History of Astronomy in Iran: An Overview

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In a general view, history of astronomy in Iran may be divided into three main periods: 1) pre-Islamic Iran, 2) Islamic civilization period, and 3) Modern period.

Islam was introduced in Iran around 14 centuries ago. Before that, Iranians believed in the teachings of the prophet Zoroastre whose exact time is unclear. The sacred book of Zoroastrians was *Avesta* composed around 3000 years ago, in which there is a reference to the spherical shape of the earth. No scientific text from pre-Islamic Iran has survived. In the Zoroastrian religious texts, some references to the names of stars, constellations including zodiacal signs are found. Prof. Michio Yano has published a horoscope from *Bundahishn* (lit.: "base of creation"), an encyclopedic text from pre-Islamic Iran. Pre-Islamic Iranians scholars were familiar with Indian and Greek astronomy.

We know that an astronomical work consisting tables of astronomical parameters and variables plus explanation of the methods of using them was composed in pre-Islamic Iran. Such standard handbooks were named *zig* and Middle Persian. This Persian term was later Arabicized as *az-zij* and Latinized as *Ezich*. In Persian the word *zig* (in modern Persian transformed as *zeh*) meant "thread" or "chord". By extension the word came to mean "the set of parallel threads making up the warp of a fabric". Then since the closely drawn vertical lines of a numerical table are similar to the parallel strings of a textile, the meaning was further extended to include the former. And finally, the word came to denote the whole sets of astronomical tables with instructions. The word *Qanun* (Canon) was also used for the same meaning.

The astronomical handbook composed in pre-Islamic Iran was called *Zij-e Shah* or *Zij-e Shahriyaran*, both meaning "The Royal Astronomical Tables". In a later time, it was compared against Ptolemy's *Almagest* and an Indian *zij* (one of the *Sidhanta*s) and was revised on the basis of the Indian work referred to as *Zig Hendug* (Indian *zij*) which was found to be better than the Greek one. The first Arabic translation of *Almagest* into Arabic was from a Pahlavi (Middle Persian) translation.

After the invasion of Iran by the Muslim Arabs in the 7th century AD, *Zij-e Shahriyaran* was translated into Arabic and the scholars used it and quoted from it until the 11th century. Today we only have these quoted fragments. Biruni (973-1048) and Abu Ma'shar (787-886) are among those who have quoted from the pre-Islamic *zij*. Biruni who was the greatest Iranian scholar of the Islamic civilization, has quoted from *Zij-e Shahriyaran* the mathematical method of graduation of horizontal sundials.

In another Zoroastrian religious book entitled *Shayest-Nashayest* (lit.: "What to do [and] what not to do"), the lengths of the shadow of a gnomon at midday and afternoon prayer times are provided for each solar month.

I the first century AD, a group of Zoroastrian scholars who were also religious leaders emigrated from the Sistan province in south-east of Iran to India. They took their beliefs and knowledge to India and mixed them with Indian beliefs and knowledge. They were called *Mugh-Brahman*s or Sun worshipper Sistanis and in Sanskrit they were called Shaka Dvipy. They took also their solar calendar in which the year begins with spring equinox. It was called Shaka calendar in India. The Shaka calendar was the basis of Indian Vikrami calendar which had just a shift compared the former. The Vikrami calendar which was based on the Shaka calendar became the official calendar of India after independence in 1947.

From the 7th to the 9th century AD no scientific text has remained because it was the period of war and resistance against the Arab invaders. Some information about the Iranian calendar in this period has survived in the work of Anania of Shirak, the Armenian scholar who flourished in the first century AD.

From the 9th to the 15th century there was a flourishment of scientific activity in Iran and we find a galaxy of eminent scholars in this period. This was mainly because the Arabic language became the lingua franca of a vast territory from South Spain (Andalusia) to North Africa, Middle East, and Central Asia up to West China. There was a lot of scientific exchange and cooperation between scholars of different language, ethnic origin and even religion. It is sometimes interpreted as the renaissance of pre-Islamic Iranian science. Most of the works composed were in Arabic, most of the scholars were Iranians and this was the period on Islamic civilization. So the is a debate on whether it should be called Arabic, Iranian or

Islamic science. But this is just a matter of terminology which should be a subject for conflict.

In the 8th century AD, the Indian astronomical treatise *Surya Sidhanta* was translated into Arabic and influenced the early astronomical works composed in Iran. Some Sanskrit terms and methods from Indian astronomy entered Islamic period astronomy in this way. Dividing the length of a gnomon into 12 parts and the Sanskrit term *bhukti* (in Arabic form *buht*) for the daily mean motion of the celestial bodies may be mentioned as examples.

