Finally, as Mônica Rius has already finished her survey of methods for qibla orientation in the writings of Maghribi faqahā', this study should be extended to the writings of astronomers on this topic and to other mīqāt subjects (visibility of the new moon, times for prayers etc.). The collection of materials published by Khaṭṭābī60 is now the object of a preliminary study.

A PRELIMINARY ASSESSMENT OF THE PROBLEMS OF EDITING THE ZĪJ AL-SANJARĪ OF AL-KHAZINI

David Pingree

One of the major zījes composed in Arabic in the medieval period was written during the reign of the Saljuks in Iran. Abū Mansūr (also known as Abū al-Fath) ʿAbd al-Rahman al-Khażīnī1, a Greek slave of Shaykh al-ʿAmīd al-Qāḍī Abū al-Ḥasan ʿAlī ibn Muhammad, al-Khāzin (the Treasurer) of Marw, dedicated al-Zīj al-Sanjari to the Sultān, Sanjar ibn Malikshāh, who ruled as Sultān from 1118 until his death in AD 1157. This lengthy work is preserved in a very complex manuscript tradition consisting of two incomplete representatives of the original version, two complete copies of a misnamed Wajīz or summary sometimes said to have been made in AH 525 (AD 1131), and three manuscripts of a Byzantine Greek version of the Wajīz executed, through the intermediary of an oral Persian translation of Shams al-Bukhari, by Gregory Chioniades at Tabrīz in the late 1290’s. All three traditions contribute to the reconstruction, which can never be complete without further manuscript copies, of the original of ca. AD 1120. In this paper I shall discuss each tradition separately and then examine their several contributions to our knowledge of al-Khażīnī’s zīj.

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The 'original' version is preserved in two manuscripts. Oriental 6669 of the British Library is a manuscript containing the text on ff. 1-68 and the tables on ff. 68v-157. The scribe, 'Umar ibn Ahmad al-Sâlim al-Muqaddasi, states at the bottom of f. 157 that he finished copying it on 25 Jumādâ al-âkhira in AH 620, corresponding to 26 July 1223 AD. Arabo 761 of the Vatican Library is an undated copy, with the text on ff. 1-104v and the tables on ff. 106-192. Neither manuscript is complete, and the folia of both, but especially those of the London manuscript, are in extreme disorder. When the leaves of the canons in the London copy are restored to their original sequence - ff. 57-62, 7-8, 2, 1, 3-6, 9-56 and 63-68 - it is clear that about six folia are missing from the beginning, two leaves after f. 6, about ten folia after f. 55, and about four folia after f. 56. The leaves of the canons in the Vatican manuscript are in correct order but about six folia are missing after f. 104; they are now replaced by a single leaf, apparently from a different manuscript. This f. 105 contains a brief text entitled Kitâb gharîb 'ilm al-târîkh (Book of Curiosities of the Science of Chronology) of which an epitome is found in the Wâjiz, so that it is not unconnected to the tradition of al-Khâzînî's works.

The canons of the original Zīj al-Sanjârî are divided into thirteen parts. The first is a preface in praise of Allâh, of Allâh's Prophet and of the Sultan, and in presentation of the author's humility before the Sultan, his dependence on him, and his efforts to base his astronomy on observations and on sound theory. The second is a risâla on instruments and theory; this risâla is either identical with or at least closely related to al-Khâzînî's Risâla Fi al-âlâm al-ajîba (Epistle on Wonderful Instruments) which is preserved as an independent treatise in several manuscripts, including one in Teheran. After this comes the main body of the

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proportion. They agree in not numbering the first bāb of the second qism of maqāla five, on the retrogressions and direct motions of the planets; in reorganising the three abwāb of the fourth qism of the same maqāla, on the velocities and apparent diameters of the Sun, the Moon, and the Earth’s shadow, into five abwāb; in omitting the second and third abwāb of the second qism of the sixth maqāla, on the parallax of the Sun on a circle of altitude by computation and from the relevant table; in re-writing much of the section on lunar parallax that follows these two abwāb; in omitting the seventh bāb, on the ascendants at the times of the syzygies, from the second qism of maqāla seven; and in omitting the second bāb, on the sighting of the lunar crescent, from the second qism of the ninth maqāla.

