KushyĀr Ibn Labb | Encyclopedia.com

(*fl.Ca*. 1000)

astronomy, trignometry, arithmetic.

Little known about Kushyār's life. The word "al-Jīlī" added to his name refers to Jīlīn, a region of northern Iran south of the Caspian Sea.

The earliest arabic biographers to write about Kushyār is al-Bayhaqī (*d*. 1065), who states that Kushyār lived in Baghdad and died about A. H. 350 (A. D. 961). Later biographers copy al-Bayhaqī and add several attributes to Kushyār name, including the title "al-kiya," which seems to mean "master." But 'Alī ibn Aḥmad al-Nasawī, an arithmetician who flourished after 1029, is said to have been a student of Kushyār's. This makes 961 too early; and accordingly, Schoy, Suter, and Brockelmann state that Kushyār must have flourished between 971 adn 1029. It may be pointed out, however, that Ibn al-Nadīm does not mention Kushyār,. Ibn al-Nadīm completed the main bulk of his *Fihrist* about 987 but continued to make additions to it until about 995. It would be rather strange if *al-kiya* Kushyār, the prolific writer, had lived in the same city at the same time and remained unnoticed by Ibn al-Nadīm. In his study of Kushyār's *zījes*, kennedy points out that most of them were probably written after 1000. Accordingly, until further evidence appears, it will be safe to state only that Kushyār ibn Labbān florished around A. D. 1000.

The works attributed to kushyār have survived, but of these only three have received scholarly attention, two *zījes* and an arithmetic. The two *zījes* are al-Jāmi', "The comprehensive," and *al-Bāligh*, "The Far-reaching." Each is in four sections: introductory notes, tables, explanations, and proofs. Of the *al-Bāligh* only the first two sections are extant in the Berlin manuscript. In his "Survey of Islamic Astrrtonomical Tables," E. S. Kennedy refers to the doubts whether Kushyār actually wrote two distinct *zījes* and gives the impression that *al-Bāligh* is an abbreviated copy of al-Jāmiʿ.

Kushyār's arithmetic is *Uṣūl Ḥisāb al-Hind*, "Elements of Hindu Reckoning." There is a Hebrew commentary to this work written by 'Anābī in the fifteenth century.

Kushyār also wrote *al-Lāmiʿ fī amthilat al-zīj al-Jāmiʿ*, "The Brilliant [Work] on the Examples Pertaining to *al-Jāmiʿ zīj*"; *Kitāb al-Asṭurlāb wa kayfiyyat 'amalihī wa iʿtibārihi*, …, "A Book on the Astrolable and How to Prepare It and Test It …"; *Tajrād Uṣūl Tarkīb al-Jurūb*, "Extracts of the Principles of Building up Sine Tables"; *al-Madkhal [or al-Mujmal] fī ṣinā' at ahkām al-Nujām*, "An Introduction [or Summary] of the Rules of Astrology [and Astronomy]"; and *Risāla fī al-Abʿād wa al-Ajrām*, "A Treatise on Distances adn Sizes," i.e., measuration.

It is believed that Kushyār did not make any astronomical observations of his own; his *zījes* are classified with a few others called "al-Battānī's group." These take their elements from Muhammad ibn Jābir ibn Sinān al-Battānī's al-Zīj al-ṣābi''.

Kushyār is, however, credited with having developed the study of trignometric functions started by Abu'lWafāʾ and al-Battānī. Abu'l-Wafāʾ gives sine tables, and al-Battānī gives sines and cotangents; but Kushyār's *zījes* contain sines, cotangents, tangents, and versed, together with tables of differences. In most of these tables the functions are calculated to three sexagesimal places and the angles increase in steps of one degree.

Kushyār's unique position in the development of Hindu arithmetic is not yet well understood. The Muslims inherited two arithmetical systems; the sexagesimal system, used mainly by astronomers, and finger reckoning, used by all. Finger reckoning contained no numeration. Numbers were stated in words, and calculations were done mentally. To remember intermediary results, calculators bent their fingers in distinct conventional ways; hence the name finger reckoning. Scribes were able to denote manually numbers from 1 to 9,999, one at a time.

