COMETS IN ISLAMIC ASTRONOMY AND ASTROLOGY

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INTRODUCTION

THIS paper is a collection and analysis of all references in medieval Arabic sources to "tailed stars" (Arabic *kawākib mudhanniba, kawākib dhawāt al-adhnāb*) presently available to the author. His attention was first attracted to the topic by passages in a recent publication of Thorndike[1] and in a much older notice by Lee.[2] It will be seen that the eleven sources in which the references occur are spread fairly evenly, in point of date, from early Abbasid times (the ninth century A.D.) through the sixteenth century. In view of the considerable interest in early cometology[3] and the paucity of reports on the related Oriental material it seemed worthwhile to work through such as was at hand.

Each section below deals with a single document, these being arranged in chronological order of origin. The capital letters designating sections are also used to stand for the sources they describe. Most of the latter are *zījes*, handbooks for the practicing astronomer and astrologer, of which well over a hundred are known to have been computed.[4]

A. IBN HIBINTĀ

A Christian astrologer of Baghdad, this individual[5] in 829 wrote an astrological work entitled *Al-Mughnī*, a copy of the second part of which (Cod. arab. 852) is in the Bayerische Staatsbibliotek in Munich.[6] On folio 67 vs. of this document there begins a section entitled "On the Stars Having Tails." The passage states that there are seven such stars in the heaven (or sphere) of the sun, surrounding it after the fashion of stars. The manuscript names five of these:

Ṭaifūr, an Arabic given name (cf. the comet name Typhon[7]).
Naizak, a Persian loan word in Arabic meaning a short spear, hence "a meteor."
Al-ᶜAṣā, meaning "the stick."
Dhū al-Laḥya, "the bearded one."
Dhū al-Qaṣaᶜa, "the hunchback."

If God permits some event to transpire in a certain locality, says Ibn Hibintā, He displays one of these stars as a sign. Their indications were explained by the ancients.

There follows a series of confused remarks as to where comets may be expected to appear. Most of the conditions involve proximity to the planet Mercury, which, since Mercury never elongates far from the sun, is consistent with the opening sentence of the section.

The same folio has a marginal gloss in a

[1] L. Thorndike, "Albumasar in Sadan," *Isis*, XLV (1954), 22–32.

[2] Samuel Lee, "Notice of the Astronomical Tables of . . . Al Farsi, . . . ," *Transactions of the Cambridge Philosophical Society*, I (1822), 249–65.

[3] Doris Hellman, "The Comet of 1577: Its Place in the History of Astronomy" (New York: Columbia University Press, 1944).

[4] E. S. Kennedy, "A Survey of Islamic Astronomical Tables," *Transactions of the American Philosophical Society* (N.S.), Vol. XLVI, Part II (1956).

[5] H. Suter, *Die Mathematiker und Astronomen der Araber* . . . , ("Abhand. zur Gesch. der Math . . . ," Heft 10 [Leipzig, 1900]), p. 16.

[6] The author wishes to thank the authorities of this library, as well as the curators of manuscript collections at Cambridge University, the Rijksuniversiteit of Leiden, the Bodleian Library, the Vatican, and the Bibliothèque Nationale of Paris for the arrangements made by them to microfilm the manuscripts referred to in this paper.

[7] A. Bouché-Leclercq, *L'astrologie grecque* (Paris, 1899), p. 359.

hand different from that of the main text and in bad Arabic.[8] The gloss begins by stating that in the year of the taking of Constantinople (1453) there appeared for a month a comet having a marvelous motion and a long tail, in the north above the land of the Byzantines. The author of the note then adds that he himself saw a comet during the rule of an individual whose name is illegible in the gloss. Its motion was like that of the moon; it appeared in the west and traversed the zodiacal signs until within a month it appeared in the east.

The third object mentioned in the gloss was seen during the first part of the month of *Shaᶜbān*, 876 A.H. (January 1472). It was as big as the moon and had a tail twenty cubits long (*sic*). It traversed half the sky in fifteen days, appearing first at midnight in the east and eventually disappearing in the west. Professor O. Neugebauer has pointed out that this is the large comet Pingré 471[9] seen in Europe and China.

