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MUHAMMAD IBN MUSA AL-KHWARIZMI REPRESENTATIVE OF THE ISLAMIC RENAISSANCE (783-850)

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Abstract
This article, while highlighting the work of our great ancestor Musa al-Khwarizmi, attempts to reflect the scholar's versatility and the importance of his incomparable legacy in the field of mathematics in the development of modern exact sciences.

Keywords: Musa al-Khwarizmi, mathematics, development.

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Introduction

The great mathematician, astronomer, and geographer Muhammad al-Khwarizmi lived and worked in the late 8th and first half of the 9th centuries. At that time, Central Asia was part of the Arab Caliphate. The socio-economic requirements imposed by the existing system that was developing in the first half of the 9th century became one of the main factors of the development process of this period. In order to further develop construction, trade, crafts, agriculture and other areas, it became necessary to develop such sciences as astronomy, geodesy, geometry. The advanced scientists of that time had a clear idea of the practical significance of these sciences, and Muhammad al-Khwarizmi was the leader and guide of these scientists.

Khorezm's contribution to the development of world science

Khwarizmi was born and raised in the land of Khorezm. In the literature, 783 is accepted as the year of his birth. It can be assumed that he received his initial education and knowledge in various fields mainly from many teachers in his homeland, in the cities of Central Asia.

The sources also add the terms al-Majusi and al-Qutrubbuli to the name of Khwarizmi. The first of these indicates that the scholar originally came from the local population of Khorezm, that is, from a family of pagans (in Arabic - "majus" - pagan), or rather from a family of priests of this pagan religion, and at the same time, the scholar himself or his father were pagans, who later converted to Islam. In Khorezm, pagans preserved their religious traditions for a long time after Islam. This is testified to by Beruni in his work "Osari Baqiya". The second of the names mentioned indicates that Khwarizmi spent his youth in the village of al-Qutrubbuli on the banks of the Tigris near Baghdad. Usually, Arabs give a person several different names - "nisbats" - depending on their characteristics, professions, favorite habits, or place of residence. This is how Al-Khwarizmi's name al-Qutrubbuli arose.

Khwarizmi had a very ancient culture, its agriculture was based on irrigated agriculture, which in turn required the existence of advanced methods of calculation of astronomy and chronology. Indeed, astronomy was very developed in ancient Khorezm, the Khorezmians knew the "secrets" of the sky much better than the Arabs. Archaeological excavations testify to the fact that

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observatories existed in Khorezm several centuries before Islam and that continuous astronomical observations were carried out there. An analysis of the works of Khwarizmi that have come down to us shows that he was well versed in Greek, Indian and Iranian astronomy and mathematics.

It is known that al-Ma'mun was in Merv from 809, first as the viceroy of Caliph Harun al-Rashid, then as caliph from 813, and moved to Baghdad in 819. While in Merv, al-Ma'mun attracted Al-Khwarizmi and other scholars from Transoxiana and Khorasan to his court.

During the reign of Caliph al-Ma'mun, a group of prominent scholars from Central Asia and Khorasan worked in Baghdad. Among them, along with Al-Khwarizmi, were Yahya ibn Abu Mansur from Merv, al-Farghani, Shabash al-Marwazi, Khalid ibn Abdumalik al-Marwarrudi, Abul Abbas al-Jawhari from Farab, and other scholars.

In Baghdad, al-Ma'mun comprehensively improved the activities of the scientific center "Bayt ul-hikma" founded by his father, giving it the appearance of a large state institution, and initially developed translation activities on a large scale. Many books were brought from Byzantium and India, and the scope of the "Bayt ul-hikma" was somewhat expanded, and two large observatories were built under it: the first in 828 in the ash-Shammosiya neighborhood of Baghdad, and the second in 831 on Mount Qasiyun near Damascus. The activities of both observatories were managed by scientists from Central Asia and Khorasan. As the director of this scientific center, Khwarizmi monitored its activities.

Among the major translators who worked at the Bayt al-Hikma during the Khwarizmi era were Hajjaj ibn Yusuf ibn Matar, Abu Zakariyya Yuhanna ibn al-Bitriq, Hunayn ibn Ishaq, and Kusta ibn Luqa al-Ba'albakki. Among the Central Asian scholars who came to Baghdad, the famous astronomer Ahmad ibn Kathir al-Farghani should be mentioned. Yahya ibn Abu Mansur of Merv became the founder and director of the observatory in the ash-Shammosiya neighborhood of Baghdad. He reported on the work at the observatory to the director of the Bayt al-Hikma, Khwarizmi. After Yahya's death in 831, Khwarizmi continued to direct this observatory and actively participated in observations there. An astronomical work by Yahya entitled "Zij al-mumtahan" ("The Tested Zij") is known. The observatory on Mount Kasiyun near Damascus was directed by Khalid ibn Abd al-Malik al-Marwarrudi. He also creates his own "Zij". Khalid leads the work of measuring the length of the Earth's meridian.

