Journal for the History of Arabic Science
vol. 14, 2006(in press).

Kushyar ibn Labbans Account of Calendars in his Jami Zij

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Kūshyār ibn Labbān's Account of Calendars in his *Jāmi' Zīj*

Kūshyār ibn Labbān was an eminent Iranian mathematician and astronomer who lived in the second half of the 10th and the early 11th century C.E. He was from the Gīlān province situated in the northern part of Iran, on the southern coast of the Caspian Sea. All his works are written in Arabic [Saidan 1973; Qurbani 1996, 414-420; Yano 1997; Jaouiche 1986; Pingree 2003; Bagheri 2005]. Since he finished writing a copy of his *Jāmi' Zīj* in 393 A.Y./1025 C.E., and, according to al-Nasawī, was dead in 416 A.Y./1048 C.E. (see below), he must have died some time between 1025 and 1048 C.E. In Book I of the *Jāmi' Zīj* (Chapter 5, Section 7), Kūshyār presents an example of a nativity in 332 A.Y./963-4 C.E. that may refer to his own date of birth. He then finds the years that had elapsed from that year up to 389 A.Y./1020-21 C.E., which may be taken as the year in which he wrote Book I of the *Jāmī' Zīj*.

Although most of Kūshyār's scientific legacy has come down to us, very little is known about his life. I will here summarize all the major references to Kūshyār in the historical and literary sources which have been found up to now. Kūshyār was said to be an astronomer at the court of Voshmgīr (d. 357 A.H./967-8 C.E.), the Iranian local ruler in Māzandarān province, on the southern coast of the Caspian Sea, immediately east of Gīlān. In *Tārīkh-i Māzandarān* ("A history of Māzandarān") composed in the 17th century C.E., we read: "One day in the month of Muḥarram 357 A.H., in the city of Jurjān[1], Kūshyār advised the ruler of Māzandarān, Voshmgīr, not to ride horses throughout that day lest he should be killed. All the saddles were taken off the horses, and the ruler did not ride all day long. However, in the evening he heard the grunt of a wild boar, and he could not help riding. He mounted a horse and followed the wild boar; the boar rushed towards the horse, Voshmgīr fell and died" [Gīlānī 1973, p. 78]. This account is not consistent with the above assumption for Kūshyār's date of birth. However, older sources such as [Ibn Isfandiyār 1941, part 2, pp. 3-4], composed in the early 14th century C.E., which mentions Kūshyār among the astronomers of Ṭabaristān (another name for Māzandarān) [ibid, part 1, p. 137], and [Mar'ashī 1954, 131], composed in the late 15th century C.E., give similar accounts of the same event without naming Kūshyār. Therefore, it is probable that the astronomer in this story was someone else, and Kūshyār was in fact at the court of Voshmgīr's son, Qābūs (reigned 367-403 A.H./977/8-1012/3 C.E.), to whom al-Bīrūnī presented his

[1] This is the Arabicized name of Gurgān, an old city in Māzandarān province whose ruins are near Gonbad-i Qābūs in present-day Iran, about 100 kilometers north-east of modern Gurgān.

Chronology of the ancient nations in 390 A.H/999-1000 C.E. The following account confirms this conjecture.

In the medical treatise *Dhakhīra-yi Khwārazmshāhī* ("Khwārazmshāh's resource"), written in Persian by Seyyed Ismā'īl Jurjānī in 504 A.H./1110-11 C.E., the author says that Kūshyār was a knowledgeable astronomer from Gīlān who lived in Gurgān in the service of Qābūs (Voshmgīr's son). Then Jurjānī narrates his encounter with descendants of Kūshyār in Qum. They showed him treatises written by Kūshyār in a very neat and nice form. They told Jurjānī that "Kūshyār wrote things only when he was calm and relaxed, and his books are written very neatly in a nice calligraphy; when Kūshyār was told that his writing style required too much time to complete a single book, he replied, '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 with the quality and contents of the books'." [Jurjānī 1976, p. 644]. Sa'dī, the famous Iranian poet of the 13th century, in one of his poems on humbleness, names Kūshyār as the symbol of a wise scholar [Sa'dī 1879, pp. 245-246]. In his article on Kūshyār, Beyhaqī quotes the following dictum by him: "If two persons are interested in a single thing, the one ignoring the defects of that thing is really unfair to himself." [Beyhaqī 1935, p. 84].

Kūshyār's works have attracted the attention of modern scholars since the early 19th century C.E. In March 1988, his millenium was celebrated at Gīlān University during the 19th Annual Iranian Mathematics Conference. Below I will discuss Kūshyār's most important works. For a detailed list of his works and their manuscripts see [Sezgin 1974, pp. 343-345; 1978, pp. 246-249; 1979, pp. 182-183; Rosenfeld-Ihsanoğlu 2003, pp. 118-119[2]].

Kūshyār's only known mathematical work is entitled *Uṣūl ḥisāb al-Hind* ("Principles of Hindu Reckoning"). It was translated into Hebrew by Shālôm ben Joseph 'Anābī in the 15th century C.E. (see [Cecotti 2004]). An edition of the Arabic text of this treatise was published by Saidan [Saidan 1967]. In recent decades, it has been translated into English, French, Persian, and Russian [Kūshyār 1965; Mazaheri 1975, pp. 73-133; Kūshyār 1988a; Abdullazade 1990, 233-250]. For a comparative survey of the

[2] Some remarks and additional data relating to the entry on Kūshyār ibn Labbān in [Rosenfeld & Ihsanoğlu 2003, #308, pp. 118-119] (R&I): The "Treatise on the principles of the composition of sine tables" (M3 in R&I) is not by Kūshyār; for my argument on its attribution to al-Battānī, see M. Bagheri, Battānī's version of trigonometric formulas, *Taḥqīqāt-i Islāmī*, vol. 7 (1992), no. 2, pp. 169-76. The Alexandria ms. of the *Jāmi' Zīj* (A1) includes Book IV besides Book III (R&I only lists the latter). The Vehbi ms. contains only Book IV of A1. Revanköök 1708 is a ms. of A8 (*Astrology*) rather than of A1. Leiden Or. 8 and Leiden CCO 1054 both refer to the same ms. of A1, whereas Leiden Or. 1021/3 turns out to contain sections I.7, I.8 and I.11 of A8. There is no ms. of A1 in Tehran. There is a copy of A1 in the Russian State Library (previously Lenin Library) in Moscow, namely MS 154/3, containing Books III and IV. The ms. no. 3894/1 in Tashkent (listed under A5 in R&I) is an old Persian translation of Kūshyār's treatise on the astrolabe (A3), but *Irshād-i asturlāb* (Majlis MS 6, Cat. vol. 1, p. 3, listed under A4 in R&I) is not by Kūshyār. The Turkish translation of A8 by Mīkhālījī is kept in the Süleymaniye library, Hamidiye collection, as MS 835.

different versions of this work extant in four mss. in Istanbul, Tehran, Bombay and Cairo, see [Bagheri 2004].

Kūshyār's astrological treatise is entitled *al-Madkhal fī ṣinā'at aḥkām al-nujūm* ("Introduction to the art of astrology"). An edition of the original Arabic text has been published by Prof. Michio Yano with a modern English translation and an edition of the medieval Chinese translation prepared in 1383 C.E. [Kūshyār 1997]. There are also medieval Persian and Turkish translations of this treatise which have not yet been published [Sezgin 1979, p.183; Pingree 2002, p. 408].

Kūshyār's treatise on the astrolabe is extant in several manuscripts. Mr. Taro Mimura has prepared an edition of the Arabic text under the supervision of M. Yano at Kyoto Sangyo University and plans to publish it with an English translation. There is an old Persian translation of this work in Tashkent (MS 3894/1). Abdullazade has provided a table of contents of this treatise [Abdullazade 1990, pp. 194-212] and I have published an edition of the old Persian translation with an introduction [Kūshyār 2004].

Kūshyār's most important astronomical work is the *Jāmi' Zīj* (*al-Zīj al-Jāmi'*; lit., "The comprehensive astronomical tables"). *Zīj*es were standard astronomical treatises in the Islamic period containing extensive tables for astronomical quantities with some texts explaining the calculations based on the tables. More than 200 *zīj*es are known to us of which more than 100 are extant. For detailed accounts of the *zīj* tradition in Islamic civilization and the contents of *zīj*es, see [Kennedy 1956; King and Samsó 2001]. A new survey of Islamic *zīj*es is currently under preparation by Dr. Benno van Dalen.

Kennedy has given a summary account of Kūshyār's *Jāmi' Zīj* in [Kennedy 1956, pp. 125, 156-57]. He maintains that the elements of the *zīj* were taken from al-Battānī's *Ṣābi' Zīj*, and that it is improbable that new observational data were incorporated into it. The *Jāmi' Zīj* was famous and influential in Islamic period astronomy. Although it is influenced by Ptolemy's *Almagest* and al-Battānī's *zīj*, it distinguishes itself by presenting proofs of the underlying mathematical theorems systematically; we find this only in a few other extant *zīj*es e.g., Abu'l-Wafā's *Almagest*, al-Bīrūnī's *Qānūn al-Mas'ūdī*, and al-Kāshī's *Zīj-i Khāqānī*.

The *Jāmi' Zīj* consists of four books (*maqāla*s): I) Elementary calculations, II) Tables, III) Astronomy, and IV) Proofs. Two chapters of the third book entitled *al-Ab'ād wa'l-ajrām* ("<On> the distances and sizes <of the celestial bodies>"), and *Jawāmi' 'ilm al-hay'a* ("A compendium of astronomy") containing definitions of around 130 astronomical terms were also copied, translated, and circulated as independent treatises. An edition of the former (on distances and sizes) has been published in India [Kūshyār 1948], and a Persian translation of it has been published in Iran [Kūshyār 1988b].

Muḥammad ibn 'Umar ibn Abī Ṭālib Tabrīzī translated the first book of the *Jāmi' Zīj* into Persian in 483 A.H./1090 C.E. [cf. Bagheri 1998]. Versions in Hebrew characters of different parts of the *zīj* are kept in four manuscripts that cover the whole work altogether [Langermann 1996, p. 151]. 'Ali ibn Aḥmad al-Nasawī, probably a disciple of Kūshyār, wrote an Arabic commentary on the first book of the *Jāmi' Zīj* entitled *al-Lāmi' fī amthilat al-Zīj al-jāmi'* ("Explanation of the examples in the *Jāmi' Zīj* ") (MS Or. 45/7, Columbia University, New York, fols. 49r-75v)[3]. He presented numerical examples for each of the 85 chapters[4] in Book I of the *Jāmi' Zīj* except for five chapters[5] that according to him did not need any example and two chapters[6] simply skipped. The folios of this ms. are not in their correct order[7] and there is a lacuna from the middle of chapter 6.14 to the middle of chapter 6.20. It is particularly interesting that on folios 50r and 51v al-Nasawī mentions the year 416 of the Yazdigird era (1047-8 C.E.) as "the present year". So he flourished around 1050, and since at the beginning of the treatise he names Kūshyār with the phrase "may God have mercy on him!", this confirms that Kūshyār had died at that date.