Another comet was seen on 16 *Shaᶜbān* of the same year (January 28, 1472). At the time Mercury was combust, i.e. hidden in the rays of the sun, which, as the commentator remarks, is contrary to what Ibn Hibintā says in one place. Some people asserted that the object was Mercury and that it had gained its long ray, i.e. the tail, from the sun.

Farther along in the manuscript, beginning on folio 71 vs., is a section entitled "The Chapter of *al-Kaid*." It commences by saying that al-Kaid is one of the stars having a tail, that it appears once every hundred years, that it travels backwards (i.e., contrary to the succession of the zodiacal signs) like the lunar nodes, and that it crosses a sign in twelve years.

Ibn Hibintā then gives the following rule for determining its position in the zodiac on any date, assuming that the latter is expressed in the Yazdigerd (Persian) calendar: Subtract ninety from the number of complete years which have elapsed since the epoch of the era. From the remainder subtract in turn the highest multiple of 144 which it contains. Multiply the second remainder by 360 and divide the product by 144. The result will give the longitude of al-Kaid measured backward from the first point of Aries. Subtract it from 360° to obtain the longitude as usually expressed.

Thus al-Kaid is an object moving in the ecliptic with a constant angular velocity of $-2\frac{1}{2}°$ per Persian (or Egyptian) year of 365 days. It passes through the vernal point at the beginning of 91 Yazdigerd, and continued to do so at intervals of 144 Persian years thereafter.

At one point Ibn Hibintā remarks that some of the computers claim that al-Kaid lags the (mean?) sun in the ecliptic by nineteen degrees and twenty-five minutes. He states, which is obvious, that this is contrary to what was previously said, and he adds that it is far from the truth.

This star is maleficent (the Arabic word *kaid* means "rancor" or "deceit"). In particular, according to Ibn Hibintā, if it is in the same sign as one of the astrological "centers" (the ascendant, midheaven, the setting point, or lower culmination) of a horoscope, the indication is of great loss and misfortune.

The remainder of the chapter consists of a long list of special indications for horoscopes in which al-Kaid is configured with various particular planets in various particular signs. In this recital the name of Hermes (Trismegistos) appears.

[8] The author acknowledges with appreciation the assistance of Mr. Muhammad Saffouri in reading these passages.

[9] P. V. Neugebauer, *Astronomische Chronologie* (Berlin, 1929), p. 185.

B. ABŪ MASHAR (*ca.* 850)

The oriental astrologer most often referred to in medieval Europe was Albumasar (Abū-Maᶜshar, Jaᶜfar ibn Muḥammad al-Balkhī). A disciple of his, one Aposaytes (Abū Saᶜīd) Sadan (Ibn Shādhān) set down a collection of anecdotes reciting various professional opinions and triumphs of his master. "Albumasar in Sadan,"[10] is a précis of a Latin version of this collection which contains two passages relevant to our topic.

In the first[11] Abū Maᶜshar is asked about the meaning of *kint*. He replies that ". . . some said it was a small cloud, some said it was a southern star, and others said that it was the connection of certain spheres. He himself could elicit nothing concerning it from the ancients." But some say that it moves two and a half degrees in a year, in a single day nine seconds (of arc), and in a month twelve minutes. The latter statement is self-inconsistent, for an annual mean motion of $2\frac{1}{2}°$ corresponds to a daily one of about twenty-four seconds. The monthly travel, however, is consistent with the annual motion. The resemblance between the names and the velocities leads to the immediate inference that the object is al-Kaid, the Arabic characters for which could fairly easily be read as *kint*. (Lee read them as *kibd*.[12]) The substitution of 9 (*ṭa*) for 24 (*kāf dāl*) is likewise an easily made scribal misreading.[13]

The second reference[14] is to comets as such. Abū Maᶜshar says that the classical opinion that comets are in the sphere of fire is wrong, that he himself has seen a comet beyond Venus.

What seems to be the Arabic original of a part of this work is in a Cambridge University manuscript (Gg. 3. 19).

