts to a thorough and minute study of these astrolabes which are very complicated in nature. The study of these

historical astrolabes would be more meaningful and purposeful to a science historian if the entire problem can be reviewed from the following angles:—

- (a) Whether the signatures of the astrolabe-makers or any kind of seal engraved on it is actually authentic or not. Is there any room of forgery, duplicating or copying out an astrolabe previously devised.
- (b) Did any institution or school or traditional craft of astrolabe-making ever exist in India? If so, who were the pioneers? Where those centres were located and what was their actual nature?
- (c) Whether the Indian Astrolabes constructed by the same maker differ with their counterparts found in the different parts of Europe, Middle-east and Islamic countries. To what extent they differ in construction with the contemporary astrolabes found in other parts of world?
- (d) To what extent the information furnished by the astrolabes is authentic?
- (e) To what extent the total available information is corroborated by the contemporary or anterior sources?
- (f) To what extent the regional variations or the typological variations in the art of astrolabe-making can be traced out?
- (g) To what extent Humayun, the Mughal Emperor, made contributions in the art of astrolabe-making?
- (h) To what extent the longitudinal and latitudinal positions of different cities, places, help us in determining their geographical location precisely?

The study on the Indian Astrolabes with the aforesaid set-in objectives has, indeed, been terra incognita. It will indeed be an onerous task before the historians to take up the stubborn problem with all their earnestness and fill up the vast gaps of knowledge which lie untapped at our disposal in the art of Astrolabe-making in India. Such studies would unravel the dim vista of India's highly rich and voluptuous techno-mechanical heritage of the by-gone days, which the preceding centuries imbibed and carried on with persistence and innovations even as late as in the mid-nineteenth century.

NOTES AND REFERENCES

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