No complete edition of the *Jāmi' Zīj* has ever been published, and the *zīj* has not been studied as a whole. However, partial editions, translations and studies of it have appeared during the last two centuries. Muḥammad A'lā al-Tahānawī in his *Kashshāf iṣṭilāḥāt al-funūn* (A dictionary of the technical terms used in the sciences of the Musulmans), composed in 1158 A.H./1745-45 C.E., quoted from Kūshyār's *Jāmi' zīj* about the similarities of the Greek and the Syrian calendars, in his entry on chronology (*al-ta'rikh*) [al-Tahānawī 1862, I, 57]. Ludwig Ideler published an edition of some fragments of the chapter on calendars with German translation [Ideler 1825-1826, II, pp. 623-633]. Joachim Lelewel cited some data from the table of geographical coordinates given in the *Jāmi' Zīj*, and compared them with those of al-Bīrūnī and Ibn Yūnus [Lelewel 1852, pp. xlvi-xlix]. E. Wiedemann translated the preface of the *zīj* into German [Wiedemann 1920, p. 132]. Prof. E. S. Kennedy has studied Kūshyār's method for the calculation of the equation of time [Kennedy 1988, pp. 2-4]. Khurshid F. Abdullazade has vastly discussed the spherical trigonometry, mathematical astronomy and geographical materials in the *zīj* [Abdullazade 1990, pp. 61-193, 213-230]. Dr. Benno van Dalen has analyzed the table for the equation of time in the *Jāmi' Zīj* and was able to explain its method of computation

[3] Late Prof. A. S. Saidan has erroneously attributed this work to Kūshyār and has given wrong manuscript data for it [1973, pp. 531, 533].

[4] Book I consists of an introduction and Sections 1 to 8 containing 6, 6, 3, 12, 22, 20, 6 and 10 chapters, respectively. I indicate Chapter *m* of Section *n* as *n.m*.

[5] Chapters 2.1, 7.1, 6.6, 8.9 and 8.10.

[6] Chapters 4.7 and 4.8.

[7] A fragment from the middle of 5.21 to the middle of 6.3 is misplaced in the middle of 7.1, one folio from 7.4 is misplaced in the middle of 5.21, and one folio of a Persian treatise on arithmetic is misplaced in the middle of 7.4.

by taking into account that the tabular values are influenced by the displacement of the solar mean motion. He has also analyzed a table for the true solar longitudes found in the sequel of the Berlin ms. of the *zīj* and has shown that it most probably derives from Yaḥyā b. Abī Manṣūr [van Dalen 1993]. The large number of tables appended at the end of the Berlin and Leiden mss. reveal important information about various early *zīj*es that are now lost.

Prof. J. L. Berggren has discussed the spherical trigonometry in the third section of Book IV of the *Jāmi' Zīj*. He concluded that, while Kūshyār's account of the trigonometry of his day was not particularly original, it did contain the latest results and showed Kūshyār's taste for systematic exposition based on simple argumentation [Berggren 1987]. Glen Van Brummelen has described Kūshyār's ingenious innovative interpolation scheme for composing double argument tables for the planetary equations of anomaly. The process significantly simplified the determination of a planet's longitude at a given time, although at the cost of some accuracy in the result. This innovation, besides Kūshyār's systematic use of displacement and shift for *all* planets to avoid computations involving subtraction and his use of a different parameter for Mars, shows that he was no mere copyist [Van Brummelen 1998]. Toshiaki Kashino has discussed the planetary theory in the *Jāmi' Zīj* and has provided an edition of the Arabic chapters and tables related to this subject from all four books of the *zīj* [Kashino 1998].

In his *Introduction to astrology*, Kūshyār mentions his other *zīj* entitled *al-Zīj al-Bāligh* ("The extensive astronomical tables") [Kūshyār 1997, pp. 6/7, 216/217]. No manuscript of the integral text of this work has been reported up to now. However, a short chapter entitled *Fī isti'māl adwār al-kawākib 'alā madhhab al-Hind min Zīj al-Bāligh li-Kūshyār* ("On the application of the cycles of the planets according to the Indian method from Kūshyār's *Zīj al-Bāligh*") kept in Bombay (MS R. I 86, Mulla Firuz collection, Cama Oriental Institute) is reported by F. Sezgin [1974, p. 248]. I have discussed the content of this chapter in a paper presented at the 17th Annual Conference for the History of Arabic Science, Sweida (Syria), 1993.

This article is based on part of my Ph.D. dissertation under the supervision of Prof. Henk Bos and Dr. Jan P. Hogendijk of the Mathematics Department of Utrecht University (The Netherlands). This dissertation will consist of an edition of the Arabic text with English translation and commentary of the first and fourth books of Kūshyār's *Jāmi' Zīj*. Here I provide my edition of the introduction to the *zīj* (except for the detailed list of the titles of the 85 chapters of the first book) and the first chapter of the first book, which deals with calendars, with an English

translation and commentary. This chapter is one of the earliest extant Arabic treatments of calendars, and provides important information especially on the old Persian calendar whose remnants were still in use in Kūshyār's time. I have based the edition of the Arabic text on the Fatih manuscript and I have used the Cairo manuscript as an alternative. I have used the following abbreviations for these two manuscripts and other manuscripts to which I have referred whenever it was necessary.

F Istanbul, Fatih, MS 3418/1 (Cat., p. 196; Books I-IV, copied in 545 A.H.), 1v-175v.

C Cairo, Dār al-kutub, MS DM 213/1 (D.A. King, *Fihris al-makhṭūṭāt al-'ilmīya al-maḥfūẓa bi-Dār al-Kutub al-Miṣrīya*, vol. 1, p. 414 and vol. 2, p. 104; Book I, copied in 1169 AH), 1v-26r.

B Berlin, Staatsbibliothek, MS Mq. 101 (W. Ahlwardt, *Verzeichniß der arabischen Handschriften der Königlichen Bibliothek zu Berlin*, vol. V, pp. 203-206, no. 5751; Books I and II, copied in 806 A.H.[8]), pp. 2-221.

L Leiden, Universiteitsbibliotheek, MS Or. 8 (P. de Jong et al., *Catalogus Codicum Orientalium*, vol. III, pp. 84-86, no. 1054; Books I-IV, copied in 634 A.H.), 1v-124r.

Y Istanbul, Yeni Cami, MS 784/3 (Cat. Ahmet III, p. 64; Books I-IV, copied in the 6th century A.H.), 230r-362r .

P Leiden, Universiteitsbibliotheek, MS Or. 523/1 (P. de Jong et al, *Catalogus Codicum Orientalium*, vol. III, pp. 87-88, no. 1056; Persian translation of Book I, copied in 689 A.H.), 31 fols. (MS 305, Āṣafīya, Hyderabad, cat. vol. I, p. 798 has been reported as another ms. of a Persian translation of Book I [Sezgin 1978, 248].)

The first book of the the *Jāmi' Zīj* is missing in other manuscripts of the *zīj* extant in Moscow (Russian State Library 154/3, Books III and IV, 36v-111r, copied in 525 A.H., mentioned in: *Revue de l'Institut des Manuscrits Arabes*, vol. 23 [1977], Fasc. 2, p. 140; Matvievskaya & Rosenfeld 1983, p. 217), Istanbul (Vehbi Efendi 893, Book IV, 1v-74r, copied in 427 A.H., see Krause 1936, p. 472), and Alexandria (Baladiyya 4285 *jīm*, see Y. Zaydān, *Fihris makhṭūṭāt Baladiyat al-Iskandariya*, vol. I, pp. 216-217, Books III and IV, 1v-73v, copied in 566 A.H. from an autograph dated 393 A.Y./415 A.H.) that were accessible to me.

[8]. The date 832 is also written on the ms. by a later hand

In the edition of the Arabic text, I have used angular brackets <> for reconstruction of the text and rectangular brackets [] for abundant phrases. In the English translation, I have used angular brackets to make the English sentences complete and meaningful. My explanatory additions to the English translation are given in parentheses. An asterisk * refers to an explanation in the commentary.

I sincerely thank Prof. Dr. Fuat Sezgin for offering me the opportunity to work on my PhD dissertation in the Institute for the History of Arabic-Islamic Science (Johann Wolfgang Goethe University, Frankfurt) during the period June-August 2005. I also thank Dr. Jan P. Hogendijk, Dr. Benno van Dalen, Dr. Hushang A'lam, and Mr. A. Thobut for their useful comments on my research. Furthermore, I am grateful to Prof. Dr. F. Sezgin, Prof. G. De Young, Dr. M. Yano, Dr. Gleb Mikhailov, Mr. M. Mar'ashi Najafi, Mr. A. Hadzad, and Mr. S. Farrokh-Seresht for their precious help in preparing copies of the manuscripts which I needed. Mr. Claudio Cecotti kindly provided me with the necessary data about present-day Christian feasts. Late Mr. Abu'l-Qasem Qorbani, who also provided me with a copy of the Vehbi ms., was a pioneer in the studies about the history of mathematics and astronomy in Iran. He always encouraged me to work as a full time researcher in this field and to his esteemed memory I dedicate this article.

<Translation>

In the name of God the merciful, the compassionate, and we ask for your assistance, o Generous One!

Kūshyār ibn Labbān ibn Bāshahrī al-Jīlī says: When I examined the *zījes* composed on the art of astronomy and reflected on them, <I found that> there was incorrectness in some of them that needed rectification; some had long-windedness and difficulty that needed simplification; and some had omissions that needed completion. <Even> the *Almagest* is not free of them (i.e., the defects). All of them (i.e., the *zījes*) <contain> careless calculations, devoid of clear exposition and unsupported by adequate demonstration. <Therefore,> I made up my mind to work out a *zīj* combining theory and practice, in which I <would> rectify the incorrectness, bring closer what was far-fetched, fill up for deficiencies, elucidate every <technical> term with a comment, and provide proofs for every calculation in it. Therefore, any difference found in anything between this <*zīj*> and the others, is <caused by my> rectification of the incorrectness or <my> bringing closer the far-fetched or <my> filling of gaps. I have discussed practice before theory in order to facilitate the beginner's access to it and to quicken his benefiting by it. I have composed this <work> in four Books: the first on elementary calculations, the second on their (i.e., of the calculations) tables, the third on commentary and astronomy, and the fourth on the demonstration of the accuracy of the elementary calculations.

When I resolved to do this and reaffirmed my intention about it, I begged God for success and guidance.

Section 1: On eras, <in> 6 chapters
Chapter 1: On the beginnings of the ancient eras and the <numbers of> years and days between any two of them.

The famous eras preserved by the ancients (i.e., those who lived up to the author's time) are: the era of the Deluge, the era of Nabonassar, the era of Philippus, the era of <Alexander> the Two-Horned, the era of Augustus, the era of Diocletianus, the era of the Hejira, and the era of Yazdigird.
The Deluge: The era of the Deluge is used by the authors of the ancient *zījes* such as the *Sindhind zīj* and *Shāh zīj*. Its beginning was the Friday close to the occurrence of the Flood in the time of Noah – peace be upon him! On that day, at sunrise, the sun was in Aries and the moon was in conjunction with it in the beginning of Aries, and the other planets were around the beginning of Aries. Subsequent eras are related to it (i.e., the Deluge).
Nabonassar: He was Nabonassar I, among the kings of Babylon.* The first day of his era was a Wednesday. Ptolemy rendered the mean motions of the planets in the *Almagest* for this era,* and he rendered the positions of the fixed stars for the beginning of the year 886 of it, which was the first day of the reign of Antoninus. Between Friday, the first day of <the era of> the Deluge, and Wednesday, the first day of this era, there are 860,172 days, which are equal to 2,356 Persian-Egyptian years of 365 days, and 232 completed days.
Philippus: He was Philippus, known as the Mason,* father of the Two-Horned*. He was one of the kings of Athens. He <reigned> after the death of Alexander of Macedonia (Alexander III). Theon of Alexandria based his *zīj*, called the *Canon*, on this era. The first day of his era was a Sunday, between which and the era of the Deluge there were 1,014,834 days or 2,780 years and 134 days.
The Two-Horned: He was Alexander II, known as the Two-Horned.* The first day of his era was a Monday, which was the first day of the seventh year of his reign, when he left the land of Macedonia, traveled over the <whole> Earth, and reached <very remote places of> the inhabited world. Between the Monday <which was the beginning> of this era and the epoch of the Deluge there were 1,019,273 days or 2,792 <completed> years and 193 completed days.
Augustus: He was one of the Roman kings. Christ was born in some year of his <reign>. The first day of this era was a Thursday, between which and the epoch of the Deluge there were 1,122,316 days or 3,074 years and 306 days.