C. THE ḤĀKIMĪ ZĪJ OF IBN YŪNIS (*ca.* 990)

This great work, composed in Cairo, is only partially extant. Its first twenty chapters have survived as Leiden Ms. 1057 (Cod. or. 143) which contains a complete set of tables of planetary mean motions and equations. Although the accompanying explanatory text has no section on comets, these tables are followed by another (pp. 200, 201) for determining the longitude of al-Kaid accurate to seconds of arc. Curiously enough, while the mean motion tables are computed for use with the Yazdigerd calendar, that for al-Kaid is set up for the Muslim lunar calendar. The position of the object is given for the beginning of the Hijra era and for multiples of thirty years (for the thirty-year Hijra cycle) up to 2700 A.H. The motion of the comet in 1, 2, 3, . . . , 30 years; 1, 2, 3, . . . , 12 months; and 1, 2, 3, . . . , 29 days is also tabulated, thus enabling the determination of the longitude on any date within the range by the addition of not more than four tabular entries.

Disregarding two errors made by the original computer, it can be shown that the table imposes on al-Kaid a constant angular velocity of $-2;29,59,18°$ per Persian year, a number close to the $-2;30°$ cited in *A* above.[15] Using this rate and the longitude given at the Hijra

[10] Cf. n. 1 above.

[11] Thorndike, *op. cit.*, p. 28.

[12] Lee, *op. cit.*

[13] R. Irani, "The Development of the Arabic Decimal and Sexagesimal Numeral Forms," *Centaurus*, IV, 1–12.

[14] Thorndike, *op. cit.*, p. 29.

[15] Following the usage of the manuscripts we will display numbers as sexagesimals, a place-value system in which sixty plays a role analogous to that of ten in the familiar decimal system. In the manuscripts, sexagesimal digits are denoted by symbols consisting of letters or joined pairs of letters of the Arabic alphabet (cf. Irani, *op. cit.*). In transcription we separate digits with commas and use a semicolon for the "sexagesimal point." Written out, the first of the two numbers above is $-(2 \times 60^0 + 29 \times 60^{-1} + 59 \times 60^{-2} + 18 \times 60^{-3})$.

epoch (4,7;0,43°), the longitude at 91 Yazdigerd turns out to be −2;47,26°, an amount which represents over a year's travel from the vernal point.

D. THE SANJARĪ ZĪJ OF ᶜABD AL-RAḤMĀN AL-KHĀZINĪ (ca. 1120)

On folio 129 vs. of the Vatican copy (Cod. arab. 761) of this zīj is a section headed "On the Position of al-Kaid according to the Claim (or Pretension, *zaᶜm*) of Those Who Speak of It." There follows a rule for computing its longitude which is essentially the same as that of Ibn Hibintā in *A* above. Al-Khāzinī says, "add ninety to the complete Yazdigerd years," rather than to subtract fifty-four, but since the sum of these numbers is 144, the period of the object, the results are the same.

He says further,

> If we want, we take the complete years of the Two-Horned (i.e., Alexander the Great, hence the Seleucid era) from the first of *Ādhār* (March), not from *Tishrīn I* (October, the usual starting point for the Seleucid calendar), and increase it by 120, and we take cycles from it (the remainder). With what is left enter the table and operate with it as we explained. But do not consider the current year, so that the last day of *Shibāt* (February) will have passed away. But the first (reckoning, i.e. with the Persian calendar) is the preferable (one).

Since the two eras are separated by roughly 942 years, and since $942 + 54 + 120 = 7 \times 144$, apparently the second rule is a crude method of establishing dates in the Seleucid calendar when al-Kaid passes the vernal point.

The table referred to is laid out like that of *C*, but having the motions for 12, 24, 36, . . . , 144 years; and the motion in 1, 2, 3, . . . , 12 years; 1, 2, 3, . . . , 12 months (Persian and Seleucid months separately); and 1, 2, 3, . . . , 30 days. No allowance is made for the fact that the Seleucid year is a quarter of a day longer than the Persian; for both years the motion is −2;30°.

