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THE LAHORE FAMILY OF ASTROLABISTS AND THEIR OUVRAGE

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1.1 In 1935, at the request of Dr. Harald von Klüber of Berlin, Syed Sulaiman Nadvi put together a list of astrolabes and celestial globes manufactured by one Ḍiyāʾ al-Dīn of Lahore. Through this exercise, Nadvi brought to light the existence of a family of astrolabe makers at Lahore, who were active during the reigns of Humāyūn to Aurangzeb. Nadvi identified eight astrolabes and four celestial globes made by four different members of this family.[1]

1.2 Sixty years later, today we know of more than one hundred instruments signed by seven members of this family belonging to four successive generations, thanks to the efforts of Derek Price,[2] Alain Brieux and Francis Maddison,[3] Emilie Savage-Smith,[4] David King,[5] and myself.[6] Besides the one hundred and odd signed instruments, there are also several unsigned specimens which can be attributed to this family on stylistic grounds. These instruments are scattered in various parts of the world: India, Pakistan, Iraq, Kuwait, Egypt, Turkey, France, Germany, the Netherlands, Britain, Canada and the United States of America.[7] Thus in the entire history of scientific instrumentation in the Middle Ages there has been no other family comparable to this one, be it in the long continuous family tradition, be it in the immense quantum of work produced, or in the artistic and technical excellence of production, or in the innovations in design.

1.3 In the course of preparing *A Descriptive Catalogue of Indian Astronomical and Time-Measuring Instruments,* I had occasion to study more than fifty astrolabes and celestial globes of this family which are deposited now in various public and private collections in India, U.S.A, France, the Netherlands, and U.K.[8] My project will take a few more years to complete and there is a fair chance of some more unpublished instruments of this family coming to light. Even so, it is time to make an interim assessment of the achievements of this family, and also to pose some interim questions. Before doing this, a few words are in order on the function and history of the astrolabe and celestial globe.

2.1 The astrolabe and the celestial globe are the two most important astronomical instruments invented in the Hellenistic antiquity. Together with Ptolemaic astronomy, these two instruments were adopted by the Islamic world, where they were preserved, elaborated upon and disseminated westwards to Europe and eastwards to India.

2.2 The celestial globe[9] (Arabic: *al-Kura*) consists of a spherical globe made usually of brass on which the celestial equator, ecliptic, tropics and other circles are plotted. Upon this grid are marked the positions of about 1020 fixed stars either according to the coordinates given by Ptolemy in his *Almagest,* or by Ulūgh Beg in his Tables,[10] or by any other subsequent astronomer.[11] Often, the figures of the twelve signs of the Zodiac, and also the figures of another 36 constellations like the Great Bear, as conceived in the Hellenistic and Islamic traditions, are drawn with great ingenuity.

2.3 The celestial globe is mounted on a stand consisting of a horizontal ring and a vertical ring, these two acting as the local horizon and meridian respectively. When the axis of the globe is adjusted according to the local latitude, the hemisphere visible above the horizontal ring will resemble the starry sky above the viewer's latitude.[12] Thus the celestial globe makes an excellent teaching instrument.

3.1 The astrolabe[13] (Arabic: *asṭurlāb or aṣṭurlāb*), on the other hand, is a versatile instrument for observation and computation. Here the great circles and other circles, the star positions etc. are drawn on a plane of two dimensions[14] by a method called stereographic projection which was known already to Hipparchus in the second century B.C. In a stereographic projection, the circles are drawn as circles and the angle between any two circles remains the same on the two-dimensional plane. Since the projections drawn on the common astrolabe pertain to the northern celestial hemisphere, it can also be called the northern astrolabe (*asṭurlāb shumālī*).[15]

3.2 The astrolabe consists of two principal parts. First, the rete (Arabic: *ʿankabūt*) which is an openwork circular disc, containing stereographic projections of the ecliptic and of the positions of some prominent fixed stars. Leaving the ecliptic and the star positions, the remaining part of the disc is cut out, so that the rete forms a sort of net through which the lines upon the tympan underneath can be read. The second part, called tympan, or plate or disc (Arabic: *ṣafīḥa*) represents the sky as seen from the observer's latitude. It contains stereographic projections of the equator, the tropics, and equal altitude curves (Arabic: *al-muqanṭara*) and *afimuth* lines. There are also curves to measure time, in seasonal hours, or in equal hours. Some Islamic astrolabes contain additional curves to indicate the prayer times. The rete, when rotated above the tympan, will simulate the motion of the heavens upon that particular latitutde on any given day. Since the tympan is calibrated for a specific locality, one needs to have several tympans to serve different terrestrial latitudes.

3.3 The rete and the set of tympans are accommodated in the hollow space of a thicker disc with a raised rim, which is named appropriately as the mater (Arabic: *umm*). On the inner side of the mater, there is usually a geographical gazetteer. The mater is surmounted by a crown-like triangular projection called *kursī,* to which are attached a shackle, a ring and a cord for suspending the astrolabe. Often the *kursī* and the rete are highly decorated.

3.4 The back of the mater (Arabic: *ẓahr*) is divided into four quadrants. Each of these contains various trigonometric scales and astrological tables. A dioptre called alidade (Arabic: *al-ᶜiḍāda*) with two sighting vanes is pivoted to the centre of the mater at the back. This is the observational part of the astrolabe.

3.5 With the alidade, one measures the altitude of the sun in the daytime, or the altitude of some prominent fixed star at night. When the rete is adjusted according to these values, it simulates the starry heavens upon the observer's place. Then one can read off from the dial the time and also note the times of prayer. One can also directly read off the ascendant for that moment and the other three points on the ecliptic, without resorting to complicated calculations. The knowledge of these four points on the ecliptic is essential for casting horoscopes, or for determining the auspiciousness or otherwise of a given moment. More important, the astrolabe works as an analog computer, and can be used to solve a number of trigonometrical problems. The astrolabe can also be used in land surveying, for determining the heights or depths of objects and for calculating the distances.

