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THE PERSIAN VERSION OF 'ZĪJ-I JĀMI'  
BY KŪŠYĀR GĪLĀNĪ

The text I want to introduce here is the Persian translation of Kūšyār's *Zīj-i jāmi'*. The original Arabic text was written about 1000 years ago and the Persian version one hundred years afterwards. Kūšyār Gilānī (also known as Kūšyār b. Labbān al-Jilī) whose life and works have been the focus of my research into the history of astronomy and mathematics, was from the northern province of Iran called Gilan which is situated on the southern coast of the Caspian Sea.

According to Suter in his book *Die Mathematiker und Astronomen der Araber und ihre Werke*<sup>1</sup> Kūšyār lived between the years 971 and 1029 AD. However, according to A. Qurbānī in his precious Persian biographical work on the mathematicians of the Islamic period<sup>2</sup>, some references and examples found in *Zīj-i jāmi'* and Kūšyār's astrological book imply that he lived a few decades earlier, say, between 940 and 1010 AD. There is little data about his biography which includes some ambiguities.

The province of Gilan, Kūšyār's native land, is covered by forests and separated from central Iran by the Alborz mountain range and was therefore conquered by Arabs much later than the rest of the country. Hence, Iranian culture and civilization both resisted Arab influence and lasted longer in the region. Even after the acceptance of Islam, most rulers of the region were Shiites mostly accepted by Iranians. These rulers made their court as a place of refuge for thinkers and scientists like al-Bīrūnī, Avicenna and Nāṣir Ḥusraw.

At the time of Kūšyār there were still many Zoroastrians in Gilan. The name Kūšyār is a pure Persian name and its original form was Gūšyār, consisting of the name *Gūš* and the suffix *yār*. In ancient Iran, all the months had 30 days and each day of the month had a special name. The 14th day of each month was called *Gūš*, after the name of the Zoroastrian angel of useful quadrupeds. *Gūš* followed by the suffix *yār* means a gift from *Gūš* or aided by *Gūš*. Kūšyār had apparently accepted Islam because he had chosen the Arabic title Abū al-Ḥasan, which means Ḥasan's father. In this respect, he can be compared with Bīžan Ibn Rustam Kūhī, an astronomer and mathematician of the same transitional period, from the neighbouring province of Tabaristan which had a similar natural and social environment. Bīžan, having a Persian name, chose the Arabic title Abū Sahl for himself. The social and historical situation of Gilan and Tabaristan at the time of Kūšyār is described in detail by the late Prof. Ali Mazaheri in the introduction to

1. H. Suter, *Die Mathematiker und Astronomen der Araber und Ihre Werke*, Leipzig, 1900, p. 83.

2. A. Qurbānī, *Zindigī-nāma-yi riyāḍidānān-i dawra-yi islāmī*, Tehran, 1365 (1986), p. 414.

his book, *Les origines persanes de l'arithmétique*<sup>3</sup>, which includes the French translation of Kūšyār's book on arithmetic. Although Kūšyār was born in Gilan he lived in the great, ancient city of Rayy (near modern Tehran) where he met al-Bīrūnī.

Kūšyār was an eminent figure in mathematics and astronomy during the Islamic period. In a Persian book entitled *Čahār maqāla*, written in 1155 by °Arūđī Samarqandī<sup>4</sup>, a good command of Kūšyār's book on astrology is mentioned as being necessary for any astronomer. Furthermore Sa°dī, the famous 13th century Iranian poet, in one of his poems about humility names Kūšyār as a symbol of a wise scientist.<sup>5</sup>

There is also an interesting reference to Kūšyār<sup>6</sup> in the preface to a Persian medical compendium entitled *Daḥīra-yi Ḥ'ārazmšāhī*, written by Sayyid Ismā'īl Jurjānī. According to Jurjānī, Kūšyār wrote only when he was calm and relaxed and his books were written very neatly in a good hand. When he was told that his style of writing required too much time to complete a single book, his response was: 'Yes, it takes much time, but once I am gone, people won't be concerned with how long I took to write them, but rather the quality and contents of the books.'