E. THE MUẒAFFARĪ ZĪJ OF AL-FĀRISĪ (*ca.* 1260)

The only extant copy of this work is Cambridge University Ms. Gg. 3. 27. Folio 66 rt. has a short section on al-Kaid saying, "Know that al-Kaid is of the stars having tails. It is not in the heaven (or sphere) of the stars, but its position is in the heaven of the ether (*Marginal gloss:* and it is the heaven of heavens), below the heaven of the moon. . . ."[16] The passage goes on to refer the reader to a table for computing the longitude of the comet. This table is on folio 118 vs., is in the usual form, and is arranged for use with the Yazdigerd calendar. The motion shown is −2;30° per Yazdigerd year, and the object passes through the vernal point at year 91 Yazdigerd, that is, after the completion of ninety such years. This accords completely with *A* and *D*. A marginal note, perhaps in the hand of the scribe who copied the whole manuscript, gives information already implicit in the table. But in addition it states that al-Kaid is maleficent, more so than Saturn, and if it falls in the sign of the ascendant it spoils (or mars) the horoscope.

F. THE SHĀMIL (INCLUSIVE) ZĪJ

Folio 22 rt. of the Paris copy (Bibliothèque Nationale, Ms. arabe 2528) of this anonymous work contains a table of the basic planetary parameters used in the zīj, that is the mean, apsidal, and anomalistic motions displayed to five fractional sexagesimal places in degrees per day. In addition, the initial positions of all these motions are given for the epoch of the zīj. This is evidently the year 600

[16] Cf. Lee, *op. cit.*

Yazdigerd, since the mean motion tables start from the latter date. In the lowest right-hand position in the folio mentioned above the single word al-Kaid is written, and underneath it in a smaller hand, not that of the copyist, "the name of a star." In the compartment to the left is a longitude, 2,50;3,0°, presumably the initial position of al-Kaid. Applying the rule of A and D to 600 Yazdigerd, thus 599 completed years, we obtain a longitude of 2,47;30°, which is fairly close to the value of the text.

In another compartment of the same table is an entry to the effect that the daily motion of al-Kaid is 0;0,24° per day, backward. Since 2;30° per Yazdigerd year is about 0;0,24,39,27° per day, it looks as though the value given in the zīj is a crude approximation to the latter.

The epoch 600 Yazdigerd permits a gross estimate of the date of composition of this work. Assuming that the compiler would lay out the tables to begin in the century in which he was living, and recalling that the epoch of the Yazdigerd era is 632 A.D. we may place this document at, say, A.D. 1280, give or take a half century. This is consistent with the presence in the zīj of a description of the (Seljuk) Malikī calendar, which makes the date of composition not earlier than, say A.D. 1100.

G. THE ZĪJ OF MUḤĪ AL-DĪN AL-MAGHRIBĪ (*ca.* 1280)

The present writer had occasion to examine cursorily the only extant copy of this work (Ms. 332 [103]) in the Shrine Library of Meshed, Iran. Among a set of mean motion parameters used in the zīj there appears the value 0;0,24,39,27,7,24° for the daily travel of al-Kaid. This corresponds very accurately to 2;30° per Persian year. There may be other references in the zīj to comets, but microfilm is not at present available from this library.

H. THE ZĪJ OF AL-BAGHDĀDĪ (1285)

It is necessary to abandon the date previously conjectured (920) for this work, extant in a unique Paris copy (Bibl. Nat., Ms. arabe 2486). For one thing, one of the tables it contains is attributed to Abū al-Wafāʾ al-Būzjānī (*fl.* 970). And, which is more drastic, the zīj contains a description of the Malikī calendar not adopted until *ca.* 1100. Finally, although the Arabic of the colophon is somewhat ambiguous, the only interpretation[17] consistent with known facts about al-Baghdādī is that this copy was prepared for him personally and completed in the month of *Muḥarram*, 685 A.H. (March/April, 1285).

Folios 98 vs.–100 rt. are given over to rules and tables for determining the position of comets. For al-Kaid a constant angular velocity of −2;30,3,20° per Persian year is given. A plausible explanation of the slight divergence between this and the otherwise standard −2;30° is that if the daily rate corresponding to the latter, −0;0,24,39,27,7, . . .° is rounded off to −0;0,24,40° and then reconverted into its degrees-per-year equivalent, al-Baghdādī's parameter results.

For the Yazdigerd year 631, al-Kaid's longitude is given as 1,29;24,4°. Assuming the speed given in the text, the corresponding position at 91 Yazdigerd turns out to be −0;5,56°, which is close to the vernal point.