3.6 Finally, it was thought that when one held the astrolabe in one's hand, one was in fact holding [the secrets of] the universe. Therefore any person who owned or understood the astrolabe was highly esteemed throughout the medieval world.

4.1 The astrolabe was introduced into India probably in the first half of the eleventh century by al-Bīrūnī, who authored several tracts on this instrument. In the subsequent centuries, scholars migrating from Central Asia to the court of Sultans at Delhi must have brought with them their personal astrolabes together with their collection of books.

4.2 Manufacture of the astrolabe commenced at Delhi under the auspices of Fīrūz S̲h̲āh Tug̲h̲laq in the second half of the fourteenth century.[16] The *Sīrat-i Fīrūz S̲h̲āhī,* an anonymous chronicle composed at his court, has a long account on the astrolabes manufactured at Fīrūz's orders.[17] According to this chronicle, Fīrūz got constructed five astrolabes. The grandest of these is named *Asṭurlāb-i Fīrūz S̲h̲āhī.* It is said to have contained projections of both the northern and the southern celestial hemispheres (*asṭurlāb s̲h̲umālī wa janūbī*). But none of these instruments survive today.

4.3 The celestial globe was relatively a latecomer to India. Although it was a standard instrument for teaching astronomy in the madrasas, it was not mentioned in Indian context until the time of Humāyūn. This monarch was adept at using both the astrolabe and the celestial globe. Two charming anecdotes speak about his interest in these instruments.[18] But no celestial globes manufactured at the time of Humāyūn have survived either.

5.1 With one exception,[19] all the earliest surviving astrolabes and celestial globes emanate from the Lahore family. Hence the importance of this family in the history of scientific instrumentation in India. The patriarch of the family is called Allāhdād.[20] Two astrolabes made by him survive today. The first is dated 1567 and is now at the Salar Jung Museum of Hyderabad. The second one is not dated. It is at the Museum of History of Science, Oxford. On both these he signed his name as Ustād Allāhdād Asṭurlābī Lāhūrī, thus proclaiming himself to be a resident of Lahore. Allāhdād's son ʿĪsā adds the soubriquet "Humāyūnī" to his father's name, implying that he was the astrolabe maker to Humāyūn.[21]

5.2 Allāhdād's descendants sign their names invariably along with those of their ancestors.[22] From this and from the dated specimens we can trace the history of this family from 1567 to 1691. Allāhdād's son ʿĪsā[23] is known through three astrolabes produced between the years 1600 and 1604. He had two sons, Qāʾim Muḥammad and Muḥammad Muqīm.

5.3 The dates on the instruments made by Qāʾim Muḥammad range from 1609 to 1637. Consequently his period of activity coincides with the reign of Jahāngīr. Qāʾim was in fact a protégé of Nawāb Abul Ḥasan, brother of Nūr Jahān Begum.[24] His extant instruments include six astrolabes—two of these he made jointly with his brother Muqīm—and four celestial globes. He is the first member of the family whose celestial globes survive today. He is said to have perfected the art of casting celestial globes in one piece through *cire perdue* or lost wax process.[25]

5.4 Qāʾim's younger brother Muḥammad Muqīm has the largest number of astrolabes to his credit. We know of some 37 astrolabes made during the half a century of creativity between the years 1609 and 1659. In addition, there are also some eight unsigned astrolabes which can be attributed to him on stylistic grounds. However, he does not seem to have produced many celestial globes. There is only one single globe which bears his signature.[26]

5.5 Qāʾim had one son by name Ḍiyāʾ al-Dīn Muḥammad, who was the most prolific and versatile member of this family. He manufactured both astrolabes and celestial globes in great numbers; he also crafted some unusual varieties of astrolabes and celestial globes. Between 1645 and 1680, he produced some 32 astrolabes and 16 celestial globes.[27]

5.6 Muqīm had two sons, Ḥāmid and Jamāl al-Dīn. Ḥāmid's instruments are dated from 1628 to 1691. During this period he produced some 11 astrolabes and 2 globes.[28] Ḥāmid also copied a manuscript of Naṣīr al-Dīn Ṭūsī's well-known work on the astrolabe entitled *Bīst Bāb* together with an anonymous commentary.[29] The other son Jamāl al-Dīn produced five astrolabes between the years 1666 and 1691.

5.7 While instrument making reached its highest pinnacle in Ḍiyāʾ al-Dīn Muḥammad's oeuvre, the decline also can be simultaneously witnessed in that of his two first cousins. The quantity of their production is meagre in comparison to Ḍiyāʾ al Dīn's. In quality also there is a steep and inexplicable degeneration. With these three cousins, instrument making in the family comes to end in 1691. If their descendants continued making instruments, none of them seems to have survived.

6.1 After this introduction to the various members of this family and their chronology, we may now examine the main features of their work. Allāhdād's two extant astrolabes exhibit nearly all the features that are distinctive of the work not only of his family but also of the other astrolabists of India. Therefore, it is essential to define these features precisely and to trace the sources of inspiration. Modern writers classify all the Indian astrolabes with legends engraved on them in Arabic/Persian characters (as opposed to those with Sanskrit legends) as Indo-Persian astrolabes because, as they say, these were influenced in style by the Persian astrolabes of the Safavid period. Certain degree of similarity exists no doubt between the Persian and Indian astrolabes as regards the high *kursīs,* star pointers being joined by floral traceries and perhaps in having geographical gazetteers engraved in concentric circles.

6.2 But the differences are not inconsiderable either. In Indian astrolabes the *kursī* is generally pierced while it is solid and decorated on the surface in the Persian exemplars. In the Indian astrolabe, the rete contains more star pointers and the back has more scales. The arcs of the signs of the zodiac are equidistant in Indian astrolabes whereas they are stereographically projected in Persian astrolabes. More important, in Indian astrolabes, a graph of the meridian altitude of the sun is plotted upon the arcs of the zodiac signs, which is not the case in Persian astrolabes. Finally, in the Persian Safavid astrolabes, the entire surface is filled with fine ornamental engraving, the letters and numerals being engraved in high relief against a patterned background. In contrast, the engraving on the Indian astrolabes is plain and austere.[30] Therefore, we must seek elsewhere for possible prototypes of Allāhdād's astrolabes.

