

## DEVELOPMENT OF MATHEMATICS AND ASTRONOMY DURING THE TIMURID PERIOD

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<https://doi.org/10.5281/zenodo.21011970>

**Abstract.** *This article examines the development of the exact sciences, particularly mathematics and astronomy, during the Timurid period. It highlights the establishment of scientific schools and the scholarly contributions of outstanding scientists, especially Mirzo Ulugh Beg and his contemporaries.*

**Keywords:** *Timurid Empire, exact sciences, astronomy, mathematics, Mirzo Ulugh Beg, Samarkand, observatory, scientific school.*

### Introduction

The Timurid period (the late fourteenth and fifteenth centuries) represents one of the brightest stages in the history of science, culture, and civilization in Central Asia. Following the establishment of a powerful state by Amir Timur, favorable conditions were created for the development of education, scientific research, and intellectual activity. As a result, Samarkand, Herat, and other major cities became internationally recognized centers of learning, attracting prominent scholars from different regions of the Islamic world.

This intellectual environment contributed significantly to the advancement of the exact sciences, particularly mathematics and astronomy. Among the greatest achievements of the Timurid Renaissance was the establishment of the Samarkand scientific school under the leadership of Mirzo Ulugh Beg. Unlike many contemporary rulers, Ulugh Beg devoted much of his life to scientific research and education. He founded educational institutions, supported outstanding scholars, and established one of the most advanced astronomical observatories of the fifteenth century. The scientific investigations conducted at the Samarkand Observatory led to the production of highly accurate astronomical observations and mathematical calculations that remained authoritative for several centuries.

### Relevance

The Timurid period is regarded as one of the most significant eras in the history of Uzbekistan and world civilization due to its remarkable achievements in science and culture. In particular, the rapid development of mathematics and astronomy, the establishment of the Samarkand scientific school, and the outstanding contributions of Mirzo Ulugh Beg and his scholars played a crucial role in the advancement of global scientific knowledge. Studying this rich scientific heritage is highly relevant today, as it helps to evaluate its historical significance, promote national scientific traditions, and demonstrate the contribution of Central Asian scholars to the development of world science. Furthermore, investigating the mathematical and astronomical achievements of the Timurid period provides valuable insights into the evolution of scientific thought and the history of exact sciences.

### Purpose

The purpose of this article is to analyze the development of mathematics and astronomy during the Timurid period based on historical and scientific sources. It aims to examine the scientific activities of Mirzo Ulugh Beg and the scholars of the Samarkand scientific school, as

well as to evaluate their contributions to the progress of world science. In addition, the study seeks to reveal the historical and scientific significance of the mathematical and astronomical achievements of the Timurid era and their lasting influence on the development of modern scientific knowledge.

### **Main part**

Uzbekistan holds a significant place in world history as one of the major centers of scientific and cultural development. The scientific foundations established by the scholars of this region played an essential role not only in the progress of Central Asian civilization but also in the advancement of global science. Following the remarkable achievements of the ninth to twelfth centuries, the reign of Amir Timur and the Timurid dynasty witnessed another period of outstanding scientific progress. During this era, considerable advances were made in various branches of knowledge, resulting in numerous scientific works that continue to retain their academic importance today. Studies on scientific development during the Timurid period have mainly focused on the legacy of Mirzo Ulugh Beg and his astronomical school, while achievements in other fields have often received less attention. In reality, historians, mathematicians, engineers, geographers, physicians, philosophers, jurists, and scholars in many other disciplines also made significant contributions to the advancement of science.

Research on the scientific achievements of Amir Timur and the Timurid period began several centuries ago. From the seventeenth century onward, Western European scholars, including Oxford University researchers John Greaves, Bainbridge, Thomas Hyde, G. Sharp, the Polish astronomer Jan Hevelius, Greenwich Observatory Director John Flamsteed, English Orientalists J. J. Sédillot and L. P. E. A. Sédillot, Francis Baily, and others, published numerous studies and editions dedicated to Ulugh Beg's astronomical tables ("Zij").