Diocletianus: He was one of the kings of Christendom.* The first day of his era was a Wednesday, between which and the epoch of the Deluge there were 1,236,639 days or 3,388 <completed> years and 19 completed days.

The Hejira was the emigration of the Prophet—God bless him and grant him salvation!—from Mecca to Medina. He entered it (i.e., Medina) on Monday, the eighth of the month Rabīʿ al-awwal, and the era is reckoned from the beginning of that year, which was a Thursday, the first day of Muḥarram. Thus between it and that <day of emigration> there are 67 days. The year <of the Hejira calendar> is 354 days plus 1/5 plus 1/6 <of a day>. When <the accumulation of> these fractions exceeds half a day, one day is added to the days of Dhu'l-ḥijjah, so <the number of> its days becomes 30, and <the number of> the days of this year becomes 355. This happens 11 times in the computation of every 30 years, because 11 is 1/5 plus 1/6 of 30. Between this epoch and the epoch of the Deluge there are 1,359,973 days or 3,725 years and 348 days. The determination of the intercalation is such that you should cast out thirties from the <elapsed> years including the desired year, and you should multiply the remainder by 11 and cast out thirties <from the product>. If the remainder is greater than 15, then the <given> year is a leap year, and if it is less, then it is not*.

Yazdigird: He was Yazdigird, son of Shahriyār, son of Kisrā, the last of the Persian kings. The first day of the year in which he acceded to the throne was a Tuesday, between which and the epoch of the Deluge there were 1,363,597 days or 3,735 years and 322 days.

If we want to know <the number of the days or years> between any two epochs, we subtract the <number of> years or days closer to the epoch of the Deluge from the <number of> years or days farther from it, and the remainder is the <number of> years or days between them.*

Chapter 2: On the three calendars used in our time.

The calendars used among us and in our time are: (a) The calendar of the Two-Horned, which is the Greek and the Syrian <calendar> because there is no difference between them except in the names of the months.* The first Greek month is *Kānūn al-thānī* (i.e., *Kānūn* II) with <its> Greek name, and the following <months are based> on its arrangement (i.e., the arrangement of the Syrian months regarding the number of the days in each month); (b) the calendar of the Hejira, that is the Arabian calendar; and (c) the calendar of Yazdigird, that is the Persian calendar.

As to the Syrian <calendar>, its beginning was a Monday as has been mentioned before. The Syrian names of the months and the numbers of their days, added up and separately, are as I say: *Tishrīn* I, 31 days, 31;

Tishrīn II, 30 days, 61; *Kānūn* I, 31 days, 92; *Kānūn* II, 31 days, 123; *Shubāṭ*, 28 days and a quarter of a day, 151; *Ādhār*, 31 days, 182; *Nīsān*, 30 days, 212; *Ayyār*, 31 days, 243; *Ḥazīrān*, 30 days, 273; *Tammūz*, 31 days, 304; *Āb*, 31 days, 335; *Aylūl*, 30 days, 365. So a year has 365 days and a quarter of a day. Whenever <the accumulation of> the quarter is greater than half a day, the number of days of *Shubāṭ* is increased by one, so <the number of> its days becomes 29. The <number of> days of this year becomes 366, and it is a leap year. To know it (i.e., the leap year), you cast out fours from the number of years including the desired year. If the remainder is 3, then this is a leap year, and if the remainder is less, it is not.*

As to the Arabic <era>, its beginning was a Thursday, the first day of the year in which the Prophet <Muḥammad>—God bless him and grant him salvation!—emigrated <to Medina>. It is the 15th of *Tammūz* of the year 933 of <the era of> the Two-Horned. The names of its months and the numbers of their days, added up and separately, are as I say: *Muḥarram*, 30 <days>; *Ṣafar*, 29 <days>, 59; *Rabīʿ I*, 30 <days>, 89; *Rabīʿ II*, 29 <days>, 118; *Jumādā I*, 30 <days>, 148; *Jumādā II*, 29 <days>, 177; *Rajab*, 30 <days>, 207; *Shaʿbān*, 29 <days>, 236; *Ramażān*, 30 <days>, 266; *Shawwāl*, 29 <days>, 295; *Dhu'l-qaʿda*, 30 <days>, 325; *Dhu'l-ḥijja*, 29 <days> plus a fifth and a sixth of a day, 354; <22>. Thus a year <has> 354 days plus a fifth and a sixth of a day. Whenever <the accumulation of> these fractions exceeds half a day, its calculation is as has already been mentioned. The <numbers of> the days of these months are found in this way: You subtract the mean daily motion of the sun from the mean daily motion of the moon, and a complete revolution (i.e., 360°) is divided by the remainder. The result is 29;31,50 days approximately. Thus the months were established <as having> 30 days and 29 days alternately, and we add the extra fractions, i.e. the excesses over half a day, at the end of the year; this adds up to a fifth and a sixth of a day.*

As to the Persian <calendar>, its beginning was a Tuesday, the first day of the year in which Yazdigird, son of Shahriyār, acceded to the throne. It is the 22nd of Rabīʿ I of the year 11 of Hejira, and the 16th of Ḥazīrān of the year 943 of the <era of the> Two-Horned. The names of its months* and the numbers of their days, separately and added up, are as I say: *Farwardīn-māh*, 30 <days>, 30; *Ardībahisht-māh*, 30 <days>, 60; *Khurdād-māh*, 30 <days>, 90; *Tīr-māh*, 30 <days>, 120; *Murdād-māh*, 30 <days>, 150; *Shahrīr-māh*, 30 <days>, 180; *Mihr-māh*, 30 <days>, 210; *Abān-māh*, 35 <days>, 245; *Ādhar-māh*, 30 <days>, 275; *Day-māh*, 30 <days>, 205; *Bahman-māh*, 30 <days>, 235; *Isfandārmadh-māh*, 30 <days>, 265. Thus a year <has> 365 days. The five days added at the end of Abān-māh are called the *mustaraqa* ("stolen") <days>. Since the

Persian year is approximately a quarter of a day less than a solar year, this becomes one day in every four years and one month in every 120 years. During the period of their domination, the Persians observed one intercalary month every 120 years. Thus this year had 13 months. They counted the first month of this year twice: once at the beginning of the year and once more at the end of the year. They put the extra five <days> in the intercalary month (i.e., at the end of the year). <Thus,> the first month of the year was the one in which the sun entered Aries. So, the five <days> and the beginning of the year were moved from one month to the next every 120 years. In the time of Kisrā, son of Qubād, Anūshervān, the sun entered Aries in Ādhar-māh, and the five <days> were placed at the end of Abān-māh. When 120 years had passed, it was the end of the reign of the Persians, the disruption of their government, and <the beginning of> the domination of the Arabs over them. So, this tradition was neglected, and the five <days> remained at the end of Abān-māh until the year 375 Yazdigird, when the sun entered Aries on the first day of Farwardīn-māh. We have been informed that in <the province> Fārs and those areas <near it>, the five <days> were moved to the end of Isfandārmadh-māh according to the ancient tradition.* But in our areas, which are Rayy, Jurjān and Ṭabaristān, they are <still observed> at the end of Abān-māh. People think that it is <something related to> the Zoroastrian religion and tradition, and should not be replaced and changed. Each day of the <Persian> months has a special name by which it is called, viz.: *Hurmazd, Bahman, Ardībahisht, Shahrīr, Isfandārmadh, Khurdād, Murdād, Day-ba-ādhar, Ādhar, Abān, Khūr, Māh, Tīr, Kūsh, Day-ba-mihr, Mihr, Surūsh, Rashan, Farwardīn, Bahrām, Rām, Bād, Day-ba-Dīn, Dīn, Ard, Ashtād, Asmān, Zāmyād, Mārasfand, Anīrān*, and the five 'stolen' days <are> *Ahunavad, Ushtavad, Isfandmad, Vahukhshatra*, <and> *Vahishtavasht.*

Chapter 3: On converting the years of these calendars into days, and the days into <the corresponding> years by calculation and by <using> table<s>.

Calculation for the Syrian <calendar>: You multiply the <number of> completed Syrian years by 21,915, you divide the product by 60, and thus the <number of> days in those years will be obtained.* If the division has a remainder greater than 30, we restore it to one day. You multiply the given <number of> days by 60 and you divide the product by 21,915: The <number of> years <contained> in those days will be obtained. We divide the remainder of the division by 60: The <number of > days of the incomplete year will be obtained.*

<Calculation for> the Arabian <calendar>: You multiply the <number of> completed Arabian years by 21,262 and you divide the product by 60: The <number of> days in those years will be obtained. You multiply the given <number of> days by 60 and you divide the product by 21,262: The <number of> years <contained> in those days will be obtained. We divide the remainder of the division by 60: The <number of> days of the incomplete year will be obtained.

<Calculation for> the Persian <calendar>: You multiply the <number of> completed Persian years by 365: The <number of> days in those completed years will result. You divide the given <number of> days by 365: The <number of> completed years will be obtained. The remainder is the <number of> days in the incomplete year.

<Conversion by means of> the table: If we compile tables, we record in them the multiple or single years, and months, and opposite them, the numbers of days in them in sexagesimals. Then the first <digit> of them (i.e., these numbers) is the absolute <number of> days. The second of them is a multiple of 60, i.e., once divided by 60. The third one is a multiple of 60×60, i.e., twice divided by 60. The fourth one is a multiple of 60×60×60. If we want <to find> the <number of> days of given years and months, we enter with the completed years in the table of the multiple years. We take the <number of> days corresponding to the nearest number below it, and write it down (B adds: "on the <dust> board"). Then we enter with the remainder <of the years> in the table for the single years, take the <number of> days corresponding to it, and add it to what we wrote down before, any <sexagesimal> digit to its corresponding <sexagesimal> digit. Then we take the <number of> days corresponding to the completed months and add it to the sum already obtained. Then the <number of> days in the given years and months will be obtained.

If we want <to find> the <numbers of> years and months <corresponding to a certain number> of days, we enter with the days in <the column for> the multiples of days, take the <number of> years corresponding to the nearest lesser number, and write it down. Then we subtract the <number of> days found in the table from the given <number of> days, each digit from its corresponding digit. Then we enter with the remainder of the days in <the column for> the single days and take the <number of> years corresponding to the nearest lesser number. Then we add it to the <number of> years that we wrote down before. We subtract the <number of> days found in the table of single <days> from the <remaining> days that we have, any digit from its corresponding digit. We take the <number of> months corresponding to the nearest number below the <number of> remaining days. What remains from the <number of> days is the <number of> days of the incomplete month.

Chapter 4: On extracting <dates in> these calendars from each other.

If <a date in> one of these three calendars is known and we want to know <the corresponding date in> another calendar, we convert the known date into days until the present day, and keep it in mind. Then if <the era of> the known <date> precedes the <era in which the date is> unknown, we subtract the <number of> days between the two eras from the <number of> days that we kept in mind. If the <epoch of which the date is> unknown precedes the <epoch of which the date is> known, we add the <number of> days between the two eras to the <number of> days that we kept in mind. Then the remainder or the sum is the unknown <date of the desired> calendar in days. Then we convert it into years as already described. The <beginning of the> Syrian era precedes the <beginning of the> Arabian era by 340,700 days, and precedes the <beginning of the> Persian era by 344,324 days; the <beginning of the> Arabian era precedes the <beginning of the> Persian era by 3624 days. In order to check <the correctness of> the result of <converting> the calendar, we determine the weekday of the given date in the known calendar, and the weekday of the unknown date <in the desired calendar>. If they agree, then it is correct, and if they differ one or two days, we adjust the unknown <date> according to the known <date>.*

Chapter 5: On the weekday of <any date of> these calendars.