6.3 The two astrolabes signed by Allāhdād have high *kursīs*. But the *kursī* on the dated astrolabe at Hyderabad is solid with a geometrical pattern engraved on the front. The tracery on the rete exhibits an archaic pattern of tiger's claws. These two elements are not repeated in any of the astrolabes of the family. As against this, the other astrolabe at Oxford has a pierced *kursī* with a finely cut design and the rete has a floral pattern. These two features became the hallmark of the Lahore astrolabes.

On the back, the top left quadrant has a sine graph and the top right quadrant has equidistant arcs of the signs of the zodiac. However, neither of the astrolabes contains the graph for the meridian altitudes of the sun. This graph was introduced for the first time by his son ʿĪsā. In the two lower quadrants, Allāhdād engraves shadow squares for 12 digits and 7 feet respectively, and, within these squares, incorporates elaborate astrological tables.

On the inner side of the mater, Allāhdād provides a geographical gazetteer, containing the names of cities, their latitudes, longitudes, *inḥirāf* and the duration of the longest day. The majority of the cities are from the Middle East, starting from Mecca at 21;40° and reaching up to Samarqand at 39;37°. But there are also a few Indian cities, and this number grows with each successive descendant. The astrolabe at Hyderabad contains a gazetteer of 96 cities. It promises but does not give the *inḥirāf* and the longest day; the cells meant for these values are left blank. In the astrolabe at Oxford, all these values are given for some 157 towns. Allāhdād's successors provide such gazetteers of towns, but give only the latitudes and longitudes.[31]

6.4 Since Allāhdād calls himself a Lāhūrī, one would expect that his astrolabes contain a tympan calibrated for the latitude of Lahore (roughly32°), but none of the tympans in the two astrolabes relate to any specific Indian city. Therefore, neither astrolabe can be used with accuracy in India.[32]

6.5 To sum up, though these are the first surviving astrolabes made in India, the two astrolabes by Allāhdād do not display any feature specific to India (except the names of some Indian towns in the gazetteer). However, in the undated astrolabe at Oxford, beginnings of the stylistic peculiarities of Lahore school can be seen, which gradually developed in the works of his descendants. Since his descendants invariably recite their genealogy up to Allāhdād, it may be safely assumed that he migrated to Lahore and set up his workshop there at the behest of Humāyūn. He may have come from Samarqand and continued to make astrolabes specific to Samarqand but did not or could not adapt the design to Lahore or any other Indian city.

7.1 The three surviving astrolabes made by Allāhdād's son ᶜĪsā present a uniform appearance with a solid and multi-lobed *kursī*. The tracery on the rete is more delicate than in that of his father. At the back, the top right quadrant contains the arcs of the signs of the zodiac upon which the curves for unequal hours are projected. In the two astrolabes at Chicago, there is an additional graph for the meridian altitude of the sun at 31;50° i.e. the latitude of Lahore. This is the first time this feature occurs in the astrolabe. Later on, his descendants began plotting two graphs for 27° and 32°, which are the latitudes of the two imperial capitals Agra (modern value 27;10°) and Lahore (31;37°).[33] ᶜĪsā reduces the astrological data to the minimum and displays just the correspondances between the twelve signs of the zodiac and the twentyeight lunar mansions in two concentric semicircles. Thus ᶜĪsā lays the real foundation for what are typically Indo-Persian astrolabes.

7.2 These then are the main features of the astrolabes made in this family. We shall now briefly discuss the work of the other members of this family and highlight some unusual specimens. Muqīm, as we have noted, is a very prolific astrolabe maker. Though he made a large number of instruments, rarely does he repeat the design or even the size. This shows his virtuosity as instrument maker. This also indicates that he had a discerning clientele. (See Fig, 1 & 2).

Muqīm produced a number of large sized astrolabes, which can only be presentation pieces to high nobility. Notable among these is an astrolabe dated 1047/1637 with a diameter of 256 mm, now at the Salar Jung Museum, Hyderabad. It has a zoomorphic rete. A still larger astrolabe with a diameter of 352 mm and a zoomorphic rete is in Jaipur. This one is not signed, but because the zoomorphic rete is quite similar to that at Hyderabad, there cannot be any doubt that this magnificient piece was also crafted by Muqīm.[34] In both retes, the star pointers display the animal shapes of the respective constellations, as conceived in the Hellenistic or Beduin traditions. For example, Sirius, the dog star (*Alpha Canis Majoris*) is shown with a dog's head. *D̲hanab al-qīṭus al-janūbī* (the southern tail of the sea monster Cetus or *Beta Ceti*) is represented by a fish tail, whereas *Fam al-qīṭus* (the mouth of the sea monster Cetus or *Gamma Ceti*) is depicted through the mouth of a fish.[35]

To Muqīm goes also the credit of the world's smallest astrolabe. This miniature astrolabe has a diameter of just 43 mm, with five finely engraved plates. The *kursī* was cut *à jour* incorporating the phrase *Allāh-u Akbar*. This delicate piece fits nicely into the palm and thus

Fig. 1
Front of Astrolabe dated 1031/1621 by Muḥammd Muqīm.