This zīj has in addition tables for computing the positions of six other tailed stars, named respectively:

Dhu al-Dhawāba, that is "the one having a lock," or "mane."

Ghaṭaiṭ, "snoring," or "gurgling."

Laḥyān, the name of a South Arab tribe.

ʿAzīm, meaning a "strong enemy," or the adjective "patient."

[17] The explanation of the passage is due to Professor Nicula Ziadeh.

Sarmūs, in *J* below the terminal letter is written with three dots above making it a *shīn*. The name can then be read as Persian *sar-i mūsh*, i.e. "mouse head."
Kilāb, "dogs."

The vowels in the transcriptions above are mainly conjectural, although some diacritical marks appear in the manuscript. The meanings shown behind the words have no necessary connection with the stars. The first and fifth names, however, are reminiscent of the fanciful appellations which Ptolemy says were given to comets.[18]

It is evident from the descriptive material and tables that these six stars are to move backwards along the ecliptic at fixed distances from al-Kaid. Displayed in the first column of the table below are their positions as of 631 Yazdigerd. The second column shows the respective amounts by which each one leads al-Kaid. Strangely enough, the tables giving the positions of each of these six stars at the beginnings of years 610, 630, 650, . . . , 790 Yazdigerd use implicitly a motion of −2;30° per year, whereas the tables for interpolating the additional motion for individual years, months, and days use the −2;30,3,20° noted above.

TABLE 1

	H, AL-BAGHDĀDĪ		*J*, CYRIACUS	
	(1) Longitude at 631 Yazd.	(2) (1)-Longitude of al-Kaid	(3) Name Variants	(4) Distance from al-Kaid
Dhū al-Dhawābā.....	4,10;1,0°	2,40;36,56°		2,39;46,0°
Ghaṭaiṭ.............	5,45;45,0°	4,15;20,56°		4,16;15,0°
Laḥyān..............	4,12;44,0°	2,43;21,56°	al-Ḥayānī	2,42;29,0°
ʿAzīm................	5,4;31,0°	3,35;6,56°		3,35;16,0°
Sarmūs..............	2,30;3,0°	1,0;38,56°	Sarmūsh	1,0;48,0°
Kilāb...............	4,12;35,0°	2,43;10,56°	Killāb	2,42;20,0°

I. AN ANONYMOUS ZĪJ (*ca.* 1370)

The approximate date of this work (Paris, Bibl. Natl. Ms. arabe 2513) is inferred from the epoch used for the tables of planetary mean motions, 750 A.H.

On folio 14 vs. is a table of the usual type for obtaining the longitude of al-Kaid. In spite of several errors made by the individual who computed the table the motion employed in this document can be shown to be −0;0,24,39,40° per day.

It was evidently intended to give positions of the object for 750, 780, 810, . . . , 1200 A.H., but entries for only the first two dates have been made, 3,46;17,1,24° and 3,51;6,29,4° respectively. If either one of these longitudes is accepted the other must be wrong, for their difference is nothing like the displacement of the comet during the Hijra thirty-year cycle. On the basis of the longitude for the earlier date, the longitude at 91 Yazdigerd turns out to be −5;21,52°, over five degrees from the vernal point.

On folio 91 vs. is a short section entitled "The Knowledge of the Rising of the Tailed Star." It says:

> Take the years and fractions thereof of Alexander the Two-Horned and subtract from them 249. Multiply the remainder by four and from what results take away thirties successively, (beginning?) from the sign of Libra. Wherever the number ends, there will be the comet. And if it is in a sign distant from the sun by 120°, and if the degree of the star is in the first of the sign, it (the star) will be seen. But if there is less than 120° between it and the sun, then it will not be seen. This star appears one time after each thirty years, but God knows better.

[18] Ptolemy, *Tetrabiblos* ("Loeb Classical Library" [London and Cambridge, Mass., 1940]). p. 193.

This rule is not clear, but the form of the statement resembles the verbal rule for al-Kaid given in *A*, *D*, and *E*. Professor O. Neugebauer has remarked that reversal of the digits of the first number given in the rule yields 942, the number of years between the Seleucid and Yazdigerd eras, so that the number given may be the result of a scribal error. In either case, if we assume that the dropping of successive thirties represents passages through the thirty degrees of a zodiacal sign, the multiplication by four must be a conversion into degrees. This would give the object a period of ninety years and a passage through the vernal point at 250 Alexander, provided that the years referred to in the rule are elapsed years since the epoch of the era, and assuming that 249 is what was intended. In the case of this source the stock reference to the Deity at the end of the rule seems particularly appropriate.