Several of Kūšyār's works, all in Arabic, are extant. His famous book on arithmetic *Uṣūl-i ḥisāb al-Hind* (Principles of Hindu Reckoning) is translated and commented in Hebrew, English, French and Persian. This book was the oldest extant Arabic work on Hindu reckoning until 1966 when the late Prof. Ahmad Salim Saidan introduced, in *Isis*<sup>7</sup>, the book *al-Fuṣūl fī al-ḥisāb al-hindī* (Chapters on Hindu Reckoning) written by Abū al-Ḥasan Ahmad Ibn Ibrāhīm Uqlidīsī who lived in Damascus some decades before Kūšyār's time.

Kūšyār's famous book on astrology is his *Mujmal al-uṣūl fī aḥkām al-nujūm* (Summary of Principles of Astrology) also called *al-Madḥal fī šinā'at aḥkām al-nujūm* (Introduction to Art of Astrology). This work has been translated into, and commented in, Persian, Turkish and Chinese. Prof. Michio Yano of Kyoto Sangyo University plans to publish its original Arabic text with an English translation.

In addition to *Zīj-i jāmi'*, which is his most important astronomical work, Kūšyār wrote another *zīj* called *Zīj-i bālig* (Expressive Astronomical Tables) of which only a short chapter on the application of the planets' cycles according to Indian belief is found in the Mullā Fīrūz manuscript collection in Bombay.

Kūšyār also wrote a treatise on the astrolabe. Several manuscripts of this work are extant, but the supposed Persian manuscript of this treatise, entitled *Iršād al-uṣṭurlāb* (Introduction to [the use of] the Astrolabe), in Tehran's Majlis Library is not truly its translation.

3. M. Mazaheri, *Les origines persanes de l'arithmétique*, Université de Nice, 1975.

4. Nizāmī °Arūđī, *Čahār maqāla*, ed. Muhammad Mu°in, 3rd printing, Tehran, 1333 (1954), p. 89.

5. Sa°dī, *Būstān*, English tr. H. Wilberforce Clarke, London, 1879, pp. 245-6.

6. Ismā'īl Jurjānī, *Daḥīra-yi Ḥ'ārazmšāhī*, facsim. ed. by °A.-A. Sa°idī Sīrjānī, Tehran, 1355 (1976), p. 644.

7. A. S. Saidan, 'The earliest extant Arabic arithmetic', *Isis*, 57 (1966), pp. 475-490.

*Zij-i jāmi<sup>c</sup>* was written in the year 352/963 and means 'universal *zīj*' or 'comprehensive *zīj*'. *Zīj* is an ancient Persian word which originally referred to the parallel threads of a textile but, because of the similarity between the parallel lines of astronomical tables and the threads, came to be used for collections of astronomical materials and tables. The ancient form of the word was *zīg*, as in *Zīg-i Šahryār* (The Royal Astronomical Tables), the well-known astronomical work of the Sassanid period. In Arabic it became *zīj* and entered Latin astronomical texts as *zich* or *ezich*.

Carl Brockelmann in his *Geschichte der Arabischen Litterature* has assigned only one *zīj*, named *Zij al-jāmi<sup>c</sup> wa'l-bāliġ*, to Kūšyār.<sup>8</sup> However, other sources, such as Ḥājjī Ḥalīfa, mention the *Zij al-jāmi<sup>c</sup>* and the *Zij al-bāliġ* as two distinct works.<sup>9</sup> Kūšyār himself, in the introduction of his astrological book, explicitly speaks of composing two *zījes* entitled *jāmi<sup>c</sup>* and *bāliġ*. Prof. E. S. Kennedy and Dr. B. van Dalen believe that the differences found in the manuscripts of *Zij-i jāmi<sup>c</sup>* may be explained by the fact that Kūšyār wrote two independent *zījes*. Final judgement may be made easier when a manuscript of *Zij-i bāliġ* comes to light or a complete critical edition of *Zij-i jāmi<sup>c</sup>* is published.