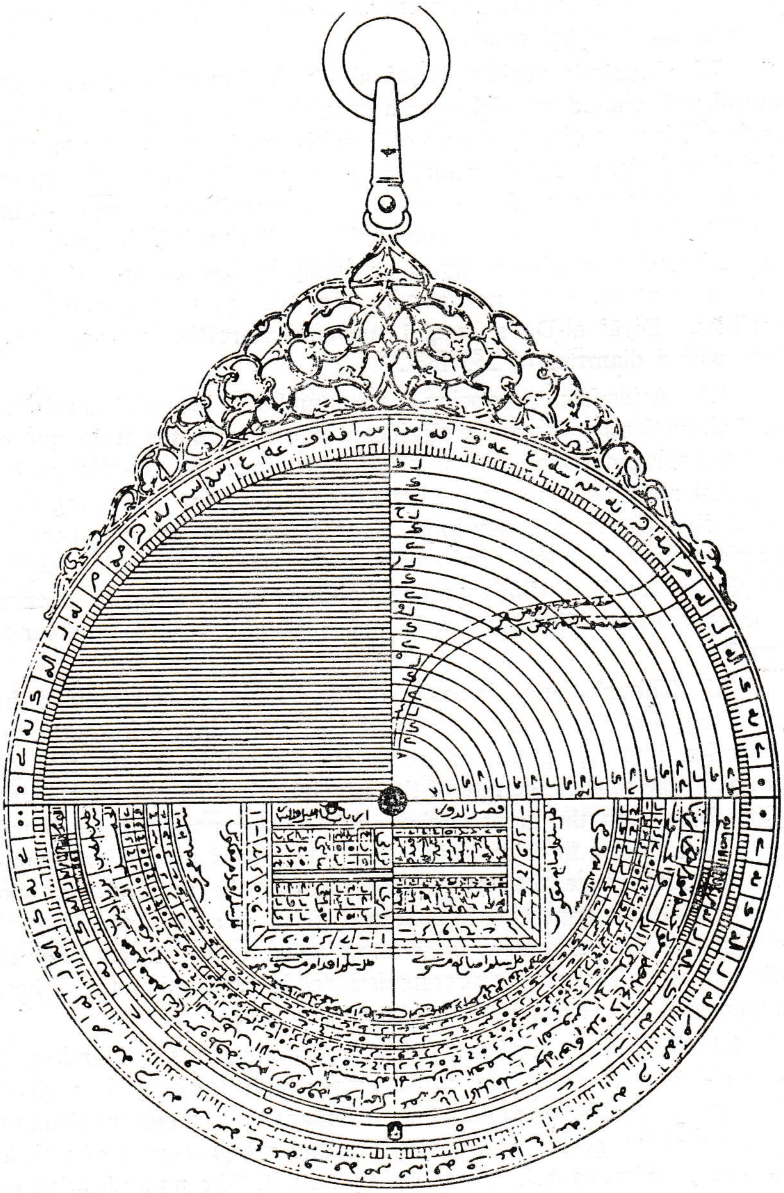

Fig. 2
Back of the Astrolabe dated 1031/1621 by Muḥammd Muqīm.

illustrates the adage that the astrolabe represents the universe in one's own palm.[36] Neither the large ones nor this very small one are really convenient for actual use but must have been highly prized collector's items at the Mughal court.

7.3 Muqīm's nephew Ḍiyā᾽ al-Dīn Muḥammd also produced several well crafted astrolabes with exquisite floral retes and thrones. Some of his retes display shapes of floral bouquets and are reminiscent of similar designs painted or inlaid in *pietre durre* in the Mughal monuments. Ḍiyā᾽ also crafted some unusual astrolabes: a north-south astrolabe in 1085/1674 and a universal Zarqālī astrolabe in 1091/1680. The universal astrolabe, designed originally by ibn al-Zarqāllu in the eleventh century, does not require separate tympans for different localities. Ḍiyā᾽ al-Dīn's Zarqālī universal astrolabe is a very large piece with a diameter of 555 mm.[37]

8.1 Aside from producing a large number of beautiful astrolabes, the Lahore family also made significant advances in the technique of manufacturing celestial globes. Until this time, the celestial globes were first made as two separate hemispheres and then joined together. But Qā᾽im Muḥammad developed the technique of casting them in one piece through the *cire perdue* or lost wax method, which is a highly complex process.[38] Qā᾽im's son Ḍiyā᾽ al-Dīn excelled in the production of these seamless globes as well, and produced a large number of them.[39]

8.2 Though the basic design of the celestial globe remained the same from the Hellenistic times, Ḍiyā᾽ al-Dīn did indeed introduce an innovation into one globe. Here he cut the surface of the globe *à jour,* as in the case of the rete of the astrolabe, leaving out the constellation forms and the great circles. At the star positions, he bored small holes. When lit from inside, the globe would present an illuminated celestial sphere, the stars shining through the perforations, and the constellations appearing in silhoutte. Thus he applied the Mughal technique of the perforated brass lampshades to the ancient craft of globe making. This globe was commissioned by no less than the highest personage of the realm, emperor Aurangzeb himself.

9.1 With the exception of a few degenerate pieces by Ḥāmid and Jamāl al-Dīn, each one of the instruments manufactured by the various members of this family exhibits fine workmanship in metal, meticulous engraving of the geometrical projections and a high degree of artistic excellence. Also, as A.J. Turner rightly puts it, "the multiplication of complexity and a delight in the unusual, seem to be typical of the astrolabe-makers of Lahore."[40]

9.2 Therefore these instruments appear to have been sought after by nobility. In four cases their names are engraved on the instruments themselves. The earliest of these is a celestial globe which Qāʾim Muḥammad made in the 18th regnal year of Jahāngīr (1032/1622) for Nawāb ʿItiqād Khān, who was a brother of Nūr Jahān Begum. The globe is now in Lancashire, England. Five years later, Qāʾim designed an exquisite astrolabe for Nawāb Abul Ḥasan, another brother of Nūr Jahān. Unfortunately, only the rete of this spectacular astrolabe survives at Patna. The star pointers on the rete are joined by a calligraphic design which states that the astrolabe was made in 1037 A.H. during the reign of Jahāngīr for Nawāb Jumdātul Mulk Khwājā Abul Ḥasan. Perhaps this is the only astrolabe where calligraphy is fully incorporated into the design of the rete.

Qāʾim's son Ḍiyāʾ al-Dīn designed, as we have stated above, an unusual celestial globe in 1090/1679 for Muḥī al-Dīn Muḥammad Aurangzīb Bahādur ʿĀlamgīr. In the next year, i.e. in 1091/1680, he also designed a universal astrolabe for Nawāb Iftikhār Khān, who was a Faujdār of Jaunpur.