About 200 astronomical handbooks (*zij*es) were composed in the period 9th to 15th century AD out of which 100 texts are extant. Only a few of them are edited, translated and published up to now. I have prepared an edition of the Arabic text of the astronomical work *az-Zij al-Jami'* (lit.: "The Comprehensive *zij*" composed by Kushyar ibn Labban (963/4-before 1048 AD) with English translation and commentary. The Books I and IV of the work have been published in Frankfurt (2009). The remaining Books II and III are being prepared to be published.

The late Prof. E. S. Kennedy composed a book entitled *A Survey of Islamic Astronomical Tables* (1956, reprinted in 1989) which is being revised and completed by Dr. Benno van Dalen, the Dutch brilliant scholar now based in Munich. My Persian translation of Kennedy's book was published in Iran in 1995.

Japanese contemporary scholars have investigated the astronomical legacy of the Iranian scientist of the Islamic civilization. Prof. Michio Yano has published an edition of Kushyar ibn Labban's Arabic treatise entitled *An Introduction to Astrology* with English translation and old Chinese translation in 1997. He received honorary citizenship of Gilan (birthplace of Kushyar) for this publication in 2007. He has also translated the astrological treatise of Biruni entitled *Tafhim* into Japanese together with the late Prof. Keiji Yamamoto (d. 2018). This translation has been published in three parts in the *Kyoto Bulletin of Islamic Area Studies* (March 2010, February 2011 and 2013). Toshikai Kashino has prepared his master thesis entitled *Planetary Theory of Kushyar ibn Labban* in Kyoto Sangyo University in 1998. Dr. Taro Mimura has prepared and edition of Kushyar ibn Labban's Arabic treatise on astrolabe with a Japanese translation as his master

thesis in Kyoto Sangyo University in 2000. His work has been published in Iran in 2013.

The first eminent Iranian astronomer was Muhammad ibn Musa Khwarazmi (9th century AD) whose *zij* was composed in the Indian tradition. The original Arabic text has not survived, but a Latin translation of a summary of the work has come down to us. The modern word "algorithm" is said to be a distorted form of the Arabic version of his name al-Khwarazmi due to the Latin translation of his book on arithmetic. He also composed a treatise on algebra and the word algebra, from the Arabic term *al-jabr* (lit.: "compensation") has found its way into the European mathematics as the name of the mathematical branch.

Jamshid Kashani (al-Kashi) may be regarded as the last noticeable astronomer of Iran in the Islamic period. He lived in the 15th century AD. He went from Kashan to Samarkand on the invitation of Ulugh Beg, the grandson of Tamerlane who was the ruler of Samarkand. Jamshid Kashani designed an observatory in Samarkand and made precise and long-run observations there which led to the composition of the Persian work *Zij-e Soltani* (lit.: The Royal *zij*). Kashani also calculated a precise value of π which was surpassed by Western mathematicians only two centuries later. Kashani found an exact value for the sine of one degree using an iterative method for solving the involved cubic equation. The method was discovered later in Europe and is named as Newton's method.

Modern astronomy was introduced in Iran in the 17th century. A trace of this introduction is the existence of three similar astrolabes kept in Cambridge (Whipple Museum of History of Science), Greenwich (The National Maritime Museum) and a private collection in Antwerp. They are made by a certain Muhammad Mehdi Khadem Yazdi in 1070 AH/ 1659-60 AD. The date is mentioned in the form of a poem engraved on them using the *abjad* alphanumerical system. On one of the plates relating to the constellations of the northern celestial hemisphere the following fragment is engraved in Persian: "Since there were some deviations in the positions of the fixed stars based on the old observations, and the most accurate positions of the fixed stars were found by the European observations, we based the positions of the fixed stars in this plate on their observations carried out ten years ago." This was possibly the celestial map prepared by Melchior

Tavernier in Paris in 1650. Tavernier's brother visited Iran in 1651 and was in contact with the court of the Safavid dynasty king of Iran.

At present, there are research and educational astronomical observatories in several cities of Iran. The National Observatory of Iran is being constructed near the city Qum (Iran). Astronomy and astrophysics is taught in several universities of Iran. There is a master program in history of astronomy in the Institute for the History of science, University of Tehran. Several journals and books are published in Iran in the field of astronomy.

Amateur astronomy has a noticeable growth in Iran in the recent 20 years. Amateur astronomical societies actively cooperate and establish scientific cooperation with other societies inside or outside Iran.

I organized a workshop on origami sundials in Mehr Astronomical Society in Bushehr, a city in the south of Iran, on the coast of the Persian Gulf. In another amateur astronomical society Sagheb in the city of Rasht, in the north of Iran, near the Caspian Sea, there is noticeable activity in the history of astronomy and gnomonics (the science of making and using sundials). There are several modern sundials in this city and a sundial excursion was recently organized there. The last sundial made in Iran was designed by me recently. I append here a photo of this vertical sundial situated in Apadana Residence Complex in west of Tehran. Sundials have a long history in Iran, from the pre-Islamic era to the Islamic period and modern times. They are regarded efficient tools to raise curiosity towards astronomy among the younger generations.