The sexagesimal system used letters of the Arabic alphabet for numeration. Its fraction were always in the scale of sixty, but integers could be in the scale of sixty or of ten. We have arithmetic books that explain the concepts and practices of finger reckoning—most important being the arithmetic written by Abu'l-Wafāʾ for state astronomers performed their calculations in the scale of sixty before the Indian mwethods began to exert their influence.

Almost every *zīj* starts by giving arithmetical rules stated rhetorically. Mainly these comprise rules of multiplication and division that may be expressed as

$60^m \cdot 60^n = 60^{m+n}$

$60^m \div 60^n = 60^{m-n}$

In books on finger reckoning and on Hindu arithmetic we find statements describing sexagesimal algorisms; these sum to bear Hindu influence. One is thus left with the impression that before they learned Hindu arithmetic, astronomers, like finger reckoners made their calculations mentally, probably depending on finger reckoning as well as sexagesimal calculation. It should be stressed, however, that in Islam the system of finger reckoning used fractions to the scale of sixty and was very rich: it comprised algebra, mensuration, and the elements of trigonometry. it must therefore have been elaborated by the more gifted mathematicians. But whatever the case may be, there remains the question of whether there were any special manipulational methods devised for astronomical calculations.

Abu'l-Wafāʾ was more of an astronomer than an arithmetician; but since his arithmetic was expressly written for state officials, he may have deliberately avoided bothering his readers with material that he considered too advanced for them.

The importance of *Kushyār's Uṣūl Ḥisāb al-Hind* lies in his living written it to introduce the Hindu methods into astronomical calculations. Abū Hanīfa al-Dīnawarī, a lawyer, wrote on arithmetic to introduce these methods into business. ʾAlī ibn Ahmad al-Nasawā, known to have been Kushyār's student, AbŪ Ḥanifā was lengthy and Kushyāy's was compact; he said that the former proved to be for astronomers and the latter for businessmen. But al-Nasawī copied Kushyāy freely in his work and showed no better understanding of the Hindu system.

Kushyāy *Uṣūl* is in two sections supplemented by a chapter on the cube root. The first section gives the bare rudiments of Hindu numeration and algorism on the dust board, and in at least one place we find that Kushyār was not well informed on the new practice. wishing to solve 5625 – 839, like any other computer he puts the array.

5625

839

on the dust board.

Other Arabic writers on Hindu artihmetic (excluding al-Nasawī) would start by substacting 8 from 6; as this was not possible, they "borrowed" 1 from the 5, broke it down to 10, adn thus subtracted 8 from 16. This process of borrowing and breaking down was not known to Kushyār (adn his student). He subtracted 8 from 56 complete, obtaining 48. His next step was to subtract 3 from 82.

The second section of Kushyār's *Uṣūl* presents calculations in the scale of sixty, using Hindu numerals and the dust board. Here it seems, although it cannot always be proved decisively schemes alien to with concepts and manipulational schemes alien to both the Hindu system and what is found in books on finger reckoning. These must be schemes in the scale of sixty practised by astronomers.

Briefly Kushyār states that the scale of sixty is indispensable because it is precise. In the absence of decimal fractions, which were added to the Hindu system by Muslim arithmeticians, Kushyār's statement is true. He then shows how to convert decimal integers to this scale; this is necessary for the methods he presents. His multiplication, division, an extraction of roots require the use of a multiplication table extending from 1 X 1 to 60 X 60, expressed in alphabetic numeration and in the sexagesimal scale. With this background he presents homogeneous methods of addition, subtraction, multiplication, division, and extraction of the square root (and, in the supplementary section, the cube root).

Kushyār certainly worked on the dust board and resorts to erasure and shifting of numbers from place to place; these were the distinguishing feature of the Hindu methods as they came to the Arabic world. But apart from these, he worked out 49°36' ÷12°25' as an endless operation of division in decimal fractions would be worked out. He obtained the answer 3°59' and had 8'25" left as a remainder. He added that the division could be continued if more precise results are desired.

The same applied to roots. Kushyār found the square root of 45°36', obtaining the result 6°45'9"59"', with a remainder. He added that the process could be continue to find the answer to higher degrees of precision.

From this tratment there is only one step to decimal fraction. Al-Uqlīdisī mae it again in the fifteenth; but it was left to Stevin to establish it in his *La Disme* (1585).

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