The Syrian <calendar>: We convert its date into the <number of> days up to the desired day, plus this day. Then we cast out sevens and count the remainder from Monday. The <week->day at which <the number> finishes, will be the weekday <corresponding to> the given day. If we want to, we <may> cast out twenty-eights from the <number of> years including the desired year. We enter with the remainder in the weekday table, and take the weekday of <the beginning of> the desired month.*
The Arabian <calendar>: We convert its date into the <number of> days as has already been discussed for the Syrian <calendar>.Then we cast out sevens and we count the remainder from Thursday. The <week->day at which the number finishes will be the weekday of the <given> day. If we want to, we <may> cast out multiples of twohundred-ten from the <number of> years including the given year. We enter with the remainder in the weekday table and we take <the number corresponding to> the weekday <of the beginning> of the desired year. Then we add to it <the number corresponding to> the weekday of the desired month.*
The Persian <calendar>: We cast out sevens from the <number of> years including the given year and we count the remainder from Tuesday. The <week->day at which <the number> finishes will be the weekday of <the

beginning of> that year. For each month after Farwardīn we add two days, but we do not add anything for the weekday of Ādhar-māh because the weekday of <the first of> Abān-māh and that of Ādhar-māh are the same on account of the <five> "stolen" <days>.*

Chapter 6: On the feasts and <other> events in these calendars*.

Syrian <feasts>:
Mā'althā (for the literal meaning of the names of the feasts and their equivalents, see the commentary*): If the 29th of Tishrīn I (October) is a Sunday, it is *Mā'althā*; otherwise, <it is> the Sunday which follows it.
Subbār: If the 28th of Tishrīn II (November) is a Sunday, it is *Subbār*; otherwise, <the Sunday> that follows it.
Mīlād: the night which is followed by the morning of the 25th of Kānūn I (December).
Dinḥ: the 6th of Kānūn II (January).
Ṣaum al-'adhārā: It is the feast of *Ghayṭās*, the Monday which follows *Dinḥ*.
Ṣaum Naynawī: <It consists of> three days beginning on a Monday 22 days before *al-Ṣaum al-kabīr*.
'Īd al-haykal: the 2nd of Shubāṭ (February).
Al-Ṣaum al-kabīr: <For its> calculation we take the years of the Two-Horned <era> with the year we desire (i.e., the current year), and we add five to it. We cast out nineteens and we multiply the remainder by nineteen. If the product is greater than 250, we always subtract one from it; if it is less, we do not subtract anything. We cast out thirties from the result. Then we observe the remainder. If it is equal to <the number of days of> Shubāṭ <in that year> or less than that, then the <beginning of the> fast is on that day of Shubāṭ, if it is a Monday. Otherwise, the Monday after it <is the beginning of the fast>. If it (i.e., the remainder) is greater than the <number of> days of Shubāṭ <in that year>, we subtract the <number of> days of Shubāṭ from it. The remainder, <taken> as <number of the day> of Ādhār, is the beginning of the fast if it is a Monday. Otherwise, the Monday after it <is the beginning of the fast>.
We have compiled a table for it. For working with it, we take the years of <the era of> the Two-Horned with the year we desire (i.e., the current year), and we write it down in two positions. We divide one of the <numbers written in the> two positions by twenty eight and we divide the <number in the> other position by nineteen, after adding five to it. We enter along the length of the table with the remainder of the division by twenty eight, and along the width of the table with the remainder of the division by nineteen. The crossing position of the <column and the row of

the> two numbers is the beginning of the fast. If it is <written> in black, it is in Shubāṭ, and if it is <written> in red, then it is in Ādhār.
Another method: It (i.e., the beginning of the fast) is on the nearest Monday to the conjunction which occurs between the 2nd of Shubāṭ (February) and the 8th of Ādhār (March). If we are in doubt about the nearest Monday, then it is <the Monday> which lies between Sha'ānīn and the *Fiṭr* that follows it.
Sha'ānīn: the Sunday, the 42nd of the days of the fast.
Fiṭr: the Sunday next to *Sha'ānīn*.
Al-Sha'ānīn al-ṣaghīra: the Friday following *Fiṭr*.
Sullāq: the Thursday 40 days after *Fiṭr*.
Finṭīqusṭī: the Sunday 10 days after *Sullāq*.
Ṣaum al-Salīḥīn: the Monday after *Finṭīqusṭī*.
Ṣaum Mārt Maryam: the first day of Āb (August).
Ẓuhūr al-Masīḥ: 6th of Āb (August).
Fiṭr Maryam: 15th of Āb (August).
'Īd al-ṣalīb: 14th of Īlūl (September); 13th of Īlūl (September) according to the Nestorians; 15th of Īlūl (September) according to the Romans and the Jacobites.
Suqūṭ al-jimār: the 7th, 14th, and 21st of Shubāṭ (February).
Ayyām al-'ajūz: Seven days starting on the 26th of Shubāṭ (February).
Nayrūz al-Mu'taẓid: 11th of Ḥazīrān (June).
Ayyām al-bāḥūr: Eight days starting on the 19th of Tammūz (July). The variation of the weather on these days indicates that during (the first to the eighth month of) the next year.*

Arabian <feasts>:
'Āshūrā: It is the date of the murder of Ḥusayn b. 'Alī—May God honor him and be pleased with him!—<which occurred on> the 10th of Muḥarram.
Maulid al-Nabī - may the exalted God bless him and grant him salvation!: 12th of Rabī' I.
Yaum al-jamal: 15th of Jumādā I.
Mab'ath al-Nabī - may God bless him and grant him salvation!: 26th of Rajab.
Mi'rāj: the night of the 27th of Rajab.
Laylat al-ṣakk: the night of the 15th of Sha'bān.
Ṣaum: the days of Ramażān.
Fatḥ Makka: 20th of Ramażān.
'Īd al-Fiṭr: 1st of Shawwāl.
Al-Tarwīya: 8th of Dhu'l-ḥijja.
'Arafa: 9th of Dhu'l-ḥijja.
'Īd al-aẓḥā: 10th of Dhu'l-ḥijja.

Ghadīr Khumm: 18th of Dhu'l-ḥijja.

Persian <feasts>:
Nayrūz: 1st of Farwardīn-māh (i.e., the month of Farwardīn).
Nayrūz al-khāṣṣa: 6th of Farwardīn-māh.
Mihrajān: 16th of Mihr-māh.
Mihrajān al-khāṣṣat al-ṣaghīr: 21st of Mihr-māh.
Gāgīl: 15th of Day-māh.
Bahmanjana: 2nd of Bahman-māh.
Sadaq: the night of the 10th of Bahman-māh.
Wādhīra: 22nd of Bahman-māh.
Katb al-ruqā': 5th of Isfandārmadh-māh, <based on placing> the "stolen" days at the end of Abān-māh.
The six *Jāhanbār*s: first, 26th of Ardībahisht-māh; second, 26th of Tīr-māh; third, 16th of Shahrīr-māh; fourth, 15th of Mihr-māh; fifth, 11th of Day-māh; sixth, the five "stolen" <days> of Isfandārmadh-māh.*

Commentary

I.1.1 Historians from the Islamic period have confused Nabonassar, the king of Assyria whose reign began in 747 B.C. and whose era was later used in Ptolemy's *Almagest*, with Nabuchadnezzar (Nabokolassar), king of Babylonia, who reigned in the period 604-562 B.C., and who conquered Jerusalem. So, they have referred to the former by the arabicized form of the latter's name, i.e., *Bukhtanaṣṣar*.

Ptolemy lived in the time of Antoninus Pius (fl. 137 C.E.) and used the era of Nabonassar because, as he says in *Almagest* III.7, this was the era beginning from which ancient observations were preserved down to his time.

The Philippus after whom the epoch 324 B.C. is named, is a son of Alexander III (the Great) and a halfbrother of Alexander IV. His reign started in the same year as that of Alexander IV (323 B.C.), namely with the death of Alexander the Great. The title Mason (*al-bannā'*) is mentioned in all mss. except L. It does not occur in other sources that I have seen, save the *Muṣṭalaḥ zīj* (MS BN arabe 2513), whose chapter on chronology seems to depend, to some extent, on Kūshyār.

In fact, it was Ptolemy's *Handy Tables*, not Theon's *zīj*, in which the Philippus era was adopted. This era also occurs in the *Almagest* as 'the death of Alexander' [Ptolemy 1984, 10, fn. 16].

It is generally accepted both by Muslim commentators and occidental scholars that the 'Two-Horned' (*Dhu'l-qarnayn*) mentioned in the Holy Koran, and used by Arab authors, Muslims, and Christians is to be identified with Alexander the Great (356-323 B.C.). He was Alexander III (not Alexander II, as Kūshyār calls him) of Macedonia. The era erroneously named after Alexander is actually the Seleucid era, which started with the death of Alexander IV and the accession of Seleucus, the founder of the Seleucid dynasty, to power [Ginzel 1906-1914, I, p. 136; Taqizadeh 1939, part 2, pp. 124-27].

Al-Bīrūnī also mentions Diocletianus as "one of the kings of Christendom" [1879, p. 105], and says elsewhere that "He was the last of the pagan Emperors of Rome; after him they became Christians" [1934, p. 173]. In the Byzantine tradition, Diocletianus is primarily remembered as a prosecutor, for his edict of prosecution against the Christians that started in 303 C.E.

In early *zīj*es, if the remainder of a division for the determination of the intercalation of the Arabian years was 15, the resulting half of a day was usually truncated, which led to an ordinary 15th year and an intercalary 16th year in every 30-years cycle. However, in table 2 of Book III of the *Jāmi' Zīj* for the number of days in multiples of Arabian years, Kūshyār

gives the number of days in 15 Arabian years equal to 5316 =15×(354+11/30)+0.5 days. This means that, as was more common in later Persian *zījes*, he rounded upwards the half of a day resulting from the accumulation of the fractions which led to a leap 15th year [cf. van Dalen 2000, p. 267].

Following is a summary of the numerical data given in this section:

Era	Weekday the Deluge	Days after	Years+days
Nabonassar (Assyrian, 26 Feb. 747 B.C.)	Wednesday	860172	2356y+232d
Philippus (Greek, 12 Nov. 324 B.C.)	Sunday	1014834	2780y+134d
Alexander (Seleucid, 1 Oct. 312 B.C.)	Monday	1019273	2792y+193d
Augustus (Roman, 30 Aug. 30 B.C.)	Thursday	1122316	3074y+306d
Diocletianus (Roman, 29 Aug. 284 C.E.)	Wednesday	1236639	3388y+19d
Hejira (Arabian, 15 July 622 C.E.)	Thursday	1359973	3725y+348d
Yazdigird (Persian, 16 June 632 C.E.)	Tuesday	1363597	3735y+22d

In this table, we see the number of days that had passed since the Deluge, at the beginning of each of the seven eras. Each number of days is also converted by Kūshyār into Persian years plus remaining days. Kūshyār's data imply that the epoch of the Deluge was taken to be Friday, 18 Feb. 3102 B.C., which was commonly used and is also implied in Kūshyār's astrological treatise [Kūshyār 1997, p. 140/141].

The above numbers of days for the Nabonassar, Alexander, Hejira and Yazdigird epochs are the most common ones [cf. van Dalen 2000, p. 266, table 2]. The correct number of days since the Deluge for the Philippus epoch is 1014932. The above number given by Kūshyār (1014834, found in the mss. C, Y, B and P) is probably an error by Kūshyār or the scribes. In the ms. L this number is given as 1014934, which is still wrong but closer to the correct number. Presumably the original digit 9 was miswritten as 8 (a possible error in the Arabic script), and the digit 2 was then changed to 4, in order to accord with the correct weekday (Sunday). For the Augustus era, the number given by Kūshyār (1122316, corresponding to 13 Nov. 30 B.C.) is one of two that are found in various other sources. It is based on the assumption that New Year in the ancient Egyptian and the Coptic calendar coincided in the time of Philippus instead of Augustus [cf. van Dalen 2000, p. 266]. Also the implied date for the Diocletian era, 12 Nov. 284 C.E., is one of two that were used in various early sources [cf. van Dalen 2000, p. 266].