9.3 There are many other pieces which must have been produced for ostentatious display. Some of these magnificient pieces were acquired by the astronomer prince Sawai Jai Singh in the early eighteenth century and they formed part of his personal collection at Jaipur.[41]

9.4 The great demand for spectacular scientific instruments should have induced artisans outside this family also to produce astrolabes and celestial globes in equally large numbers. But surprisingly enough, very few instruments produced outside this family have survived. A prominent instrument maker outside this family is Muḥammad Ṣālih of Thatta who produced three fine astrolabes and four globes between the years 1665 and 1677.[42] However, as against the nearly 130 instruments produced by the Lahore family in the late sixteenth and seventeenth centuries, those made by others do not even reach the number thirty. Surely the Lahore family was not granted a monopoly and others were prohibited from making instruments? The only possible explanation is that the ouvrage of the Lahore family overshadowed the work of others.

9.5 After Ḍiyāʾ al-Dīn, as we have mentioned, degeneration set in with the work of his first cousins and the production stopped altogether in 1691. Intriguingly enough, others also seem to have ceased producing astrolabes and celestial globes in the eighteenth century. I have not come across a single instrument belonging to the eighteenth century, nor can I account for, at the present state of our knowledge, the sudden stoppage of production of Indo-Persian astrolabes and celestial globes at a time when Muḥammad Shāh at Delhi and Sawai

Jai Singh at Jaipur were taking great interest in Islamic astronomy and astronomical instruments.

9.6 But this does not mean that the craft of the Lahore masters died at the end of the seventeenth century. In the nineteenth century, Lahore was once again the centre of production of astrolabes and globes. One Lālah Balhūmal, who proudly calls himself Lāhūrī, made astrolabes and globes of excellent workmanship.[43] Instrument-making spread also to other parts of India in this century. We hear of Zain al-ᶜĀbidīn making instruments in Delhi (none survive),[44] Ghulām Ḥusain Jaunpuri at Tikari[45] and Moḥammad Faḍlullāh in Aurangabad.[46]

9.7 The Lahore school of instrumentation, though itself dormant in the eighteenth century, inspired the production of astrolabes with Sanskrit legends for the use of Hindu Jyotiṣīs. In the eighteenth and nineteenth centuries a large number of Sanskrit astrolabes were produced in western India.[47]

Shaykh ALLĀHDĀD Asṭurlābī Humāyūnī Lāhūrī
fl. 1567
2 astrolabes

Mullā/Ḥāfiẓ ᶜĪsā
fl. 1601-1604
3 astrolabes

Qāʾim Muḥammad
fl. 1609-1637
6 astrolabes; 4 globes

Muḥammad Muqīm
fl. 1609-1659
37 astrolabes; 1 globe

Ḍiyāʾ al-Dīn Muḥammad
fl. 1645-1680
32 astrolabes; 16 globes

Ḥāmid
fl. 1628-1691
12 astrolabes; 2 globes

Jamāl al-Dīn
fl. 1666-1691
5 astrolabes

APPENDIX

THE OUVRAGE OF THE LAHORE FAMILY AN INTERIM CATALOGUE[48]

ASTROLABES

SHAYKH ALLĀHDĀD ASṬURLĀBĪ LĀHŪRĪ HUMĀYŪNĪ

1	* 975/1567	199—5	Hyderabad, Salar Jung M.	CCA 1120
2	* nd	256—6	Oxford, M. History of Science	CCA 1089

MULLĀ ᶜĪSĀ IBN ALLĀHDĀD

3	*1009/1601	170—5	Chicago, Adler Planetarium	CCA 3823
4	*1013/1604	121—8	Chicago, Adler Planetarium	CCA 1076=3824
5	*nd	262—5	Ely, Cambs, UK, PC	CCA 68=3825

QĀᵓIM MUḤAMMAD IBN ᶜĪSĀ IBN ALLĀHDĀD

6	1034/1624	?—?	PLU. ex-Calcutta, Qāḍī ᶜUbaydul Bārī	CCA 1128
7	*1037/1626	337—0	Patna, Khuda Bakhsh O.P. Library	
8	1041/1631	120—6	Baghdad, M. Arab Antiquities	CCA 3821
9	*1044/1634	193—7	Oxford, M. History of Science	CCA 71

QĀᵓIM MUḤAMMAD & MUḤAMMAD MUQĪM

10	1018/1609	84—5	Hannover, Kestner M.	CCA 69
11	nd	125—5	Baghdad, M. Arab Antiquities	CCA 3820=3826

MUḤAMMAD MUQĪM

12	1031/1621	?—5	PLU. ex-Kazan, USSR	
13	*1032/1622	67.5—5	Paris, PC	
14	1034/1624	87—5	Cengelköy, Kandilli Rasathane, Turkey	
15	1034/1624	114—5	Delhi, Red Fort M.	CCA 2700=3723
16	1034/1624	84—?	Samarqand, M. Culture and Art	

17	1047/1637	100—5	Brussels, PC	CCA 2601
18	1047/1637	260—?	Karachi, National M.	CCA 2704
19	1047/1637	203—5	Delhi, Red Fort M.	CCA 3721
20	1047/1637	256—4	Hyderabad, Salar Jung M.	
21	1048/1638	102—?	Calcutta, National M.	CCA 3730
22	1050/1640	90—6	Brussels, PC, ex-Sottas	CCA 1119
23	*1051/1641	129—4	Oxford, M. History of Science	CCA 2531
24	*1051/1641	134—5	Greenwich, National Maritime M.	CCA 1054
25	*1053/1643	168—5	Oxford, M. History of Science	CCA 72
26	1053/1643	144—5	Washington, Smithsonian	CCA 86
27	*1070/1659	142—4	London, British M.	CCA 78
28	nd	203—5	Lahore, Museum	
29	*nd	130—5	Oxford, M. History of Science	CCA 1013
30	nd	140—5	PLU, Sotheby's	CCA 2609
31	nd	?—?	PLU, Sotheby's	
32	nd	43—?	PLU, Christie's	
33	*nd	91—4	Leiden, M. Boerhaave	CCA 1097
34	nd	90—6	Paris, PC	
35	*nd	105—5	Paris, Institut du Monde Arabe	CCA 3537
36	nd	204—5	PC, ex-Paris, Nicolas Landau	CCA 3529
37	nd	?—?	PLU, ex-Paris, Nicolas Landau	CCA 3827
38	nd	206—5	PLU, ex-Paris, Nicolas Landau	CCA 3828
39	nd	270—?	Paris, George Charliat	CCA 3504
40	nd	96—5	Cannes, PC	
41	nd	92—3	Fontanay-le-Comte, PC	
42	nd	147—5	Don Mills, Toronto, Science Centre	CCA 3837
43	*nd	134—0	New Haven, Yale University	CCA 3807
44	nd	90—5	Point Lookout, NY, Linton 166	
45	nd	92—5	Point Lookout, NY, Linton 223	
46	nd	?—?	Haifa, National Maritime M.	CCA 3565