But at the same time the London and the Vatican manuscripts each omit or change chapters that the other preserves, and so are independently descended from their common ancestor, β. Thus the London copy omits abwāb four to seven of the first qism of the eighth maqāla, on various aspects of a lunar eclipse; it also omits bāb six, on the duration of a solar eclipse, from qism two of the same maqāla; abwāb three, five, and six of the first qism of the ninth maqāla, on the sighting of the lunar crescent according to al-Battānī and to Thābit ibn Qurra, and the third bāb, on the appearance and disappearance of the lunar crescent as derived from the relevant table, in the second qism of the ninth maqāla; all of these omitted chapters in the London manuscript can be recovered from the Vatican copy. On the other hand, the Vatican manuscript combines chapters eight and nine of qism two of maqāla eight of the fihrîst and of the London manuscript into a single bāb eight. Thus, probably one or more intermediate copies intervened between the hypothetical manuscript β and each of the two extant manuscripts.

The most serious deviations from each other and from the table of contents occur at the end, however. The London manuscript has lost all of maqāla ten; it is preserved in the Vatican copy but with its last six abwāb, which constitute the third qism in the index, divided into two aqsām numbered three and four. Of the maqāla maftûza the fihrîst lists three aqsām, of which the Vatican manuscript contains the first two only, while the London manuscript, omitting these two, presents four aqsām numbered three, four, five, and six; of these, the fifth qism corresponds to the fihrîst’s third. So, between the two manuscripts we have the fihrîst’s three aqsām plus three additional ones.

Therefore, assuming that the fihrîst represents correctly the contents of the canons in al-Khāzīnī’s original zij, from the two manuscripts at our disposal we can only reconstruct the hypothetical and relatively late manuscript β, and that not always with certainty.

With respect to the tables we face an even greater problem. Of course, many of the tables are referred to in the canons, so that we can eventually determine which were part of manuscript β, but in general we have no certain knowledge of which appeared in manuscript α since we possess no fihrîst for them. What we do have in our two exemplars are about 145 tables, but neither manuscript contains them all, and the folia in each are in complete confusion. The correct order of the leaves in the London manuscript is: ff. 68v-69, 71-75, 77, 79, 70, 76, 78, 81, 97, 82-96, 98, 104-107, 102, 99, 103, 108-109, 100, 138-139, 110-123, 127, 126, 124-125, 128-134, 156, 155, 140-148, 135, 149-154, 101, 137, 136, and 157. The folia of the Vatican manuscript are in almost as complete confusion. Their correct order is: ff. 106, 116-121, 115, 122, 107-114, 123-124, 149-163, 126, 128-129, 125, 141, 130-134, 127, 135-140, 142-148, 164-171, 178, 172-177, and 179-192.

Only these rearrangements will make sense of both the rectos and versos of all the folia. It places the tables in each manuscript in the same order, though each is missing some tables or parts thereof; the problem is that this order differs from the order of the canons. In particular, it places the tables of the
mean motions and the true longitudes and latitudes of the planets after the eclipse and lunar crescent tables, whereas in the fihris and in the canons themselves the planets are treated in maqālat four and five, and eclipses and lunar crescents in maqālat six to nine. I see no way to overcome this serious discrepancy. Additionally, in the light of the fact that each manuscript lacks several tables which are preserved in the other, and in particular that the geographical table is incomplete in the only copy (the London one) which contains any of it, it is not possible to assert that from these two manuscripts we can recover all of al-Khāzīnī’s tables, nor can we be sure that those we have are in their original forms.

The situation is somewhat helped by the existence of the Wajīz, allegedly written by al-Khāzīnī himself in AD 1131. It is true that the order of subjects is the same in the Zij al-Sanjārī and in the Wajīz, but there are also many differences between the two, both in the canons - which are far briefer in the Wajīz than those in the zij, though the Wajīz’s canons appear to contain material missing in manuscript B - and in the tables, which have been drastically revised, especially those for the planetary equations which in the Wajīz are double entry tables.

The two manuscripts of the Wajīz are number 859 in the Hamadiye Collection in the Suleymaniye Library in Istanbul, with the canons on ff. 1v-27 and 29-38 (f. 28 is an intrusion from a different manuscript), and the tables on ff. 39-79. The date of copying is given on f. 38 as Rabi’ al-akhir in AH 667, corresponding to 8 December 1268 to 5 January 1269. The second copy, number 682 in the Library of the Sipahsālar Mosque in Teheran, I know from a photocopy kindly sent to me by Mohammad Bagheri. It consists of 125 pages, on which only the even numbers are recorded; there are two pages numbered 112. The canons occupy pp. 2-43 (two pages are lost after p. 35, and p. 43 ends in the middle of the last chapter), and the tables are on pp. 44-112, 111b, 112b, and 113-121. On p. 123 the scribe notes that he copied the manuscript at Mawṣil in Ramaḍān in AH 631, which coincides with 31 May to 29 June 1234.