I.1.2 In Arabic texts from the Islamic period, the adjective *Rūmī* (Roman) means either 'Roman' or 'Greek'. Here it refers to the Greek era. The modern names (and the numbers of days) of the 'Greek' months

are for instance given by al-Bīrūnī in *al-Tafhīm* and his *Chronology*: Yanwārīūs (31), Febrārīūs (28), Mārṭīūs (31), Afrīlīūs (30), Māīūs (31), Yūnīūs (30), Yūlīūs (31), Aghusṭūs (31), Sebṭembrīūs (30), Aqṭubrīūs (31), Nuāmbrīūs (30), and Duqambrīūs (31). Kūshyār has observed the rule for determining the Syrian leap years in table 1 of Book II of the *Jāmi' Zīj* for the number of days in multiples of Syrian years.

The "conventional" Arabian lunar months have alternately 30 and 29 days. In the lunar months based on the visibility of the lunar crescent, generally used in modern time, the first day of any lunar month is the day following the first observation of the lunar crescent. In this system it is possible to have two consecutive 30-day months, or two consecutive 29-day months.

The Iranian calendar at the time of the advent of Islam was based on a vague solar year of 365 days consisting of 12 months of 30 days plus five extra days that were added at the end of the eighth month Abān. This year was originally taken from the Egyptian calendar. Some modern scholars have tried to determine the date of introduction of the Egyptian year in Iran on the basis of Kūshyār's description of the five epagomenai being at the end of Abān in the year 375 of the Yazdigird era (1006-7 C.E.), found in this chapter. For instance, Taqizadeh [1938, p. 12] believes that the introduction happened in the second decade of the fifth century B.C. However, none of the results have been fully satisfactory [Taqizadeh 1938, p. 5]. According to Kūshyār, as well as al-Bīrūnī and some other authors, Iranians intercalated one full month in each 120 years to compensate for the difference between the Egyptian year and the tropical year (about one-fourth of a day) and to keep the beginning of their year close to the vernal equinox [see e.g., Ginzel 1906-1914, pp. 290-91]. Taqizadeh thinks that this sort of year was by no means a wholly fictitious year, as some seem to believe [1938, p. 57]. Recently François de Blois [1996] has tried to show that such an intercalation process was a mere "legend". However, in particular his "negative" argumentation has not convinced me.

De Blois starts his discussion with the assertion that no reference to an Iranian intercalary month is found in ancient sources and no event is reported to have happened in such a month. But from a mathematical point of view, the probability of a random event happening in an intercalary month following a 120 years period as mentioned above is $1/(120\times12+1)=1/1440$, which is less than 0.07%. He then casts doubt on the reliability of the accounts provided by Kūshyār and al-Bīrūnī for the intercalation in the Iranian calendar. Here his argument that Kūshyār prepared a manuscript of his *Jāmi' Zīj* in 393 A.H./1002-3 C.E. and hence could not have mentioned a calendar reform in 375 A.Y./1006-7 C.E. turns out to be invalid. Inspection of the Alexandria manuscript of the *zīj*

shows that the date of Kūshyār's autograph was 'Sunday the 2nd of Bahman-māh of the year 393' [A.Y./8 Dhu'l-qa'da 415A.H./10 January 1025 C.E.], so Kūshyār's reference to the reform can be correct. Moreover, in the second chapter of the text presented in this article, Kūshyār says that the transfer of the five epagomenai had not yet been accepted by the inhabitants of Rayy, Jurjān and Ṭabaristān, but in the Persian translation, ms. P, prepared in 483 A.H., Rayy is omitted from the names of the cities. This indicates that Kūshyār and the translator were giving a realistic and up-to-date account of what was going on around them.

In my opinion, de Blois's arguments regarding the problem of having two anniversaries for Zoroastre's death being 8 months apart, mentioned in *Zādspram* (chapter 25), the other passage that he quotes from *Zādspram* (chapter 34), and finally, the reference he makes to *Dinkard* [de Blois 1996, p. 43] are consistent with Kūshyār's clear description that after each intercalation the first month of the year shifted to the next one, so that the months drifted slowly through the seasons but the epagomenai always kept trace of the vernal equinox (e.g., before 375 A.Y. the year began with Ādhar-māh, but the vernal equinox was at the beginning of Farwardīn-māh). Kūshyār's description of the arrangement of the *Jāhanbār*s also confirms that a calendar reform took place in 375 A.Y. that followed the intercalation system of the pre-Islamic Iranian calendar (see Chapter 6 and its commentary). For a recent discussion of the subject that confirms the intercalation system mentioned by al-Bīrūnī and Kūshyār, see [Ghasemlou 2003, 825-26].

Even after the advent of Islam the Persian solar calendar was used in Iran beside the Hejira lunar calendar until the 5th/11th century. In the year 471 A. H./1079 C.E., the Jalālī or Malikī calendar was constituted. In this calendar the years began with the vernal equinox based on astronomical observation or calculation.

The modern version of the Persian names of the months as mentioned by Kūshyār in this chapter has been used in the formal Iranian calendar since 1925. In this calendar, the year begins with Farvardīn; the first six months have 31 days, the next five months have 30, and the last month, Esfand has 29 days in normal years and 30 days in leap years. The leap years usually occur every four years, but sometimes they are five years apart. This is determined by the exact moment of the vernal equinox being before or after local solar noon on the 29th of Esfand. The 1st of Farvardīn is the first day whose noon is after the exact time of the vernal equinox.

I.1.3 The lengths of Syrian and Arabian years are 21915:60=$365\frac{1}{4}$ and 21262:60=$354\frac{11}{30}$ days, respectively.

By "completed" years and months, Kūshyār means those which have passed. An "incomplete" year or month refers to a year or month which has not yet been completed. So, when we are in the month m of the year y of any calendar, m-1 completed months and y-1 completed years have passed from the beginning of the era. The month m and the year y themselves are incomplete.

The results of Section I.1.3 are used in Section I.1.4.

I.1.4 The Syrian date is based on the Seleucid era. The following chapter gives the method of determining the weekday for any date in each of the calendars. These methods can be used for checking the correctness of a date conversion from one calendar to another.

I.1.5 The second method for finding the weekday of a date in the Syrian calendar is based on the fact that 28 times 365.25 (days) is a multiple of 7. In table 4 of Book II of the *Jāmi' Zīj*, the weekdays of the first day of any Syrian month for the years 1 to 28 are given directly. Then it will be easy to find the weekday of any date in a given month. The weekdays are shown in the table in the conventional *abjad* numbers from 0 to 6, corresponding to Saturday, Sunday,..., Friday, respectively. This allows us to convert the final remainder into weekdays directly, because the Arabic names for Sunday up to Thursday are derived from the Arabic words for 'one' to 'five', respectively.

The second method for finding the weekday of a date in the Arabian calendar works because 210 times $354\frac{11}{30}$ is a multiple of 7. Table 5 of Book II of the *Jāmi' Zīj* is in two parts: In one part, the weekdays of the first day of the years 1 to 210 are listed. The other part displays the weekdays of the first day of the 12 Arabian months (assuming 0 for the first month, because its beginning is the same as the beginning of the year).

The method for the Persian years is valid because 365 is a multiple of 7, plus 1. For any month we add 2 days, because $30 = 4\times7+2$. We do not add anything for Ādhar-māh, because with the five epagomenae Abān-māh has 35 days, which is a multiple of 7. Table 6 of Book II gives the number (0 to 6) corresponding to the weekday of the beginning of each Persian month for each remainder r (1 to 7) of the number of years y of the Yazdigird era, if $y = 7k + r$ for an integer k.

Examples:

The weekday of the first day of Tishrīn I of the Syrian year 1359 is found as follows:

1358 (completed years)×21,915÷60 ≈ 496,009

496,009+1= 496010=7×70858+4

The fourth day counting from the epoch Monday is Thursday. So the desired weekday is Thursday.

If we want to use table 4 of Book II, we proceed as follows:

1359 = 28×48+15

The table entry for 15 (remainder of the Syrian year) is 5, which corresponds to Thursday.

The weekday of the first day of *Ramażān* of the year 439 of the Hejira era is found as follows:

438 (entire years)×21,262÷60≈155,213

The number of the months from the beginning of the year to the first of *Ramażān* is 4×30+4×29=236, and we add one for inclusion of the desired day itself:

155,213+236+1=155,450=22207×7+1

The first day counting from the epoch Thursday is Thursday itself. So, the desired weekday is Thursday.

If we want to use table 5 of Book II, we proceed as follows:

439=210×2+19

The table entry for 19 (remainder of the Arabian year) is 0, and the table entry for *Ramażān* is 5. Since 5+0=5, the corresponding weekday is a Thursday.

The weekday of the first day of *Mihr-māh* of the year 416 of the Yazdigird era is found as follows:

416=59×7+3

The third day counting from the epoch Tuesday is Thursday. So, the weekday of the beginning of the year is a Thursday. Now, since *Mihr-māh* is the 7th month of the Persian year, we add 12 for the six preceding months:

3+12=15=2×7+1

The first day counting from the epoch Tuesday is Tuesday itself. So, the weekday of the beginning of *Mihr-māh* is Tuesday. In table 6 of Book II, the entry corresponding to $r = 3$ and *Mihr-māh* is 3, which corresponds to Tuesday.

I have taken these examples from the treatise *al-Lāmi' fī amthilat al-Zīj al-jāmi'* ("Explanation of the examples of the *Jāmi' Zīj* ") by Abu'l-

Ḥassan ʿAlī b. Aḥmad al-Nasawī mentioned in the introduction of this article. Al-Nasawī's calculation (fols. 51r-52r) shows some insignificant differences with what I have provided above because he made a mistake in finding the weekday of the beginning of *Tishrīn I* of the year 1359 of the Syrian era by calculation. Note that all three examples are for the years 1047-8 C.E., the time of composition of al-Nasawī's commentary.