ḌIYĀ᾿ AL-DĪN MUḤAMMAD

47	1056/1646	193—6	PLU, ex-Paris, Nicolas Landau	CCA 2600
48	*1057/1647	121—4	Chicago, Adler Planetarium	CCA 1095
49	*1057/1647	117—4	Chicago, Adler Planetarium	CCA 2558
50	1059/1649	?—?	Lucknow, Nadwatul Ulema	CCA 1126
51	1060/1650	108—4	Brooklyn, Brooklyn M.	CCA 3555
52	1061/1650	210—5	PLU, Christie's	
53	*1062/1651	149—4	Cardiff, Welsh National M.	CCA 1107
54	*1062/1651	262—6	Hyderabad, Salar Jung M.	
55	*1064/1653	109—5	Oxford, M. History of Science	CCA 2533
56	1064/1653	?—?	PLU, ex. Habibganj	CCA 1118
57	*1067/1656	312—5	Jaipur, Observatory	CCA 2702
58	1068/1657	?—?	Cairo, M. Islamic Art	CCA 3829
59	*1068/1657	171—5	Paris, Jean Soustiel/Institut du Monde Arabe	
60	*1069/1658	177—5	Oxford, M. History of Science	CCA 77=1002
61	1070/1659	90—?	Washington, Smithsonian	CCA 87
62	*1071/1660	84—5	Chicago, Adler Planetarium	CCA 2554
63	1071/1660	114—0	PLU, ex-Rockford, Time M.	CCA 2607
64	*1072/1661	182—0	Paris, PC	CCA 3517
65	*1073/1662	106—4	Cambridge/Mass, PC	CCA 3809
66	*1073/1662	95—5	Chicago, Adler Planetarium	CCA 2551
67	*1074/1663	235—4	Patna, Khuda Bakhsh O.P. Library	CCA 1117
68	*1074/1663	130—5	Rampur, Raza Library	CCA 2511
69	*1074/1663	112—5	London, Victoria & Albert	CCA 1060
70	1074/1663	101—?	Mosul, al-Basha Mosque	
71	1074/1663	?—?	PLU, ex-Aligarh, Maulana Abu Bakr	CCA 1116
72	1077/1666	?—0	Karachi, National M.	
73	*1085/1674	165—1	Jaipur, Observatory	CCA 2703
74	*1091/1680	555—1	Jaipur, Observatory	CCA 80
75	nd	?—?	PLU, ex-Paris, Nicolas Landau	CCA 3524
76	nd	?—?	PLU, ex-Paris, Nicolas Landau	CCA 3525
77	nd	282—0	PLU, ex-Paris, Nicolas Landau	CCA 3651

ḌIYĀ᾽ AL-DĪN & ḤĀMID IBN MUQĪM

78	nd	?—?	PLU, ex-Paris, Brieux	CCA 3517

ḤĀMID IBN MUḤAMMAD MUQĪM

79	1038/1628	127—4	Cambridge, Mass, Harvard U.	CCA 3624
80	*1069/1658	112—5	Hyderabad, Salar Jung M.	
81	*1071/1661	112—0	Paris, Institut du Monde Arabe	CCA 3538
82	1084/1673	141—5	PLU, ex-Paris, Boisgirard 1977	
83	1086/1676	140—5	London, Aaron	CCA 3822
84	1087/1677	140—?	PLU, ex-Allahabad	
85	*1099/1688	89—3	London, Guildhall	
86	1102/1691	116—0	PLU, ex-Paris, Brieux	CCA 3517
87	1102/1691	126—6	PLU, ex-Paris, Jean Tetreau	
88	nd	110—?	PLU, ex-Renno Rizzi	
89	nd	?—?	Cambridge, Whipple M.	CCA 3563

JAMĀL AL-DĪN IBN MUḤAMMAD MUQĪM

90	1077/1666	248—?	Philadelphia, PC	
91	1077/1666	?—?	PLU, Christie's	
92	*1092/1681	168—?	London, Victoria & Albert	CCA 81
93	1094/1682	160—5	Kuwait, PC	
94	1103/1691	254—8	Istanbul, Türk ve Islâm Eserlieri Müzesi	

GLOBES

QĀ᾽IM MUḤAMMAD

95	1032/1622	188	Blackburn, Lanc, UK	ESS 11
96	1035/1625	?	Paris, PC	ESS 12
97	*J 22/1626	156	London, Victoria & Albert	ESS 13
98	*1046/1637	173	Patna, Khuda Bakhsh O.P. Library	ESS 14