Manuscripts of the original Arabic text of *Zij-i jāmi<sup>c</sup>* are extant in Leiden, Berlin, Moscow, Istanbul, Cairo and Alexandria<sup>10</sup> and I have examined photos, films or prints of manuscripts kept in Leiden, Berlin, Cairo (213, Dār al-Kutub al-Miṣriya), and also those of the Yeni Jāmi<sup>c</sup>, Fatih and Vehbi Efendi collections in Istanbul.

*Zij-i jāmi<sup>c</sup>* is arranged in four books or *maqālas*: the first on *Abwāb* or introduction; the second on *Jadwal* or tables; the third on *Hay'at* or spherical astronomy and the fourth on *Burhān* or proofs. Most manuscripts of this *zīj* are incomplete, containing just one or two books out of the four, for example, Prof. David King has listed five manuscripts extant in Dār al-Kutub al-Miṣriya, Cairo, none of them consisting of more than two books. Nevertheless, the Leiden manuscript (No. 1054) is complete and just one third of the fourth book is missing from the Yeni Jāmi<sup>c</sup> manuscript. The Fatih manuscript in Istanbul (No. 3418) also seemed to be complete according to the table of contents prepared by Fuād I. Ḥaddād. However, while examining it recently, I found that part of the first book was missing. The manuscripts of Baladiya Library in Alexandria and the Lenin Public Library of Moscow are reported to be exquisite. Prof. Kennedy has given a summarized account of the contents of this *zīj* in his *Survey of the Islamic Astronomical Tables*.

Prof. J. L. Berggren of Simon Fraser University (Canada) has published an article on the spherical trigonometry in *Zij-i jāmi<sup>c</sup>* and Dr. Benno van Dalen has analysed two tables of this *zīj* on true solar longitude and equation of time in his

8. Carl Brockelmann, *Geschichte der Arabischen Litteratur*, 1943-9, suppl. 1, p. 397.

9. Ḥājjī Ḥalīfa, *Kaṣf al-zunūn*, Tehran, 1387 H. (1967), vol. 2, column 968.

10. F. Sezgin, *Geschichte des arabischen Schrifttums*, vol. 6 (astronomy), 1978, vol. VI, pp. 247-8.

doctoral thesis entitled: *Ancient and Medieval Astronomical Tables*. The *Zīj-i jāmi'* has also been translated into Russian by Ḥuršīd °Abdallāhzāda.

According to Ḥājjī Ḥalīfa in his *Kašf al-zunūn*, this *zīj* has been translated into Persian by Muḥammad b. °Umar b. Abī Ṭālib Tabrīzī.<sup>11</sup> The only known manuscript of this Persian version is extant in the library of Leiden University under No. 1056, and contains only the first book which has 8 chapters. Since Ḥājjī Ḥalīfa speaks of this *zīj* having 8 chapters<sup>12</sup>, maybe the other three books of the *zīj* have not been translated into Persian.

This Persian translation of the first book of *Zīj-i jāmi'* is written on 26 folios followed by miscellaneous tables on astronomy, astrology and the calendar which are not relevant to those of *Zīj-i jāmi'*. We can assume that this manuscript was written after 689/1289-90 because a *zīj* in verse, bearing that date, and written in the same hand is bound in with it.