1.1.6 The modern equivalents and the meanings of these feasts are as follows:

NAME	EQUIVALENT	MEANING
Syrian:		
Mā'althā	Presentation of Christ	
Subbār	Annunciation	
Mīlād	Christmas	Birth of Christ
Dinḥ	Epiphany	
Ṣaum al-'adhārā (Ghayṭās)		The Fast of the Virgins
Ṣaum Naynawī		The Fast of Nineveh
'Īd al-haykal	Wax Feast	The Feast of the Temple
Al-Ṣaum al-kabīr	Lent	The great Fast
Sha'ānīn	Palm Sunday	
Al-Sha'ānīn al-ṣaghīra		The lesser Sha'ānīn
Fiṭr	Easter	Fast-breaking
Sullāq	Ascension day	
Finṭīqusṭī	Pentecost, Whitsunday	
Ṣaum al-Salīḥīn		Fast of the Apostles
Ṣaum Mārt Maryam		Fasting for the illness of Mary
Ẓuhūr al-Masīḥ		Advent of Christ
Fiṭr Maryam		Fast-breaking in commemoration of Mary's death
'Īd al-ṣalīb		Feast of the Cross
Suqūṭ al-jimār		Falling of pebbles
Ayyām al-'ajūz		Days of the old woman
Nayrūz al-Mu'taẓid		Mu'taẓid's New Day
Ayyām al-bāḥūr	Dog days	
Arabic:		
'Āshūrā'		The 10th day of Muḥarram
Maulid al-Nabī		Birth of the Prophet
Yaum al-jamal		The day of the Camel Battle
Mab'ath al-Nabī		Appointment day of the Prophet
Mi'rāj		Ascension day of the Prophet
Laylat al-ṣakk		The great Liberation night
Ṣaum		Fasting
Fatḥ Makka		Conquest of Mecca
'Īd al-Fiṭr		Feast of fast-breaking

Al-Tarwīya		Watering
ʿArafa		Recognition
ʿĪd al-aẓḥā		Feast of Immolation

Persian:

Ghadīr Khumm		Khumm pool
Nayrūz	Pers. *Nowrūz*	New Day
Al-Nayrūz al-khāṣṣa		*Nayrūz* of the nobility
Al-Mihrajān al-khāṣṣat al-ṣaghīra		The lesser specific Mihrjān
Katb al-ruqāʿ		Charms against scorpions
*Jāhanbār*s	Pers. *Gāhanbār-hā*	Seasonal feasts

The calculation of Lent by means of Kūshyār's tables is explained in [Saliba 1970, pp. 197-98]. The explanation for *Ayyām al-bāḥūr* in parentheses in the translation is taken from al-Bīrūnī, whose account is clearer [1934, p. 184]. All of the feasts and fasts mentioned by Kūshyār are also described by al-Bīrūnī [1879, pp. 199-334; 1934, pp. 174-186; 1954-1956, I, pp. 238-270] whose account is more complete and gives a more extensive explanation for each case. Since al-Bīrūni dedicated his *Chronology* to Qābūs in 390 A.H/999-1000 C.E., it is highly probable that Kūshyār made use of it. In fact, he repeats the mistakes made by al-Bīrūnī (see below). In only a few cases he gives different data.

Thus Kūshyār says that first of Āb is called *Ṣaum Mārt Maryam*. But according to al-Bīrūnī [1879, p. 296; 1954-1956, I, 242] this is the *Ṣaum maraż Maryam* ("Fasting on account of the illness of Mary"), and he puts *Ṣaum Mārt Maryam* on the Monday that follows *Subbār* [1879, p. 310; 1954-1956, p. 245]. Kūshyār says that the *Ayyām al-bāḥūr* are eight days beginning on the 19th of Tammūz. Al-Bīrūnī's account in *al-Tafhīm* [1934, p. 184] is the same as Kūshyār's, but in [1879; p. 268; 1954-1956, I, p. 270] al-Bīrūnī says that they are seven days beginning on the 18th of Tammūz.

Al-Bīrūnī [1879, p. 329; 1954-1956, p. 256] puts *Yaum al-jamal* on the 3rd of Jumādā I. Only in ms. C of the *Jāmiʿ Zīj* it is mentioned to be on the 15th of Jumādā I. Other mss. do not mention it at all. According to Kūshyār (as found in all mss. that contain Book I), *Fatḥ Makka* ("the Conquest of Mecca") was on the 20th of Ramażān, but al-Bīrūnī [1879, p. 330; 1954-1956, p. 256] puts it on the 19th of Ramażān.

Al-Bīrūnī [1879, p. 214] calls the feast on the 22nd of Bahman *Bād-rūz* instead of Kūshyār's *Wādhīra*. Also instead of *Gāgīl*, we read *Kākthl* and *Kāvkīl* in al-Bīrūnī [1879, p. 212; 1954-1956, 260].

Each *Jāhanbār* (Persian *Gāhānbār*, lit. "The feasts of the [six] times [of creation]") consists of five days and Kūshyār defines their beginnings. Al-Bīrūnī's account of the beginnings of the six *Jāhanbār*s [1879, pp. 204, 205, 207, 210, 212, 217; 1954-1956, pp. 259-60] is different from

Kūshyār's. The dates according to al-Bīrūnī are as follows: I) 11th of Daymāh, II) 11th of Isfandārmadh-māh, III) 26th of Ardībahisht-māh, IV) 26th of Tīr-māh, V) 16th of Shahrīwar-māh, VI) the five 'stolen days' at the end of Abān-māh. There is a shift of two in the numbers of the *Jāhanbār*s between Kūshyār and al-Bīrūnī. Kūshyār puts the 6th *Jāhanbār* at the end of Isfandārmadh-māh and al-Bīrūnī puts it at the end of Abān-māh. Zoroastrian sources are not consistent in this regard [Taqizadeh 1938, p.11] and there were different accounts of the beginnings of the *Jāhanbār*s. Kūshyār's account matches with an old Pahlavi text *Āfaringān Gāhanbār* and with the calendar reform of 375 A.Y., and his system is now used by the Zoroastrians [Taqizadeh 1937, footnotes of pp. 18-10].

Most of the feasts listed by Kūshyār (and al-Bīrūnī) are still celebrated, but not always on the same dates. In the present lithurgical calendar of the Syrian Orthodox Church *Mā'althā* is celebrated on February 2nd as the presentation of Christ at the Temple of Jerusalem. Kūshyār's description for *Mā'althā* is valid for the present feast Sanctification of the Church, which corresponds to *'Īd al-haykal*. The latter falls on a Sunday in late October or early November. Kūshyār confused these two feasts with each other. The first Sunday of the Advent now falls on the 28th of November if it is a Sunday; otherwise it is the next Sunday. Kūshyār mentions this as *Subbār*. However, at present *Subbār* is celebrated on March 25th. *Ṣaum Maryam* now begins on the 10th of August, and ends at the date given by Kūshyār (the 15th of August). The fast of the Apostles is now celebrated on June 26th-29th, while the corresponding fast in Kūshyār's account, *Ṣaum al-Salīḥīn*, was on the Monday after Pentecost, so depended on Easter.

Nayrūz al-Mu'tażid was actually a Persian feast, but it was adjusted with the Syrian date 11th of *Hazīrān* (June) [cf. al-Bīrūnī 1934, pp. 185-86]. *Ayyām al-'ajūz* and *Soqūṭ al-jimār* are Arabian occasions but defined by the solar (Syrian) dates. Al-Bīrūnī says that, according to the Greeks, *Ayyām al-bāḥūr* (Dog days) are connected with the (heliacal) rising of the Dog-star of Orion, i.e., Sirius [see al-Bīrūnī 1934, p. 183].

The Arabian feasts have mostly been preserved up to now, because they are actually connected to Islamic occasions and rituals. However, their importance (manifested in being a formal holiday or not) is not the same in different Islamic countries and among different sects. Also their exact dates are not always agreed unanimously. *Ramażān* (the month of fasting) and *'Id al-Fiṭr* (the feast of fast breaking), as well as the occasions connected with the Prophet, i.e., *Maulad al-Nabī* (his birth), and *Mab'ath al-Nabī* (his appointment), and those connected with *Ḥajj* (pilgrimage to Mecca), i.e., *'Arafa* (recognition) and *'Id al-aẓḥā* (immolation), are evenly important in all the Islamic world. *'Ashūrā* and *Ghadīr Khumm* are of particular importance in Shi'ism.

In present Iran, *Nowrūz* (in Arabic *Nayrūz*) is celebrated as the most important formal national feast on 1-4 Farvardīn (usually 21-24 March). *Mihrgān* (in Arabic *Mihrajān*) now falls on the 10th (and not 16th) of *Mihr* because each of the first six Iranian months now have 31 days (not 30 days). *Sadeh* (in Arabic *Sadaq*) still falls on the 10th of *Bahman*. Its name is derived from the Persian word *sad* or *ṣad* which means "hundred", because on this day 50 days plus 50 nights remain until *Nowrūz* [Cf. Bīrūnī 1934, p. 182; 1954-1956, 260]. The latter two feasts are still remembered and celebrated on a limited level, but not as formal holidays. *Gāhanbār-hā* (in Arabic *Jāhanbārāt*) as well as *Mihrgān* and *Sadeh*, are regarded as important national and religious feasts among the Zoroastrians who also celebrate other old Iranian feasts.

<text>

بسم الله الرحمن الرحيم[9]

و بك الاعانة يا كريم قال كوشيار بن لبان بن باشهري[10] الجيلي اني لما تصفحت[11] الزيجات المؤلفة في صناعة التنجيم و تأملتها فكان في بعضها فساد[12] يحتاج الى اصلاح و في بعضها تطويل و تبعيد يحتاج الى تقريب و في بعضها نقصان يحتاج الى اتمام و ما خلا المجسطي منها و كلها حساب[13] غفل لا يرجع الى بيان شاف و لايستند الى برهان كاف، اردت[14] ان اعمل زيجا يجمع علما و عملا اصلح فيه الفاسد و اقرب البعيد و اتمم الناقص[15] و اكشف عن معني كل لفظ فاشرحه و ابرهن علي كل حساب فيه فاقيده[16] فما وجد[17] من التفاوت بين هذا و غيره في اى شيء وجد فهو اما لفاسد[18] اصلح و اما لبعيد قرب[19] و اما لناقص تمم[20] و اقدم العمل على العلم لسهولة وصول المبتدئ اليه و سرعة فائدته[21] له و اجعله اربع مقالات الاولى منها في حساب الابواب و[22] الثانية في جداولها و[23] الثالثة في الشرح و الهيئة و[24] الرابعة في البرهان على صحة حساب الابواب و لما صح عزمي على ذلك و تأكدت نيتي فيه سألت الله التوفيق و الهداية[25]

الفصل الاول في التواريخ ستة ابواب

الباب الاول في ذكر مبادئ تواريخ قديمة و ما بين كل اثنين منها من السنين و الايام

التواريخ المشهورة المحفوظة عند القدماء تاريخ الطوفان و تاريخ بختنصر[26] و تاريخ فيلبس و تاريخ ذى‌القرنين و تاريخ اغسطس و تاريخ دقلطيانوس و تاريخ الهجرة و تاريخ يزدجرد

الطوفان فتاريخ الطوفان تستعمله اصحاب الزيجات القديمة مثل السندهند و الشاه و اوله يوم الجمعة قريب من ظهور الماء في ايام نوح عليه السلام الشمس عند طلوعها في ذلك اليوم كانت في الحمل و القمر معها مجتمعان في اول الحمل و سائر الكواكب حول اول الحمل و الى هذا التاريخ تنسب سائر التواريخ التي بعده

بختنصر[27] و هو بختنصر الاول من ملوك بابل و اول يوم من تاريخه يوم الاربعاء و على هذا التاريخ وضع بطلميوس اوساط الكواكب في المجسطي و وضع مواضع الكواكب الثابتة لاول

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[9] F illegible from here to يا كريم !!! misplaced? This belongs to p. 26
[10] C باشهريار instead of باشهري
[11] C تصفحت instead of تصفحت
[12] F فسادا instead of فساد
[13] C om. حساب
[14] F illegible from here to اصلح فيه
[15] F illegible from here to معني
[16] C فانفذه instead of فاقيده
[17] C وجدت instead of وجد
[18] C الفاسد instead of لفاسد
[19] C البعيد اقرب instead of لبعيد قرب
[20] C الناقص اتمم instead of لناقص تمم
[21] C فايدة instead of فايدته
[22] C om. و
[23] C om. و
[24] C om. و
[25] C والهداية instead of والرشد والهداية والعصمة والكفاية انه هو المعين
[26] C بختنصر instead of بختنصر

</text>

سنة ثمان مائة و ست و ثمانين منه[28] و هو اول يوم من ملك انطينس و بين يوم الجمعة اول يوم من الطوفان و يوم الاربعاء اول يوم من هذا التاريخ 860172 يوما تكون من السنين الفارسية المصرية التي عدد ايامها ثلاثمائة و خمسة وستين يوما الفى و ثلاثمائة و ستة و خمسين سنة ومائتين و اثنين و ثلثين يوما تامة