MUḤAMMAD MUQĪM

99	1049/1639	?	Kuwait, PC/NY, Metropolitan	ESS 15

ḌIYĀʾ AL-DĪN

100	*1055/1645	170	New York, Columbia U.	ESS 18
101	1057/1647	?	St. Petersburg, Asian M.	ESS 19
102	1058/1648	?	PLU, ex-Patna, PC	ESS 66
103	*1060/1650	113	London, Victoria & Albert	ESS 20
104	*1064/1653	122	Aligarh, Tibbiya College	ESS 21
105	*1067/1656	127	London, Victoria & Albert	ESS 22
106	*1068/1657	113	Cardiff, Welsh National M.	ESS 23
107	1068/1657	100	Cairo, M. Islamic Art	ESS 24
108	1070/1659	60	Cairo, M. Islamic Art	ESS 69
109	1071/1660	94	Berlin, Staatliche Museen	ESS 26
110	*1074/1663	160	Hyderabad, Salar Jung M.	
111	*1074/1663	142	Edinburgh, Royal Scottish M.	ESS 27
112	*1074/1663	175	Oxford, M. History of Science	ESS 28
113	1078/1667	?	Cairo, M. Islamic Art	
114	1087/1676	65	Delhi, Red Fort M.	ESS 71
115	*1090/1679	164	Rockford, Time M.	ESS 30

ḤĀMID IBN MUQĪM

116	*1065/1655	99.3	Cambridge, Whipple M.	ESS 68
117	*1094/1683	170	Hyderabad, Salar Jung M.	

ASTROLABE ATTRIBUTED TO ALLĀHĀD

118	*nd	217—6	Oxford, M. History of Science	CCA 2530

ASTROLABES ATTRIBUTED TO MUQĪM

119	*nd	108—4	Oxford, M. History of Science	CCA 1014
120	nd	264—5	PLU, ex-Paris, Brieux	
121	nd	204—5	PLU, ex-Paris, Brieux	
122	nd	263—5	PLU, ex-Paris, Brieux	
123	*nd	240—5	Paris, PC	
124	nd	?—?	New York, Maxwell Rimler	
125	nd	217—4	Salem, Peabody M.	CCA 3555
126	*nd	352—7	Jaipur, Observatory	

GLOBE ATTRIBUTED TO QĀʾIM MUḤAMMAD

127	nd	217	Washington, Smithsonian	ESS 38

NOTES AND REFERENCES

* This is a revised version of a paper originally presented at the Indian History Congress, 55th session, Aligarh, in December 1994.

1 Nadvi (a).

2 CCA.

3 Brieux & Maddison.

4 ESS.

5 King (a), (b).

6 Sarma (b). See also Sarma (a) and (c).

7 A tentative list of these instruments is given in the Appendix.

8 Cf. Sarma (f).

9 On the function and history of the celestial globe, see the excellent account in ESS.

10 Thus on a globe made in the year 1047/1626 (now at the Khuda Bakhsh Oriental Public Library, Patna), Qāʾim Muḥammad writes that he made use of Ulūgh Beg's coordinates after adding 3° for precision. Cf. ESS, p. 225.

11 For example, Muḥammad Faḍlullāh b. Muḥammad Murād b. Muḥammad Mūsā Asṭurlābī Mutawaṭṭin Aurangabad plotted the star positions on a globe he made in 1223/1808 (now at the Salar Jung Museum, Hyderabad) according to the *Zīj-i Jadīd Āṣafiyah* compiled by Ḥusain Khān Riḍwī at Hyderabad. Ghulām Ḥusain Jaunpurī, on the other hand, determined the star positions afresh through his own observations with a modern Hadley's Reflecting Sextant and marked these in 1810 on a celestial globe (now in a private collection at Aligarh). For a description of the last mentioned globe, cf. Ansari & Sarma.

12 This job is performed today by the Zeiss projector in the planetarium, and there are also some computer software programmes available which project the heavens on to the monitor for any given point of time at any latitude. Yet the celestial globe is a more convenient tool.

13 The literature on the astrolabe is voluminous. The best introduction is available in Hartner; North. See also Gunther.

14 Therefore, the astrolabe is more correctly called the planispheric astrolabe. About a thousand years later, attempts were made to draw astrolabic projections on a three-dimensional globe and also on a uni-dimensional staff, which were respectively styled spherical astrolabe and linear astrolabe. But these are mere curiosities and had no practical relevance. They cannot perform all the functions a plane astrolabe is expected to do. As against some two thousand and odd planispherical astrolabes that survive today, there is only one extant spherical astrolabe and not a single linear astrolabe. Even so some modern writers tend to speak of threefold classification of the astrolabe into (i) planispheric, (ii) spherical and (iii) linear, which is clearly a historical. In this paper, the word astrolabe refers always to the plane astrolabe.

15 In theory of course one can also draw the projections of the southern celestial hemisphere and thus construct a southern astrolabe (*asṭurlāb janūbī*) or combine both kinds of projections on the same instrument and call it north-south astrolabe (*asṭurlāb shumālī wa janūbī*). But the last two versions are intellectual curiosities and have little practical relevance. In fact, among the existing astrolabes, there are not more than ten specimens of the last two types.

16 Fīrūz also sponsored the composition of the first manual on the astrolabe in Sanskrit by the Jaina monk Mahendra Sūrī in 1370. The manual is entitled *Yantrarāja* (ed. K.K. Raikva, Bombay, 1936).

17 This account will be analysed in Sarma (g).

18 Cf. Sarma (c).

19 The earliest extant globe was made by one ᶜAlī Kashmīrī ibn Luqmān in 998/1589, but save this globe nothing is known about him; cf. ESS, pp. 223-224. According to Abul Faḍl, Mawlānā Maqṣūd Hirawī manufactured astrolabes and celestial globes for Humāyūn but these have not survived, cf. Nadvi, p. 602.

20 On the question whether the name should be read as Allāhdād or Ilāhdād, cf. Abbot, p. 146.

21 There has been much unnecessary and unproductive controversy about the meaning and significance of the epithet *Humāyūnī* which, in conjunction with *asṭurlābī* can only mean an "astrolabe maker to Humāyūn." Sulaiman Nadvi conjectured that Humāyūn may have invented a special kind of astrolabe called *Humāyūnī asṭurlāb,* and that the members of the Lahore family received the epithet *asṭurlābī humāyūnī* for manufacturing such astrolabes. But all the hundred and odd surviving astrolabes belong to the conventional type. On the other hand, it is true that Allāhdād's only dated astrolabe was made in 1567, i.e. eleven years after Humāyūn's death. But this does not preclude Allāhdād's manufacturing other astrolabes in the life-time of Humāyūn. It is also perfectly legitimate that Allāhdād's descendants commemorate the royal patronage extended to their ancestor by calling themselves the descendants of the Asṭurlābī Humāyūnī.