In the opening, the translator praises Allāh and his prophet, esteems his master and mentions that the translation has been prepared at the request of a certain Ja'far Ibn Ayyāz, in the year 483/1089, in the era of Abū al-Faḥ Malikšāh Ibn Muḥammad. The latter is undoubtedly the Malikšāh son of Alb Arslān of the Saljuk dynasty of Khorasan who ruled over a vast area from the Oxus to Asia Minor between years 1072 and 1091. Following Malikšāh's order in 1074, a group of astronomers, including °Umar Ḥayyām, composed *Zīj-i Jalālī* also called *Zīj-i Malikšāhī*. They improved the Iranian calendar and devised the Jalālī or Maliki calendar, which is still the base of the Iranian formal calendar. One of the tables given in the colophon of the Persian translation of *Zīj-i jāmi'* is made on the basis of the Jalālī calendar.

After this introduction the translator adds that he has examined several ancient and recent *zījes* and has selected this one to be translated from Arabic into Persian. Then begins Kūšyār's own preface in which he points out the deficiencies he had seen in other *zījes* and which he has decided to avoid in his own work. Specifically, Kūšyār points to *Almagest* and claims he has attempted to compose a *zīj* covering materials either lacking enough explanation or proof in the latter or missing, and containing both applied and theoretical subjects. The text follows with the first book in 8 chapters consisting in total of 85 *bābs* or sections.

The titles of the 8 chapters are as follows: on calendars; on sine tables and interpolations; on tangent tables; on positioning of planets; on ascendants of the day and the night; on eclipses; on subjects of lesser necessity.

The astronomical terminology is mostly borrowed from Arabic. However, some Persian equivalents are introduced some of which are found in al-Birūnī's Persian version of *al-Tafhīm*. Like *al-Tafhīm*, throughout the work the word *āftāb* is used for the sun, while in modern Persian the word *ḥuršīd* is commonly used.

The manuscript was certainly written by an insufficiently qualified scribe and contains repetitions and dislocations as well as having some words or phrases

11. Ḥājjī Ḥalīfa, *Kašf al-zunūn*, vol. 2, column 971.

12. *Ibid.*

missing. Consequently while writing down the text I have frequently had to consult the original Arabic but, in some cases, the omission also occurs in an Arabic manuscript. For example, in the first section of the second chapter on sines of arcs, there is a fragment on the value of the sine of one degree the proof of which is referred to in the fourth book. This fragment is found in the Leiden and Berlin manuscripts, but not in the Persian translation. The same fragment is missing in the Yeni Jāmi' manuscript. Here, Kūšyār mentions an approximation for the sine of one degree, the value being correct to 3 sexagesimal or 5 decimal significant figures. Four centuries after Kūšyār, another Iranian scientist, Ġiyāth al-dīn Jamšīd Kāšānī (better known as al-Kāšī), found an elegant method for calculating this number to arbitrary precision, and calculated a value correct to 17 decimal figures.<sup>13</sup>

From a calligraphical point of view, some 'dots' are missing as is the case with most manuscripts. The four letters belonging exclusively to Persian alphabet, Pe (پ), Će (چ), Že (ژ) and Ge (گ) are written as their Arabic equivalents, Be (ب), Je (ج), Ze (ز), and Ke (ك) respectively. The name of *āb* the 11th Syriac month is written with two *alifs* at the beginning (اب) which was new to me. The ordinal numbers of the sections in each chapter, the number of days of each month and the coordinates of planets are shown by the *abjad* numeration system. The difference between several calendars counted in days is written in Hindu-Arabic numerals. Other numbers are written in the form of words. The same style is followed in the Arabic texts of the *zīj*. In addition in the third and fourth sections of the first chapter the Persian verb meaning 'we take' is in an unusual form, *hāgīrīm* (هاگیریم), still used in the dialect of Mazandaran, formerly Tabaristan, in northern Iran.