فيلبس هو فيلبس المعروف بالبناء و هو والد ذىالقرنين و هو ملك من ملوك اتون و هو بعد ممات الاسكندر المقدوني و علي تاريخه وضع ثاون[29] الاسكندراني زيجه الملقب بالقانون و اول يوم من تاريخه يوم الاحد بينه و بين تاريخ الطوفان 1014834 يوما تكون هذه الايام الفا و سبعمائة و ثمانون سنة و مائة و اربعة و ثلاثون يوما

ذوالقرنين هوالاسكندر الثاني المعروف بذي القرنين و اول يوم من تاريخه يوم الاثنين اول السنة السابعة من ملكه حين خرج من بلاد مقدونية فسار في الارض و بلغ من معمورها ما بلغ و بين يوم الاثنين من هذا التاريخ وبين تاريخ الطوفان 1019273 يوما تكون هذه الايام الفا و سبعمائة و اثنين و تسعين سنة و مائة و ثلاثة و تسعين يوما تامة

اغسطس هو ملك من ملوك الروم و في بعض سنيه ولد المسيح و اول يوم من تاريخه يوم الخميس بينه و بين تاريخ الطوفان من الايام 1122316 و من السنين ثلاثة آلاف و اربعة و سبعين سنة و ثلاثمائة و ستة ايام

دقلطيانوس هو ملك من ملوك النصرانية و اول يوم من تاريخه يوم الاربعاء بينه و بين تاريخ الطوفان <من الايام> 1236639 و من السنين ثلاثة آلاف و ثلاثمائة و ثمان و ثمانين سنة و تسعة عشر يوما تامة

الهجرة هو هجرة النبي صلى الله عليه و سلم من مكة الى المدينة و كان دخوله اياها يوم الاثنين الثامن من شهر ربيع الاول والتاريخ مأخوذ من اول السنة و هو يوم الخميس اول يوم من المحرم فاذا بينه و بين ذلك سبعة و ستون يوما فالسنة ثلاثمائة و اربعة و خمسون يوما و خمس وسدس فاذا صارت هذه الكسور اكثر من نصف يوم زيد في ايام ذي الحجة يوم واحد فتصير ايامه ثلاثين يوما و ايام تلك السنة ثلاثمائة و خمسة و خمسون يوما و ذلك في حساب كل ثلاثين سنة احدى عشر مرة لان الاحدى عشر خمس و سدس الثلاثين و بينه و بين تاريخ الطوفان من الايام 1359973 و من السنين ثلاثة آلاف و سبعمائة و خمس و عشرين سنة و ثلاثمائة و ثمانية و اربعين يوما و معرفة الكبيسة منها هي ان تلقي السنين مع السنة التي تريد ثلاثين ثلاثين و ما بقي تضربه في احد عشر و تلقيه ثلاثين ثلاثين فان كان الباقي اكثر من خمسة عشر فتلك السنة كبيسة و ان كان اقل فلا

يزدجرد هو يزدجرد بن شهريار بن[30] كسرى آخر ملوك الفرس و اول يوم من السنة التي ملك فيها يوم الثلاث بينه و بين تاريخ الطوفان من الايام 1363597 و من السنين ثلاثة الاف و سبعمائة و خمسة و ثلاثين سنة و ثلاثمائة و اثني و عشرين يوما

و اذا اردنا ما بين كل تاريخين انقصنا سني الاقرب الى الطوفان او ايامه من سني الابعد منه او ايامه فما بقي فهو ما بينهما من السنين او الايام

الباب الثاني في ذكر التواريخ <الثلاثة>[31] المستعملة في زماننا

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[27] C بختصر instead of بختصر

[28] C سنة; B, L, and Y منه

[29] C has an abundant word ثاون here, being an alternative Arabic form of Theon's name, as found in P

[30] C ابن instead of بن

[31] C om. الثلاثة found in its contents list and in other mss.

التواريخ المستعملة عندنا و في زماننا فهو تاريخ ذى القرنين و هو الرومي والسرياني لانه لاخلاف بينهما الا في اسامي الشهور و ان اول شهور السنة عند الروم كانون الثاني[32] باسم رومي <ثم>[33] على ترتيبها و تاريخ الهجرة و هو التاريخ العربي و تاريخ يزدجرد و هو التاريخ الفارسي

و اما السرياني فاوله يوم الاثنين على ما تقدم ذكره و اسماء شهوره بالسريانيه و عدد[34] ايامها مجملا و مفصلا على ما اقول تشرين الاول احد و ثلاثون يوما **لا** تشرين الثاني ثلاثون يوما **سا** كانون الاول احد و ثلاثون يوما **صب** كانون الثاني احد و ثلاثون يوما **قكج** شباط ثمانية و عشرون يوما و ربع يوم **قنا** آذار احد و ثلاثون يوما **قفب** نيسان ثلاثون يوما **ريب** ايار احد و ثلاثون يوما **رمج** حزيران ثلاثون يوما **رعج** تموز احد و ثلاثون يوما **شد** آب احد و ثلاثون يوما **شله** ايلول ثلاثون يوما **شسه** فالسنة ثلاثمائة و خمسة و ستون يوما و ربع يوم فاذا صار الربع اكثر من نصف يوم زيد في ايام شباط يوم واحد فتصير ايامه تسعة و عشرين و ايام تلك السنة ثلاثمائة و ستة و ستون و هي سنة الكبيسة و معرفتها ان تلقى السنين مع السنة التي تريد اربعة اربعة فان بقيت ثلاثة فتلك السنة كبيسة و ان بقي اقل فلا

و اما العربي فاوله يوم الخميس اول يوم من السنة التي هاجر فيها النبي صلى الله عليه و سلم و هو الخامس عشر من تموز سنة ثلاث و ثلاثين و تسعمائة لذى القرنين و اسماء شهوره و عدد ايامها مجملا و مفصلا على ما اقول المحرم **ل** صفر **كط نط** ربيع الاول **ل فط** ربيع الاخر **كط قيح** جمادى الاول **ل قمح** جمادى الاخر **كط قعز** رجب **ل** رز شعبان **كط رلو** رمضان **ل رسو** شوال **كط رصه** ذي القعده **ل شكه** ذي الحجه **كط و** خمس و سدس يوم **شند** <**كب**>[35] فالسنة ثلاثمائة و اربعة و خمسون يوما و خمس و سدس يوم فاذا صارت هذه الكسور اكثر من نصف يوم فكما تقدم [و] حسابه <و> استخرجت ايام هذه الشهور بان تنقص وسط مسير يوم الشمس من وسط مسير يوم القمر و قسم الدور على الباقي يحصل تسعة عشرون يوما و احدى و ثلاثون دقيقه و خمسون ثانيه بالتقريب فوضع شهر ثلاثين يوما وشهر تسعة و عشرين يوما و جمعنا الكسور الفاضله اى الزائدة على نصف يوم[36] في اخر السنة فاجتمع منها خمس و سدس يوم

و اما الفارسي فاوله يوم الثلاثاء اول يوم من السنة التي ملك يزدجرد بن شهريار فيها و هو الثاني والعشرون من ربيع الاول سنة احدى عشر للهجرة والسادس عشر من حزيران سنة ثلاثة و اربعين و تسعمائة لذى القرنين و اسماء شهوره و عدد ايامها مفصلا و مجملا على ما اقول فروردينماه **ل ل** اردیبهشتماه **ل س** خرداذ[37] ماه **ل ص** <تیرماه **ل**>[38] **قك** مرداذماه **ل** <**قن**>[39] شهريور[40] ماه **ل قف** مهرماه **ل** رى آبان ماه **له رمه** آذر[41] ماه **ل رعه** دى ماه **ل شه** بهمن ماه **ل شله** اسفندارمذ[42] ماه **ل شسه** فالسنة ثلاثمائة و خمسة و ستون يوما والخمسة الزائدة في[43] آخر ابان ماه تسمى المسترقه و لان السنة الفارسية تنقص عن الشمسية بربع يوم تقريبا صار في كل اربع سنين يوم واحد و في كل مائة و عشرين سنة شهر واحد و كانت الفرس في ايام دولتهم يكبسون في كل مائة و عشرين سنة شهرا واحدا فيكون تلك السنة ثلاثة عشر شهرا يعدون اول

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[32] C تشرين الاول instead of كانون الثاني found in B, L, P, and Y

[33] ثم added from B and Y

[34] C نذكر instead of عدد found in B, L, P, and Y

[35] كب added from Y

[36] C بيوم instead of يوم found in B, L, and Y

[37] L and P substitute ذ for final د in the names of the months

[38] C تيرماه illegible

[39] C قن illegible

[40] Y شهريور instead of شهريور, which conforms to the modern Persian name of this month

[41] C ازر instead of اذر found in other mss.

[42] C اسفندار instead of اسفندارمذ found in other mss.

[43] C هى instead of في

شهر من شهور السنة مرتين مرة في اول السنة و مرة في آخرها و يجعلون الخمسة الزائدة في ايام الشهر المكبوس و اول شهور السنة الشهر الذي تحل فيه الشمس الحمل فكانت الخمسة و اول السنة تنتقل في كل مائة و عشرين <سنة>[44] من شهر الى شهر و كان في ايام كسرى بن قباد انوشروان[45] تحل الشمس الحمل في آذر[46] ماه والخمسة الموضوعة في آخر آبان ماه و لما اتت عليه مائة و عشرون سنة كان اواخر ايام ملك الفرس و اضطراب دولتهم و استيلاء العرب عليهم فاهمل ذلك الرسم و بقيت الخمسة في آخر آبان ماه الى سنة خمس و سبعين و ثلاثمائة ليزدجرد و حلت الشمس الحمل في اليوم الاول من فروردينماه فنقلت الخمسة بفارس و تلك الديار علي ما بلغنا الى آخر اسفندارمذماه علىالرسم القديم فاما في ديارنا التي هي الرى و جرجان و طبرستان فهى في آخر آبان ماه فانهم يظنون ان ذلك دين و سنة للمجوس لايجوز ان يبدل و يغير و لكل يوم من ايام الشهر اسم مخصوص يسمى به و هو هرمزد[47]، بهمن، اردیبهشت، شهریر، اسفندارمذ، خرداذ، مرداذ[48]، دیبادر، آذر[49]، آبان، خور، ماه، تیر، کوش[50]، دیبمهر، مهر، سروش[51]، رشن، فروردین، بهرام، رام، باد، دیبدین، دین، ارد، اشتاد، اسمان، زامیاد، مارسفند[52]، انیران، والخمسة المسترقة : اهنود، اشتود، اسفندمد[53]، وهخشتر، وهشتوشت[54]

الباب الثالث في نقل سني هذه التواريخ الىالايام والايام الى سنيها بالحساب والجدول

اما الحساب السرياني فتضرب السريانية بالسنة التامه في احد و عشرين الفا و تسعمائة و خمسة عشر و تقسم المبلغ على ستين[55] فتحصل ايام تلك السنين فان فضل من القسمة شيئ اكثر من ثلاثين جبرناه يوما و تضرب الايام التي تفرض في ستين و تقسم المبلغ على احد و عشرين الفا و تسعمائة و خمسة عشر فيحصل سنو تلك الايام و ما فضل من القسمة قسمناه على ستين فتحصل الايام من السنة الناقصة

العربي تضرب السنين العربية التامة في احد و عشرين الفا و مائتين و اثنين و ستين و تقسم المبلغ على ستين[56] فيحصل ايام تلك السنين و تضرب الايام التي تفرض في ستين و تقسم المبلغ على احد و عشرين الفا و مائتين و اثنين و ستين فيحصل سنو تلك الايام و ما فضل من القسمة قسمناه على ستين[57] فيحصل ايام من السنة الناقصة

الفارسي تضرب السنين الفارسية التامة في ثلاثمائة و خمس و ستين فيصير ايام تلك السنين تامة و تقسم الايام التي تفرض على ثلاثمائة و خمس و ستين فيحصل سنون تامة و مابقي فايام من السنة الناقصة

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[44] C om. سنة found in B, L, and Y

[45] C انوشروانinstead of انوشروان found in B, P, and Y

[46] C ازر instead of آذر found in other mss.