Ahmad ibn Abdullah al-Marwazi, a famous astronomer and mathematician from Merv, known by the nickname Habash al-Hasib ("The Abyssinian Calculator"), also worked in Baghdad in collaboration with Al-Khwarizmi. He compiled two "zij", which were widely used by medieval astronomers. Researchers have shown that he introduced the functions tangent and cotangent, cosecant, and also provided tables of them.

It would be a mistake to call all the scholars who worked with Al-Khwarizmi in Baghdad, and later at the "Bayt al-Hikma", later known as the "Academy of Al-Ma'mun", Central Asians or Khorasan. Scholars from Syria, Iraq, Iran and other parts of the Caliphate also worked there. However, Central Asians occupied a significant place among them. Al-Khwarizmi lived and worked in such a scientific environment and died in Baghdad in 850.

Muhammad ibn Musa al-Khwarizmi made an incomparable contribution to the development of world science with his universal discoveries. He headed the scientific academy "Bayt ul-hikma" (House of Wisdom), founded by Caliph Mamun in Baghdad. It is known that the scientist wrote

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about 20 scientific works, 7 of which have survived to our time. Arithmetics, algebra, astronomy, and geography are considered the most important among them. The Arabic version of the treatise on arithmetic has not been preserved, and only a Latin copy exists. This translation is called " De numero indorum ", that is, "Fi hisob al-hind" - "On the Indian account".

The scientist's contribution to the development of arithmetic

The scholar's arithmetic first spread in the Islamic world, and after the treatise was translated into Latin in Spain in the mid-12th century, the decimal positional calculation method he described spread throughout the world.

The Latin translation of the arithmetical treatise begins with the phrase " Dixit Algorizmi ". It became known in the first half of the 19th century that the word "Algorithm" in it is a term of "al-Khwarizmi". However, in science the term "algorithm" is now widely used and means any regular calculation process. The nine numbers and the round (zero) sign introduced by al-Khwarizmi have become so ingrained in life that it is impossible to imagine the life and activities of the 7 billion people of today without them, because this concept has become the basis for modern digital information and computer technologies.

Al-Khwarizmi algebra

He became the founder of the science of algebra. The word "algebra" itself is taken from his treatise "Al-kitab al-mukhtasar fi hisab al-jabr wa al-muqabala". His treatise on arithmetic, based on Indian numerals, led to the spread of the decimal positional counting system we use today and the operations in this system in Europe. The name of the scientist "al-Khwarizmi" has become forever entrenched in science in the form of "algorithm". His work on geography laid the foundation for the creation of dozens of geographical works in Arabic. Al-Khwarizmi's "Zij" showed the way for the development of astronomy both in Europe and in the countries of the East. But unfortunately, almost no information has been preserved about the life of such a figure who laid the foundation for several branches of science, who was "the greatest mathematician of his time and, if all conditions are taken into account, one of the greatest of all times" (J. Sarton). Al-Khwarizmi's work on algebra has been preserved in Arabic copies, and its title is "Al-kitab al-mukhtasar fi hisab al-jabr wa-l-muqabala", that is, "A Brief Book on Algebra and Equation Calculation". This work was also translated into Latin in Spain in the 12th century. In this treatise, al-Khwarizmi presented a classification of first- and second-degree equations and methods for solving them in an easy way. In this way, he created the theoretical basis of the science of algebra. In the Latin translation of the treatise, the word "al-jabr" was transcribed as " algebra ", which became the name of the new mathematical science founded by al-Khwarizmi.

Muhammad Al-Khwarizmi's legacy in astronomy

Muhammad Al-Khwarizmi's astronomical book "Zij" summarizes the Indian, Persian, Greek and Central Asian astronomical traditions. It covers the movements of the Sun, Moon, five planets, mathematical geography, trigonometry, and solar and lunar eclipses. It is called "Zij" because the results of observations are presented in densely arranged tables of 30 lines. With this work, Al-Khwarizmi legitimized the structure of astronomical works in the Middle Ages. In 1126, the work was translated into Latin. It also laid the foundation for the science of trigonometry by first

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introducing the trigonometric functions now known as sine and cosine and their tables.
In the geography section of his Zij, al-Khwarizmi chose, in accordance with Indian tradition, the meridian passing through the city of Arim in central India (now Udjain in the state of Uttar Pradesh) as the prime meridian. The 15th-century French geographer Pierre Ayck, in his Imago mundi (Image of the Earth), followed al-Khwarizmi and chose the Arim meridian as the prime meridian. In the margin of the copy of this book published in 1487 belonging to Christopher Columbus, there are notes written by him, according to which it seemed to Columbus that it would be closer and easier to reach India by sailing west than around Africa. Thus, al-Khwarizmi's idea played an indirect role in Columbus's discovery of the Americas.

