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THE MERIT OF MIRZO ULUGBEK IN THE FORMATION OF MODERN ASTRONOMY

Abstract: Under the leadership of Ulugbek, Samarkand astronomers created the astronomical catalog "Zij Koragani". The catalog is also known as the "Ulugbek Star Map". These tables were the result of many years of work by scientists. In this catalog, 1018 celestial bodies are arranged according to their zodiacs (by star sets), ordinal numbers, names, location coordinates (distance and latitude from the Sun) in the celestial sphere are given. When assigning coordinates as a reference point in time, their position at the time of the equinox of 1437 according to the Solar calendar is assumed.

Keywords: astronomy, observatory, quadrant, ecliptic, celestial, luminaries, zodiac, coordinate, calendar.

Introduction

Ulugbek built an observatory on the Obi-Rahmat hill near Samarkand in 1420-29. The building had the shape of a three-storey circle with a diameter of 46-40 meters and a height of up to 30 meters. This is also evidenced by Zahiriddin Muhammad Babur. Historian Abdurazzak Samarqandiy wrote about the observatory: "The place was chosen from the northern side of Samarkand, where famous astrologers determined an auspicious day that was on the way to sending this work. The building was built on the basis of strength and grandeur. The foundations and columns were made so strong that even before the Day of Judgment they were not moved anywhere, they were not destroyed. The paintings and incomparable photographs that were placed inside these

magnificent rooms of the castle, built high, depicted the seven floors of the celestial sphere, climates, mountains, rivers, deserts, everything that belonged to the Holy World, degrees, minutes, seconds and a tenth of a second of the nine disasters. Since then, it has been decided to start observing the movement of the Sun and planets, and record those who saw it."[1]

The main pylon of the observatory consisted of a very huge instrument (a vertical circle) measuring an angle with a radius of 40,212 meters and an arc length of 63 meters. The researcher of antiquity V.L.Vyatkin suggests that the preserved fragment of the structure was "nothing more than part of a large quadrant, half of which was below the horizon, and the other half protruded above the horizon" (Fig. 1) [2].

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"Ulugbek Ziji" consists of an introduction, that is, a theoretical part (this part is given, as a rule) and tables compiled on the basis of observations made at the observatory.

Figure 1. The large square of the Ulugbek Observatory

Materials and methods

This includes empirical methods such as modeling, fact-finding, experiment, description and observation, as well as theoretical methods such as logical and historical methods, abstraction, deduction, induction, synthesis and analysis, as well as methods of heuristic strategies. The research materials are: scientific facts, the results of previous observations, surveys, experiments and tests; means of idealization and rationalization of the scientific approach.

Results and discussion:

The first book "Zij" is devoted to epochs and various calendars. It describes the eras of the Hijra, Greece and Yezdigard, the methods of their calculation, and the relationship between them. In addition, the Malikshah era, the Chinese and Uighur eras were also considered. The book also describes the issue of defining a leap year. Ulugbek says that there are 11 leap years for every 30 years [3].

The second book "Zij" is devoted to mathematics and spherical astronomy. His third book is devoted to trigonometric tables. These books contain tables of sines and tangents in decimal notation with ten-digit precision. This is considered to be a huge accuracy for the 15th century.

The third book, "Zij", devoted to applied astronomy and measurements, covers issues such as the inclination of the ecliptic to the equator, determining the coordinates of celestial bodies and determining the distances between satellites and planets [4].

To clearly show how accurate Ulugbek's calculation of the inclination of the ecliptic to the equator is, we present the calculations of scientists up to Ulugbek (Table 1).

This is part of a book on the theory of planetary motion that focuses on the "equation of time" - the difference between actual solar time and average solar time. There are two reasons why this difference is formed: firstly, the sun moves unevenly along the ecliptic, and secondly, the inclination of the ecliptic to the equator changes during the day.

Table 1

The inclination of the ecliptic (trajectory of rotation) of the Sun to the equator of the Earth according to various scientists

	№	Name of the scientist (period of residence)	The results of the survey and calculation	The results of the survey and calculation
1.		Eratosthenes (276-194 BC)	230 51` 20``	+7’ 35”
2.		Hipparchus (II century)	230 51` 20``	+8’ 23”
3.		Ptolemy (II century)	230 51` 20``	+10’ 10”

4.		Al-Battani (850-929)	230 35`	+0’ 17”
5.		As-Sufi (903-986)	230 33` 45``	+0’ 50”
6.		Abdul Wafa (940-998)	230 35`	+0’ 35”
7.		Al-Kuhi (10th century)	230 51` 01``	+16’ 36”
8.		Ibn Yunus (950-1009)	230 34` 52``	+0’ 33”
9.		N.Tusi (1201-1274)	230 30`	+2’ 9”
10.		Ulugbek (1394-1449)	230 30` 17``	+0’ 32”

Taking into account the data that Ulugbek gave on the annual movement of the planets, astronomical calculations of our days show that the scientist achieved tremendous accuracy in his time (Table 2):

Table 2

The inclination of the ecliptic (trajectory of rotation) of the Sun to the equator of some planets according to various scientists

	№	The name of the planet	According to the calculation of Ulugbek	According to modern calculations
1.		Zuhal (Saturn)	120 13’ 39”	120 13’ 36”
2.		Mushtari (Jupiter)	300 20’ 34”	300 20’ 31”
3.		Mirih (Mars)	1910 17’ 15”	1910 17’ 10”
4.		Zuhro (Venus)	2240 17’ 32”	2240 17’ 30”
5.		Utorud (Mercury)	530 43’ 13”	530 43’ 3”

In this book, Ulugbek also outlines the issues of determining the average distance over an arbitrary period, determining the true position of the planets on the celestial sphere, as well as solar and lunar eclipses. He argues that the period of lunar and solar eclipses can be determined in two different ways – using a table and direct calculation [4].

The role of Ulugbek Ziji in the star catalog also deserves attention. In this catalog, 1018 celestial bodies are located according to their zodiacs (according to the star sets), their ordinal numbers, names, location coordinates (distance and latitude from the Sun) in the celestial sphere are given. When assigning coordinates for the time reference point, their position at the time of the equinox of 1437 according to the Solar calendar is assumed [4[.

Conclusion:

It is interesting that when Western scientists endlessly argued among themselves about the correctness of the geocentric or heliocentric arrangement of the planets, including the Earth and the Sun, Eastern astronomical schools had been performing calculations for 6-7 centuries to determine lunar and solar eclipses, equinoxes on specific planets, even on distant stars. It does not require proof that this is a great merit of Mirzo Ulugbek and his associates. Ulugbek is a teacher not only of Oriental, but also of all world astronomical schools!

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