[47] L, P, and Y هرمز instead of هرمزد

[48] Y امرداد, a more ancient form of the name alternatively used in modern Persian, instead of مرداد

[49] C ازر instead of آذر found in other mss.

[50] L, P, Y جوش instead of کوش

[51] C شروس instead of سروش found in other mss.

[52] P and Y مهر اسفد and L مهر اسبند instead of مارسفند

[53] L and Y اسپتمد instead of اسفندمد

[54] B, L, and P substitute ذ for final د in the names of the days

[55] C السنين السريانية instead of ستين found in other mss.

[56] C السنين instead of ستين found in other mss.

[57] C السنين instead of ستين found in other mss.

الجدول ان وضعنا جداول اثبتنا فيها السنين المجموعة والمبسوطة والشهور و بازائها ايامها مرفوعة ستين ستين فالاول منها هو الايام المطلقه والثاني منها مرفوع مرة اى مقسوم على‌الستين مرة والثالث مرفوع مرتين اى مقسوم على‌الستين مرتين والرابع مرفوع ثلث مرات[58] فاذا اردنا ايام سنين مفروضة و شهور دخلنا بالسنين التامة في جدول السنين المجموعة [ثم الباقي في المبسوطة] و نأخذ الايام التي بازاء اقرب عدد اليها مما هو اقل منها فنثبتها[59] و ندخل بالباقي من السنين في جدول السنين المبسوطة ونأخذ الايام التي بازائها و نزيدها على ما اثبتناها كل جنس على[60] جنسه ثم نأخذ الايام التي بازاء الشهر التام و نزيدها على ما اجتمع من قبل فتحصل ايام السنين و الشهور المفروضة

و اذا اردنا سني ايام و شهورها دخلنا بالايام في ايام المجموعة و نأخذ السنين التي بازاء اقرب عدد اليها ما هو اقل منها فنثبتها و ننقص الايام الموجودة في الجدول من الايام التي معنا كل جنس من جنسه ثم ندخل بالباقي من الايام في ايام المبسوطة و نأخذ السنين التي بازاء اقرب عدد اليها مما هو اقل منها فنزيدها على السنين التي اثبتناها و ننقص الايام الموجودة في الجدول المبسوط من الايام التي معنا كل جنس من جنسه و ما بقيت من الايام اخذنا الشهور التي بازاء اقرب عدد اليها مما هو اقل منها و ما بقي من الايام بعد ذلك فهي ايام من الشهر الناقص

الباب الرابع في استخراج هذه التواريخ بعضها من بعض

اذا كان احد هذه التواريخ الثلاثة معلوما و اردنا ان نعرف منه احد الباقيين جعلنا المعلوم اياما الى اليوم الذي انت فيه و حفظناها ثم ان كان المعلوم اقدم من المجهول نقصنا من الايام المحفوظة ايام ما بين التاريخين[61] و ان كان المجهول اقدم من المعلوم زدنا ايام مابين التاريخين على الايام المحفوظة فما بقي او بلغ[62] فهو التاريخ المجهول اياما فنجعلها سنين كما تقدم القول فيه والتاريخ السرياني اقدم من العربي بايام عددها 340700 و هو اقدم من الفارسي بايام عددها 344324 والعربي اقدم من الفارسي بايام عددها 3624 و يمتحن الحاصل من التاريخ بان يعرف مدخل اليوم المفروض من التاريخ المعلوم في ايام الاسبوع و مدخل اليوم المجهول فان اتفقا فصحيح و ان اختلفا بيوم او يومين الحقنا المجهول بالمعلوم

الباب الخامس في مدخل هذه التواريخ في ايام الاسبوع

السرياني نجعل تاريخه اياما الى اليوم الذي نريد مع ذلك اليوم و نلقيها سبعة سبعة و ما بقي نعده من يوم الاثنين فاليوم الذي ينتهي اليه هو مدخل ذلك اليوم المفروض و ان شئنا القينا من السنين مع السنة التي نريد ثمانية و عشرين ثمانية و عشرين و ما بقي دخلنا به في جدول المدخل و نأخذ ما بازائه من مدخل اى [سنة نريدها ثم نزيد عليه مدخل اى] شهر نريده

العربي نجعل تاريخه اياما كما تقدم في السرياني و نلقيها سبعة سبعة و ما بقي نعده من يوم الخميس فاليوم الذي ينتهي اليه العدد هو مدخل اليوم و ان شئنا القينا من السنين مع السنة التي

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[58] C مراتب instead of مرات

[59] B adds على التخت

[60] C الى instead of على

[61] C om. from here to المحفوظة , recovered from B, L, and Y

[62] C بقى او بلغ found in B instead of بلغ او بقى

نريد مائتين و عشرة مائتين و عشرة و ما بقي دخلنا به في جدول المدخل و نأخذ ما بازائه من مدخل اى سنة نريده ثم نزيده على مدخل الشهر الذي نريد
الفارسي تلقي سنيه مع السنة التي تريد سبعة سبعة و ما بقي تعده من يوم الثلاثاء فاليوم الذي ينتهي اليه هو مدخل تلك السنة و تزيد عليه لكل شهر بعد فروردين ماه يومين يومين و لا تزيد لمدخل آذرماه شيئا لان مدخل آبان ماه و آذرماه في يوم واحد لوقوع المسترقة

الباب السادس في الاعياد والتوقيعات التي في هذه التواريخ

السرياني
ماعلثا ان كان اليوم التاسع والعشرون من تشرين الاول يوم الاحد فهو ماعلثا والا فالاحد الذي بعده
السبار ان كان اليوم الثامن والعشرون من تشرين الثاني يوم الاحد فهو السبار والا فالاحد الذي بعده
الميلاد الليلة التي صبيحتها الخامس والعشرون من كانون الاول
الدنح[63] السادس من كانون الثاني
صوم العذاري هو عيد الغيطاس الاثنين الذي بعد الدنح
صوم نينوى ثلاثة ايام اولها الاثنين الذي قبل الصوم الكبير باثني و عشرين يوما
عيد الهيكل الثاني من شباط
الصوم الكبير حسابه ان ناخذ سني ذي القرنين مع السنة التي نريد و نزيد عليها خمسة و نلقيها تسعة عشر تسعة عشر و ما بقي[64] ضربناه في تسعة عشر فان كان المبلغ اكثر من ماتي و خمسين نقصنا منه واحدا ابدا[65] و ان كان اقل لم ننقص منه شيئا فما كان نلقيه ثلاثين ثلاثين و[66]ما بقي نظرنا و ان كان مثل ايام شباط او دونه فالصوم في ذلك اليوم من شباط ان كان يوم الاثنين والا فالاثنين الذي بعده و ان كان اكثر من ايام شباط القينا منه ايام شباط و ما بقي فهو اول الصوم من آذار ان كان يوم الاثنين والا فالاثنين الذي بعده[67]
و قد وضعنا لذلك جدولا و العمل به ان نأخذ سني ذي القرنين مع السنة التي نريد و نضعها في موضعين و نقسم احد الموضعين على ثمانية و عشرين و نزيد على الموضع الآخر خمسة ابدا و نقسمه على تسعة عشر ثم ندخل بما بقي من القسمة على ثمانية و عشرين في طول الجدول و ما بقي من القسمة على تسعة عشر من عرض الجدول فموقع الالتقاء العددين هو اول الصوم فان كان بالسواد فهو من شباط و ان كان بالحمرة فهو من آذار[68]
وجه آخر الاقرب الاثنين الى الاجتماع الكائن فيما بين اليوم الثاني[69] من شباط الى اليوم الثامن[70] من آذار[71] فان شككنا في الاثنين الاقرب فهو الذي يقع بين الشعانين والفطر استقبال[72]

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[63] C الذبح instead of الدنح
[64] B add. ان كان تسعة عشر او دونه
[65] B om. ابدا
[66] B ان كان ثلاثين او دونه فان كان اقل من ايام شباط تلك السنة و كان يوم الاثنين فهو صوم instead of here up to ان كان يوم الاثنين
[67] This calculation method is only found in L and B.
[68] This method based on table 7 of Book II is only found in L.
[69] C الثامن instead of الثاني found in B, P, and Y
[70] C الثاني instead of الثامن found in B, P, and Y
[71] This alternative method is found in C, B, Y, and P. Y and P mention that there is also a calculation for this fast that accords with this method.
[72] The sentence regarding the doubtful case found in C, Y, and P, is ambiguous, because the beginning of the Lent cannot be in its last week.

الشعانين[73] يوم الاحد الثاني و الاربعون من الصوم
الفطر يوم الاحد الذي بعد الشعانين
الشعانين الصغيرة[74] الجمعة التي بعد الفطر
السلاق يوم الخميس بعد الفطر باربعين يوما
فنطيقسطي يوم الاحد بعد السلاق بعشرة ايام
صوم السليحين الاثنين الذي بعد فنطيقسطي
صوم مارت[75] **مريم** اول يوم من آب[76]
ظهور المسيح السادس من آب
فطرمريم الخامس عشر من آب
عيدالصليب الرابع عشر من ايلول و عند نسطور الثالث عشر من ايلول و عند الروم و يعقوب الرابع عشر منه
سقوط الجمار[77] اليوم السابع و الرابع عشر و الحادي و العشرون من شباط
ايام العجوز سبعة اولها السادس و العشرون من شباط
نيروزالمعتضد[78] الحادي عشر من حزيران
ايام الباحور ثمانية اولها التاسع عشر من تموز و يستدل بما يكون في هذه الايام من اختلاف الهواء[79] على ما في السنة من ذلك

العربي
العاشورا هو مقتل الحسين بن علي كرم الله وجهه و رضي عنه العاشر من محرم
مولد النبي صلى الله تعالى عليه و سلم الثاني عشر من ربيع الاول
يوم الجمل الخامس عشر من جمادي الاول
مبعث النبي صلى الله عليه و سلم السادس و العشرون من رجب
المعراج ليلة السابع و العشرون من رجب
ليلة الصك ليلة خامس عشر من شعبان
الصوم ايام رمضان
فتح مكة العشرون من رمضان
عيد الفطر اول يوم من شوال
التروية الثامن من ذي الحجة
عرفة التاسع من ذي الحجة
عيد الاضحى العاشر من ذي الحجة
غدير خم الثامن عشر من ذى الحجة

الفارسي
النيروز اول يوم من فروردين ماه
نيروز الخاصة السادس من فروردين ماه
المهرجان السادس <عشر> من مهرماه

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[73] B السعانين الكبير instead of الشعانين
[74] B, L, and Y الصغير instead of الصغيرة
[75] B, L, P, and Y om. مارت
[76] B add. **التجلي و هو**
[77] P جمرات instead of جمار
[78] L المعتضدي instead of المعتضد
[79] C الهوى instead of الهواء

مهرجان الخاصة الصغير[80] الحادي و العشرون من مهر ماه
كاكيل[81] الخامس عشر من دى ماه
بهمنجنه الثاني من بهمن ماه
السدق ليلة العاشر من بهمن ماه
واذيره الثاني والعشرون من بهمن ماه
كتب الرقاع الخامس من اسفندارمذماه على ان المسترقة في آخر آبان ماه[82]
الجاهنبارات الستة اولها **كو** من اردیبهشت ماه الثاني **كو** من تيرماه الثالث **يو** من شهريرماه
الرابع **يه** من مهرماه الخامس **يا** من دى ماه السادس الخمسة المسترقة من اسفندارمذماه

[80] B, L, P, and Y om. الصغير
[81] C تكاكيل instead of كاكيل found in B, L, P, and Y
[82] C om. from here to the end of the section found in L and Y

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