22 For example, the inscription on a celestial globe made by Ḍiyāᵓ al-Dīn in 1064/1653 reads as follows: *ᶜamal aqall al-ᶜibād Ḍiyāᵓ al-Dīn Muḥammad ibn Qāᵓim Muḥammad ibn Mullā ᶜĪsā ibn Shaykh Allāhdād Asṭurlābī Humāyūnī Lāhūrī san 1064 Hijrī.* "The work of the humblest among servants: Ḍiyāᵓ al-Dīn Muḥammad, son of Qāᵓim Muḥammad, son of Mullā ᶜĪsā, son of Shaykh Allāhdād Asṭurlābī Humāyūnī Lāhūrī, dated the year 1064 Hijrī."

23 He is usually referred to as Mullā by his descendants, but occasionally also as Ḥāfiẓ.

24 Infra 9.2.

25 Infra 8.1.

26 Though we know of some 37 instruments signed by Muqīm and eight attributable to him, only 17 of these are dated. A decade-wise distribution of the dated instruments shows large gaps inbetween:

1609—1610	1 astrolabe	
1611—1620	0 astrolabe	
1621—1630	5 astrolabes	
1631—1640	5 astrolabes	1 globe
1641—1650	4 astrolabes	
1651—1659	1 astrolabe	

Of course, the 20 undated and 8 attributable astrolabes could have been made during these gaps, but still many could have been lost.

27 The decade-wise destribution of Ḍiyāᵓ al-Dīn's production, as given below, shows that his production is much low in the last decade from 1671 to 1680.

1645—1650	6 astrolabes	4 globes
1651—1660	11 astrolabes	6 globes
1661—1670	9 astrolabes	4 globes
1671—1680	2 astrolabes	2 globes

This cannot be attributed to his old age, for he made some of his finest and more complex pieces in this decade. This could only mean that many pieces produced in this decade are lost, or have not yet been identified in museums.

28 The initial date is problematic. Ḥāmid's first extant work, an astrolabe now at the Houghton Library, Harvard University, Cambridge, Mass., is dated 1038/1628. His next available instrument is a globe in the Whipple Museum,

Cambridge, UK, and is dated 1065/1655. The gap between the two is 27 years. It is extremely surprising that no instrument manufactured during this long period came down to us.

29 Salar Jung Museum, Hyderabad, Ms No 3877, copied by Ḥāmid Asṭurlābī b. Muḥammad Muqīm on 10 Shaᶜbān 1087/17 September 1678. Cf. *Catalogue of the Persian Manuscripts,* vol. IX, Salar Jung Museum and Library, Hyderabad 1988, under no. 3877. Dr. Rahmat Ali Khan, the Keeper of Manuscripts, has kindly drawn my attention to this manuscript.

30 Cf. Turner, pp. 25-26.

31 Many of these coordinates are derived from Ulūgh Beg's tables, but those for the Indian towns may have been measured locally or derived from local traditions; cf. Kennedy; Gibbs & Saliba, appendix.

32 On all the tympans several curves are inlaid with silver, an unusual feature not repeated by any of his descendants.

33 On this graph, see especially Frank and Meyerhof, pp. 14-15; Gunther, vol. 1, p. 184.

34 This zoomorphic rete is reproduced in gold on the binding of Robert T. Gunther's celebrated work, *The Astrolabes of the World.*

35 There are other astrolabes where some star-pointers have shapes like the beaks of birds etc. Cf. Gingerich. But these cannot be really termed zoomorphic retes, because the animal forms are just fanciful and do not represent the form in which the constellation is conceived. Therefore, these two astrolabes by Muqīm are the only true zoomorphic astrolabes.

36 Christie's Catalogue 24. 9. 1992, item no. 116, pp. 44-45.

37 Cf. Sarma (e).

38 ESS, pp. 90-95.

39 When Sulaiman Nadvi took his census in 1935, Aligarh boasted three instruments made by Ḍiyāᵓ al-Dīn: two astrolabes dated 1064/1653 and 1074/1663 respectively and a globe of 1064/1663. The two astrolabes are not traceable today, but luckily the globe is still preserved in the Tibbiya College of Aligarh Muslim University, the only Indian university to own an instrument made by the Lahore family. For a detailed description of the globe, see Sarma (c).

40 Turner, p. 83.

41 Cf. Sarma (d).

42 Cf. Sarma, Ansari and Kulkarni.

43 Cf. Anderson, p. 35, item no. 129a; ESS, pp. 52-54, 235-236, 244-245, 275-276, 304.

44 Sir Syed Ahmad, *Sirat-i Farīdiya,* Urdu MS. No. 10, University Collection, M.A. Library A.M.U. Aligarh. *Editor's note:* Nawāb Zaynul ᶜĀbidīn Khān (d. 1856) was the younger son and pupil of Nawāb Farīduddīn Khān. He is said to be "an expert in making astronomical instruments and to have a profound knowledge of Zīj and astronomy (*hayᵓat*). Zaynul ᶜĀbidīn's own room was full of all sorts of instruments, for instance he constructed a brass astrolabe and a brass sphere of quite large diameter', *ibid* p. 35, pp. 43-44 (SMRA.)—Ed.

45 Cf. Ansari and Sarma.

46 Cf. Note 11 above.

47 On Sanskrit astrolabes, see Sarma (b), pp. 518-519.

48 The second column shows the date in AH/AD; the third column the diameter in mm and, in the case of the astrolabes, the number of tympans. In the fourth column is given the present or the last known location and in the fifth the serial number according to CCA or ESS. The following abbreviations are used. M=Museum; PC=Private Collection; PLU=Present Location Unknown. Those examined personally by me are marked with an *.

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