Al-Khwarizmi's role in the development of the fields of geography and cartography

Al-Khwarizmi also made an important contribution to the field of geography. He created a map of the world in his own imagination. " *Al-Mamuniya Map* " is the first geographical map of the Middle Ages, depicting the fertile quarter of the earth, and was painted in color on the wall of the palace of Caliph al-Mamun (813-833) under the leadership of al-Khwarizmi. A copy of it has survived to us in a manuscript from the 14th century in Egypt. The most important aspect of this map from a scientific point of view is that it shows that the land is surrounded by water - the world ocean, in contrast to the continental concept in the map compiled by the ancient Greek scientist Claudius Ptolemy in the 2nd century AD . That is, the correct theory was put forward that the world ocean consists of a single whole.
By order of Caliph Ma'mun, the "World Maps" were compiled, and this work was led by M. Khwarizmi. This work can be called the "World Atlas". About 70 scholars were involved in it. The compilation of the maps was completed in the 840s, and Istakhri's 18th and 19th maps were devoted to Khwarizmi, Transoxiana, and Turkestan, among other regions. Istakhri's maps provide valuable sources on the toponymy of Central Asia. Most importantly, it clearly shows that the Amu Darya River flowed into the Aral Sea through several channels at that time. It should be noted that the maps compiled by representatives of the medieval Arab cartographic school were without geographical coordinates, and geographical objects were given in geometric shapes (mostly circles). Therefore, the maps of the geographers and cartographers who lived and worked in this region differed from those created in Egypt and Rome, the first centers of cartography, which indicates the creation of a separate school of Central Asian geographers.
He was invited to Marv, to the presence of al-Ma'mun, the son of Caliph Harun al-Rashid and his governor in Khorasan. In 819, al-Ma'mun, who captured Baghdad, took with him, in addition to al-Khwarizmi, Central Asian scholars Ahmad al-Farghani, Habash al-Hasib Marwazi, Abul Abbas Jawhari and others, and formed a unique scientific community. This community formed the core of the scientific institution "Bayt ul-hikma" ("House of Wisdom"), which is considered the first official academy in the history of science. Al-Khwarizmi was a leading scientist and scientific director in this academy. Al-Khwarizmi is considered the first of the great geographers who lived after the Greek scientist Ptolemy. His work "Kitabu surat al-arz" ("The Picture of the Earth", also known as "The Geography of Al-Khwarizmi") is one of the important sources in the history of science. The famous orientalist scientist V.V. Bartold mentioned that this work was created between 836-847 and that the title of the work gives the meaning of the Greek word "Geography". The work was written in connection with the "World Maps" compiled by the

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scholars of the “Bayt ul-Hikma” on the orders of Caliph Ma'mun. Thanks to this work, Muhammad Al-Khwarizmi is also recognized as the great mathematician and astronomer of the world, the founder of Eastern geography. H.Hasanov says that Caliph Ma'mun ordered the scholars to compile detailed maps of the sky and the world, that the “World Maps” were actually supposed to be a world atlas, that about 70 scholars were engaged in the compilation of the atlas, led by Muhammad Al-Khwarizmi, that the collection of these maps was also known as the “Ma'mun’s World Map” and that its compilation was completed around 840.

Although the book is based on Ptolemy's Geography, it is not a commentary on it, but an independent work. For the first time, the division of the surface into seven climates is given in it, based on scientific research, on the basis of the geographical sizes of the climates, and information, equipment, data and information about 2402 geographical objects (most of this information was not given in Ptolemy's Geography). Khwarizmi mentions the Pacific Ocean for the first time in the history of geography. He accurately describes the location of other objects very distant from where he lived: islands in the Atlantic and Indian Oceans, Great Britain, Ireland, Sarandib (Sri Lanka). The descriptions in the book occupy an important place in the history of cartography. This book was translated into Latin as early as the 12th century and made a great contribution to the development of geography. The book consisted of several dozen works and annotations to them. Currently, 4 cpoies have survived. They are now in Strasbourg (France). The maps are annotated in a zigzag format, with 537 place names and coordinates of the most important places. Al-Khwarizmi measured the Mediterranean Sea (from the Canary Islands to its eastern edge), which had been measured and greatly exaggerated by Ptolemy before him; while Ptolemy measured it at 63 degrees, Al-Khwarizmi measured it at a more accurate distance of 50 degrees. Al-Ma'mun's geographers, like Ptolemy, depicted the Atlantic and Indian Oceans as open bodies of water, not surrounded by land. Al-Khwarizmi placed the Prime Meridian of the Old World along the eastern shores of the Mediterranean, 10–13 degrees east of Alexandria (formerly the Ptolemy meridian) and 70 degrees east of Baghdad. Most medieval Muslim geographers traveled along Al-Khwarizmi's meridian. Of the more than 20 works attributed to the pen of Al-Khwarizmi, only 10 have survived.

Conclusion

The scientific legacy of Musa al-Khwarizmi is of incomparable importance not only in his time, but also in our time. His works made a great contribution to the development of mathematics, astronomy, geography and other sciences, and are valued as one of the foundations of modern science and technology.

Musa al-Khwarizmi is not only a great scientist of his time, but also the owner of a scientific heritage that served the development of all mankind. His works played a decisive role in the development of mathematics, technology and general scientific thought, and have not lost their significance today. Al-Khwarizmi's devotion to science, research methods and approach to thinking are an example for today's younger generation. The organization of scientific conferences, international events, and awards dedicated to him is a sign that his legacy is recognized internationally.

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