In the second section of the first chapter Kūšyār discusses the Iranian calendar. He gives the names of the Persian months; names which have been formally applied again according to a law approved in 1925. Each ancient Persian month had 30 days and the solar year had 12 months plus five intercalary days (پنجه دزدیده or خمسة مسترقه). These five days had special names, now only used by Zoroastrians. Kūšyār writes that to compensate for the excess of the solar year which amounts to a quarter of a day, every 120 years one extra month was counted in ancient Iran, so that after each 120 years the first month of the year was shifted one month forward to keep close to the vernal equinox. The five intercalary days were observed before the month in which the sun entered Aries. At the time of Anūšīrvān, the famous Sassanid king, the vernal equinox was in *Ādar*, so the five extra days were counted after the earlier month of *Ābān*. After the conquest of Iran by the Arabs, this tradition was not continued and this caused some difficulties in administrative affairs. In the year 365 of the Hijra, the sun entered Aries at the beginning of *Farvardīn*. Then the Iranians shifted the intercalary days 4 months forward, so that instead of following *Ābān* (now the eighth month) they followed *Isfandārmad* (now the 12th month), and this continued up to Kūšyār's time. Kūšyār adds, 'In our region of

13. A. P. Youschkevitch and B. A. Rosenfeld, 'Al-Kāshī (or al-Kāshānī), Ghiyāth al-Dīn Jamshīd Mas'ūd', in *Dictionary of Scientific Biography*, vol. 7, 1981, p. 259.

Gurgan and Tabaristan, people still observe the five intercalary days after *Ābān*, because they believe the shifting of the days is a Zoroastrian tradition, and should be avoided'. As Taqizāda cites in his Persian book *Chronology in Ancient Iran*<sup>14</sup>, according to Šayḥ Mūsā Naṣrī Hamadānī, up to 1939 the ancient names of the months were used in Mazandaran province, and the people there still observed the five intercalary days at the end of *Ābān*.

To conclude, I quote a poem from Sa'dī's *Būstān* which refers to Kūšyār and was translated by H. Wilberforce Clarke in 1879:

'A certain one had a little skill in astronomy;  
But, he possessed a head intoxicated with pride.  
From the far road he came to Kūšyār,  
- A heart full of desire; a head full of pride.  
The sage used to close his eyes from him,  
He used not to teach him a single letter.  
When portionless he resolved to return,  
The sage, neck-exalting, said to him:  
Thou hast imagined thyself full of wisdom;  
A vase that is full, how may it take more.  
Thou art full of pretension; on that account, thou goest empty from me;  
Come empty; so that thou mayst become full of truth.  
Sa'dī-like, in the world, of self-consciousness,  
Become void, and return full of knowledge of God.'

بخشی از اب دوم از فصل هشتم از مقاله اول  
ترجمه فارسی زیج جامع کوشیار گیلانی

«...باب دوم، در ذکر تاریخها سه گانه که بروزگار ما بکار می دارند... اما پارسی : اول روز سال روز سه شنبه بود از یزدجرد که ملك یافت بیست و دوم از ربیع الاول سال یازدهم از هجرة و شانزدهم حزیران سال بر نهصد و چهل سه از ذی القرنین و نام ماهها و عدد روزها چنانك گفته اند : فروردین ماه ل، اردیبهشت ل، خرداد ماه ل، تیر ماه ل، مرداد ماه ل، شهریر ماه ل، مهر ماه ل، ابان ماه ل، اذر ماه ل، دی ماه ل، بهمن ماه ل، اسفندارمذماه ل؛ سال سیصد و شصت و پنج روز باشد و پنج زیاده که اخر ابان ماه است که انرا مستترقه خوانند یعنی دزدیده؛ و سال پارسی از سال شمسی نقصان کنیم چهار یکی روز بتقریب و بهر چهار سال روزی باشد و بهر صد و بیست سال ماهی بود و پارسیان بروزگار قدیم هر صد و بیست سال ماهی زیاده کردند تا ان سال سیزده ماه بود. اول سال را دو بار شمار کردند، يك باول سال و يك باخر سال، و مستترقه را ان سال در اخر سال کیسه گرفتند و اول ماههای سال ان ماه بوده است که افتاب بحمل رسیده است و مستترقه و اول سال بهر صد و بیست سال از ماهی بماهی گردیده است تا بروزگار کسری بن انوشروان فتاد که افتاب بحمل بماه اذر رسیده