During the Timurid period, astronomy and mathematics reached an exceptionally high level of development. This progress was not accidental but resulted from a favorable scientific environment, state patronage, and the continuity of intellectual traditions. While many scientific centers declined during the Mongol invasions of the thirteenth and fourteenth centuries, the fifteenth century witnessed a remarkable revival of science in Transoxiana. Astronomy and mathematics, in particular, achieved extraordinary success, with the scientific school established by Mirzo Ulugh Beg representing the finest example of this intellectual renaissance.

Mirzo Ulugh Beg, born in 1394, showed a deep interest in science from an early age. As the ruler of Transoxiana, he devoted himself not only to political affairs but also to scientific research. Determined to transform Samarkand into a leading scientific center, he undertook several important initiatives. Between 1417 and 1420, he founded the Ulugh Beg Madrasah in Samarkand, which soon became one of the most distinguished educational institutions of its time. Unlike ordinary religious schools, this institution offered advanced instruction in mathematics, logic, and astronomy. It attracted renowned scholars such as Qadi Zada al-Rumi, Ghiyath al-Din Jamshid al-Kashi, and later Ali Qushchi, whose contributions greatly strengthened the scientific reputation of the Timurid scholarly tradition.

The Samarkand Observatory occupies a unique place in the history of astronomy. Constructed between approximately 1424 and 1429, the observatory was one of the most remarkable scientific institutions of its time. It housed a giant sextant with a radius of nearly 40 meters, which enabled astronomers to measure the positions of stars, as well as the movements of the Sun and the Moon, with exceptional precision.

The construction and operation of the observatory demonstrate that scientific research during the Timurid period was not based on occasional observations but on systematic investigations and accurate mathematical calculations.

One of the greatest scientific achievements of Mirzo Ulugh Beg and his research team was the compilation of the "Zij-i Guragani" (Ulugh Beg's Astronomical Tables). This monumental work occupies a distinguished position in the history of astronomy. It contains the coordinates of 1,018 fixed stars, whose positions were determined with remarkable accuracy.

The star catalogue is regarded as one of the most comprehensive astronomical catalogues produced after Ptolemy's famous *Almagest*. Ulugh Beg's calculation of the length of the tropical year was another outstanding accomplishment. He estimated it to be 365 days, 6 hours, 10 minutes, and 8 seconds, a value differing from modern calculations by only a few seconds.

Considering that these observations and calculations were carried out manually during the fifteenth century, this level of precision represents an extraordinary scientific achievement.

Significant progress was also made in the field of mathematics during the Timurid period.

Ghiyath al-Din Jamshid al-Kashi was one of the most prominent mathematicians of his time and made substantial contributions to the development of decimal fractions. His renowned work, "Miftah al-Hisab" (*The Key to Arithmetic*), became a comprehensive textbook on mathematical computation. Historical records indicate that Al-Kashi calculated the value of  $\pi$  (pi) to sixteen decimal places, an accomplishment achieved long before European mathematicians reached a comparable level of accuracy. This clearly demonstrates the advanced scientific status of the Samarkand mathematical school during the fifteenth century.

The scientific achievements of the Timurid era illustrate that the remarkable progress of science was not solely the result of the personal interests of the rulers but also reflected a deliberate state policy aimed at promoting scientific development. The establishment of the Samarkand Observatory, the foundation of educational institutions, and the generous patronage provided to scholars represent clear examples of governmental support for science.

Consequently, fifteenth-century Transoxiana became one of the most important centers of the Eastern Renaissance and secured a distinguished place in the history of world civilization.

In conclusion, the Timurid period marked a golden age in the development of astronomy and mathematics. Scientific progress during this era was achieved through the establishment of scholarly institutions, the activities of the Samarkand Observatory, and systematic observations supported by precise mathematical calculations. The scientific legacy created by Mirzo Ulugh Beg and his distinguished colleagues continued to influence scholars for centuries and made a lasting contribution to the advancement of world science. The strength of the Timurid scientific tradition lay not only in addressing the intellectual needs of its own time but also in establishing a solid foundation for future generations of scientists and researchers.

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