Ulug Beg (200085)

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THE HERITAGE OF ULUGH BEG

Edward S. KENNEDY

Background and narrative

In order to describe and assess the accomplishments of the astronomer-prince Ulugh Beg it is necessary to sketch, however briefly, the historical background of the society in which he found himself. For, independently of his innate capabilities, his high birth as the favorite grandson of the Amir Timur (Tamerlane) on the one hand endowed him with the power to carry out grand designs. But on the other hand his position as a public figure inhibited much of which he was capable, and entailed finally an untimely death.

His grandfather gloried in the deeds of his Mongol forebears and sought to emulate them. A century before, Chinggis Khan and his sons had carved out the largest empire the world has ever seen, stretching from China through Central Asia and the Middle East to include part of Europe. The cost to humanity in destruction and killing is well known, but in the consolidation which followed, many regions enjoyed periods of security and prosperity, and excellent communications fostered commerce. Like the Seljuqs before them, the Mongols rapidly became sponsors of the arts and sciences. Of especial relevance to our inquiry is the example of the Ilkhan Hulagu, under whose auspices Nasir al-Din al-Tusî built the Maragha observatory, staffed with the leading scientists of the realm.

As for Timur, he was primarily a consummate general, and his career consisted essentially of a series of successful military campaigns. The field army was commanded by him in person. To administer the provinces he appointed members of his immediate family, sometimes accompanied by trusted officers chosen from among his personal adherents. Furthermore, the provincial garrisons tended to be made up of foreign soldiers whose allegiance was to the source of their pay. They were not tribal units commanded by their own chiefs. This made the probability of internal revolt small, but it militated against a peaceful and orderly succession upon the death of the sovereign ([15]*, p.87).

* Here and in the sequel, numbers in square brackets are references to items in the bibliography which follows the paper. Grateful acknowledgment is made of help from Drs. David King, Kevin Krisciunas, and George Saliba without implicating them in blunders which the text may contain.

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THE MATHEMATICAL TREATISE OF ULUGH BEG

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Mirza Muhammad ibn Shahrukh ibn Timur Ulugh Beg Guragan (1394-1449), ruler of Samarkand and grandson of the great conqueror Timur, is best known as the founder of the famous Samarkand astronomical observatory and as one of authors of the astronomical tables known as *Zij-i Ulugh Beg* (complete Russian translation,[1] incomplete French translation [2]). These were not his only scientific contributions, however: Ulugh Beg was also the author of a mathematical treatise entitled *Treatise on the Determination of the Sine of One Degree*. This treatise, like the contemporary *Treatise on Chord and Sine* (*Risala al-watar wa'l-jayb*)[3] written by the leading scientist and director of the Samarkand observatory Ghiyath al-Din Jamshid al-Kashi (d. ca. 1430), was devoted to the calculation of sin 1° -- an operation necessary for the construction of the trigonometric tables of the *Zij-i Ulugh Beg*.

The mathematical treatise of Ulugh Beg is mentioned by Nizam al-Din 'Abd al-'Ali al-Birjandi (d. ca. 1525) in his commentary on the *Zij-i Ulugh Beg*.[4] In his commentary, al-Birjandi wrote that the problem of calculation of sin 1° had been considered in two treatises, one written by the "sultan of geometricians" Jamshid al-Kashi, and other by the "sultan-martyr" Ulugh Beg.

In more recent history, the treatise of Ulugh Beg was translated into Turkish by the well-known Turkish historian of science Salih Zeki (d. 1917), who is believed to have based his translation on a manuscript at the Egyptian National Library in Cairo (ms. Mustafa Fadil Riyada Nr.37). Salih Zeki later published this translation in his book *The Remaining Traces* (*Asâr-ı Bâkiye*).[5] However, at the time Salih Zeki translated the Cairo manuscript, the true identity of its author was not yet known. The manuscript had been identified by H. Suter (1848-1922)[6] as a copy of the treatise of Jamshid al-Kashi. Even before Suter,

1 Ulugh Beg, *Zij-i 'Jadid-i Guragani*, Russian translation from Persian by A. A. Ahmedov, Tashkent: Fan, 1994.
2 *Prolegomènes des Tables Astronomiques d'Oloug-Beg*, trad. et comm. par L.A.Sédillot, Paris, 1853.
3 Ghiyath al-Din Jamshid al-Kashi, *Risala al-watar wa'l-jayb*. In *Majmu*, Tehran, 1306 h. (1888).
4 Nizam al-Din 'Abd al-'Ali al-Birjandi, *Sharh-i Zij-i Ulugh Beg*, Persian manuscript Nr. 704 at the Institute for Oriental Studies of the Academy of Sciences of Uzbekistan, Tashkent. Russian translation by A.Ahmedov: *From the History of Science of Ulugh Beg's Epoch*, Tashkent: Fan, 1979, pp.72-109.
5 Salih Zeki, *Asâr-ı Bâkiye*, İstanbul, 1329 h. (1911), pp.121-132.
6 Suter, H., *Die Mathematiker und Astronomen der Araber und ihre Werke*, Leipzig, 1900, p.174.

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MIRZA ULUGH BEG AND MODERN ASTRONOMY IN UZBEKISTAN

T.S.YULDASHBAEV

Astronomical research in Central Asia is a centuries-old tradition. The scientific school at Samarkand, which produced many prominent astronomers and mathematicians, was founded in the fifteenth century by the famous scientist Mirza Ulugh Beg. One of the most important observatories of the Middle Ages was built under Ulugh Beg's guidance in Samarkand. The observatory was equipped with the most precise instruments of the time. Ulugh Beg's *Zij*, the result of seventeen years of astronomical observations, consisted of a collection of astronomical and mathematical tables, a catalogue of 1,018 stars and their accurate positions, and data for calculating constants and other information. The *Zij* gives a clear impression of the advanced level of science in fifteenth-century Samarkand. Indeed, the results obtained by Mirza Ulugh Beg's Samarkand school represent the highest level of development in the science of astronomy to be achieved through visual observations.

In the modern epoch of optical astronomy, it has been possible to verify Ulugh Beg's catalogue of stars using telescope observations. These observations confirm the strikingly high precision of Ulugh Beg's catalogue.

Ulugh Beg's Samarkand school played an important role in stimulating research in astronomy in Eastern countries such as China and India. The Samarkand school was also widely acknowledged in seventh-century Europe, where an era of important geographic discoveries required precise astronomical data.

The ancient tradition of astronomical research has survived down to the present day in Uzbekistan. Many of the most current areas of research in modern astronomy are pursued at the Ulugh Beg Astronomical Institute of the Uzbek Academy of Science, and at the state universities of Tashkent and Samarkand.

The Astronomical Institute is the oldest scientific institution in Central Asia. It was founded at the Tashkent Astronomical Observatory (TAO) in 1873. Later, in 1928, an international latitude station in the town of Kitab (KLS) was created by TAO. In 1966, TAO was reformed and renamed as the Astronomical Institute of the Uzbek Academy of Science. Two fundamental research