14. H. Taqizāda, *Gāh-šumārī dar Īrān-i qadīm*, Tehran, 1357 (2nd ed.).

است و این پنج در آخر ماه ابان نهاده و چون صد و بیست سال برین برآمد اضطراب دولت پارسیان بود و عرب بریشان مستولی شدند. ان رسم برداشته شد و این مسترقه در آخر ماه ابان بماند تا بسال سیصد و پنجاه و پنج از تاریخ یزدجرد که افتاب بحمل روز اول فروردین ماه رسید. این پنج دزدیده پارسیان بگردانیدند چنانک بما رسید باخر ماه سفندارمذماه برسم قدیم؛ و در دیار ما که گرگان و طبرستان است این مسترقه را هم چنانک در آخر ابان ماه کردند که پنداشتند که انرا دینی و سنتی است از مجوسان و نشاید گردانیدن و تغیر کردن؛ و هر روزی را از روزهای ماه بتامی مخصوص کردند: هرمز، بهمن، اربهشت، شهریر، اسفندمذ، خرداد، مرداد، دیباذر، اذر، ابان، خور، ماه تیر، جوش، دیبمهر، مهر، سروش، رشن، فروردین، بهرام، رام، باد، دبیدین، دین، ارد، اشتاد، اسمان، زامیاد، مهر، اسفند، انیران؛ و پنج دزدیده را نام اینست: اهنود، اشتود، اسفندمذ، وهخستر، وهشت؛ والله اعلم و احکم...»

(Persian translation of a passage of *Zīj-i jāmi'* by Kūšyār Gilānī in Section 2, Chapter 8, Book 1).

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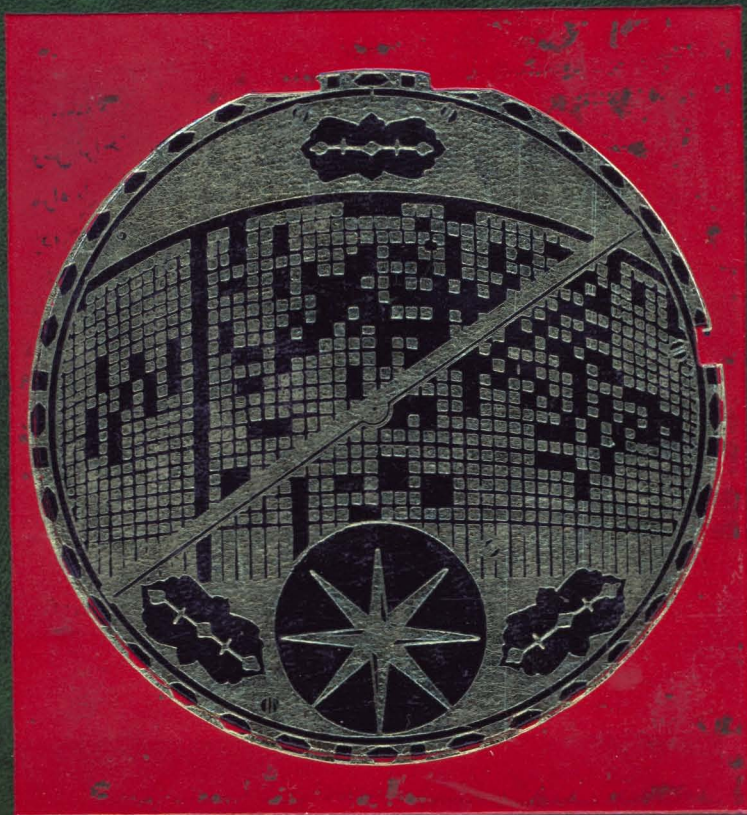
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