Instead of the ten central maqālat of the zij, the Wajīz divides essentially the same material into twelve maqālat: on calendars; on mathematical foundations; on the two declinations and the rising-times in sphera recta; on the equation of day and oblique ascensions; on the fixed stars (which are not treated in the canons of the zij, though the zij does have a table of their co-ordinates for 1427 Alexander, 509 Hijra, which are equal to AD 1115); on local time; on the mean motions of the planets; on their true longitudes, retrogressions and latitudes; on parallax; on syzygies and eclipses; on sighting the lunar crescent, and on the revolutions of years, the casting of rays, and prorogations. Each maqāla is divided into abwâb: these latter often correspond in their general contents to the aqṣām in the zij. Risāla fi al-ālāt al-ajība is written on the title-page of the Teheran manuscript, but that originally belonged to manuscript 681 (see footnote 3). Each manuscript adds after maqāla twelve a khātimat al-kitāb on the use and meanings of letters, lines, and colours in the tables.

These tables are just 45 in number instead of the zij’s 145. About 30 of the Wajīz’s tables are related to tables in the zij; the rest differ. Most of them are concerned with lunar visibility and parallax. The tables follow the order of the canons except that the tables for parallax and eclipses follow most of those for the sighting of the lunar crescent. Again, the order of the folia in both manuscripts is seriously disturbed. In the Istanbul copy it should be: ff. 39-41, 76, 75, 42-69, 78-79, 70-74, and 77; ten tables are missing that are found in the Teheran manuscript. The correct order of the pages in that Teheran manuscript is: pp. 44-48, 111-114, 49-56, 107-110, 57-98, 101-106, 99-100, 112b-113b and 114-122; nine tables are missing that are found in the Istanbul copy. Clearly, the tables are the part of a zij most vulnerable to mistreatment by both scribes and owners.
I have noted a few instances where manuscript $\beta$ is inferior to the Wajiz. For instance, $b\bar{a}b$ one of $qism$ three of the first $maqala$ is supposed to have four fusul on the festive days of the months of the Arabs, the Persians, the Romans (Byzantines), and the Hebrews, but instead of these fusul we find in the zij only a so-called second fusul on the lunar mansions. The second $b\bar{a}b$, however, does present two of the promised fusul, those for the festivals of the Romans and the Hebrews. $B\bar{a}b$ five of the first $maqala$ of the Wajiz, on the other hand, preserves the original order of the zij and a fuller text. Thus, the Wajiz here and elsewhere stands, as might also be surmised from its early date, in a closer relationship to manuscript $\alpha$ than does manuscript $\beta$. This, of course, does not change the fact that it is far from being a verbatim copy of al-Khâzînî’s original.

The Greek version of the Wajiz was made, as has been mentioned, by Gregory Chioniades at Tabriz in the late 1290’s and is, as far as the canons are concerned, quite a faithful if not very intelligent rendering of the Arabic; that is not the case, however, with regard to the tables. There exist three manuscripts: Vaticanus Graecus 211, which was copied before 1308, on ff. 38-106 (canons) and 122-159v (tables); Laurentianus 28, 17 in Florence, which was copied in 1323, on ff. 81v-167 (canons only); and Vaticanus Graecus 1058, which was copied from Vaticanus Graecus 211 in the middle of the fifteenth century, on ff. 273v-316 (canons) and 332-369v (tables). Only the first two copies, then, are of interest to us, and of these only the Vaticanus contains the tables, forty-one of them in confused order. Thirty-three of these tables have their counterparts in the Wajiz. Of the remaining eight, three are parallax tables for the third, fourth, and fifth climata; such tables are found in the Zij al-Sanjârî but not in the Wajiz. The other five must still be investigated, but it is at least possible that the tables in the Greek translation of the Wajiz represent a version of them that differs from the two extant Arabic manuscripts in including additional material derived from the original zij.

There are, of course, universal problems in editing Arabic scientific texts. Some of them are general to all Arabic texts, some are specific to scientific ones (such as the question of whether or not to correct mathematical errors), and some are specific to astronomical tables (to what extent should one change the manuscript readings so that they conform to even simple criteria of ‘correctness’ such as symmetry). I have chosen to speak of a different case in which those universal problems are compounded by a triple tradition of derivatives in two languages from an irrecoverable Arabic original. I have not mentioned that some assistance can be sought in al-Khâzînî’s sources, and in texts and tables copied by later authors from his zij and its Wajiz, but I entitled the paper ‘preliminary’ in large part because I have not yet begun the task of identifying these potential aids.