J. THE ZĪJ OF CYRIACUS (*ca.* 1480)

The author of this work (extant as Bodleian Laud 253) was evidently a Christian priest converted to Islam. His zīj uses the same planetary mean motions as *F* above, and it has tables of al-Kaid and six other comets which closely resemble the corresponding sections of *H*. In the Bodleian manuscript this information appears on folios 15 vs. and 65 rt.

The epoch of the zīj is 850 Yazdigerd, and for this date the longitude of al-Kaid is given as 4,22;27,0°. The amounts by which the other six stars lead it are displayed in the third column of Table 1 above. It will be noticed that all the values are near the corresponding ones of *H*, but none is identical. The annual motion used for computing the tables can be shown to be −2;30,3,28,48°, the largest thus far encountered. Using this speed and the initial position given above, the position of al-Kaid at 91 Yazdigerd turns out as 0;41,2°, a position near the vernal point.

K. A HOROSCOPE

The same manuscript which contains *E* includes also an abridged version of the Muẓaffarī Zīj. In this abridgement the lower half of folio 16 vs. was left blank by the copyist. This space was later used by someone who wrote in it a horoscope for the eighth hour of the night of Friday, 18 *Shaᶜbān*, 947 A.H. (=18 *Ordībehesht* 910 Yazdigerd = 18 December, A.D. 1540 Julian). The diagram gives the longitudes of the planets and the end-points of the twelve astrological houses, the ascendant being in 9;22° of Scorpio. All this is standard practice. What is unusual is that al-Kaid also appears in the diagram, at Cancer 22;13,5°. A note in the same hand states that the positions were computed by use of *E*, and the correctness of the comet's position for this date has been verified by application of the rule in the latter zīj.

TABLE 2

	Source	Approximate date	Degrees per Year	Degrees per Day	Longitude at 91 Yazdigerd
A	Ibn Hibintā	850	−2;30	−0;0,24,39,27	0;0,0°
C	The Ḥākimī Zīj	990	−2;29,59,18	−0;0,24,39,20	−2;47,26°
D	The Sanjarī Zīj	1120	−2;30	−0;0,24,39,27	0;0,0°
E	The Muẓaffarī Zīj	1260	−2;30	−0;0,24,39,27	0;0,0°
F	The Shāmil Zīj	1280		−0;0,24	
G	Muḥī al-Dīn	1280	−2;30	−0;0,24,39,27,7,24	
H	al-Baghdādī	1285	−2;30,3,20	−0;0,24,40	−0;5,56°
I	Anonymous	1370	−2;30,1,16,18	−0;0,24,39,40	−5;21,52°
J	Cyriacus	1480	−2;30,3,28,48	−0;0,24,40,1,27	0;41,2°

CONCLUSION

Of the eleven documents in which references to tailed stars were found, all save one made specific mention of an object called al-Kaid, and in six it was the only such star named. For ease of comparison the parameters ascribed to it have been assembled in our Table 2. It will be noticed that in all cases the resultant motion conforms more or less closely to that prescribed by the rule given in the earliest source, *A*. As for other stars named, those of *H* and *J* behave much like al-Kaid.

The outstanding general impression made by examination of the material is that, except for the gloss to *A*, none of it is based on observation. Ibn Hibintā (*A*) attributes his rule to "some of the books of the ancients"; abū Maᶜshar has found nothing reliable in the works of the ancients; al-Khāzinī (*D*), himself an observer, twice implies skepticism in the matter, and once ascribes the rule to the "Persians." The authors of zījes made up a class of individuals whose sense of precision in computational technique was unequaled until modern times. Nevertheless, we have noted general carelessness in their handling of the numerical material related to al-Kaid. All this confirms the conclusion that the doctrine was of pre-Islamic origin and passed along as a matter of tradition. By many it was discarded, for there are no traces of it in about half the zījes examined. By others, it was retained, but solely as a convenience in the casting of horoscopes.

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