SCIENCE FOR THE BENEFIT OF MANKIND

FAN VA TURMUSH

«Science and Life» popular science journal
Centre for Promotion of Science Uzbekistan Academy of Sciences
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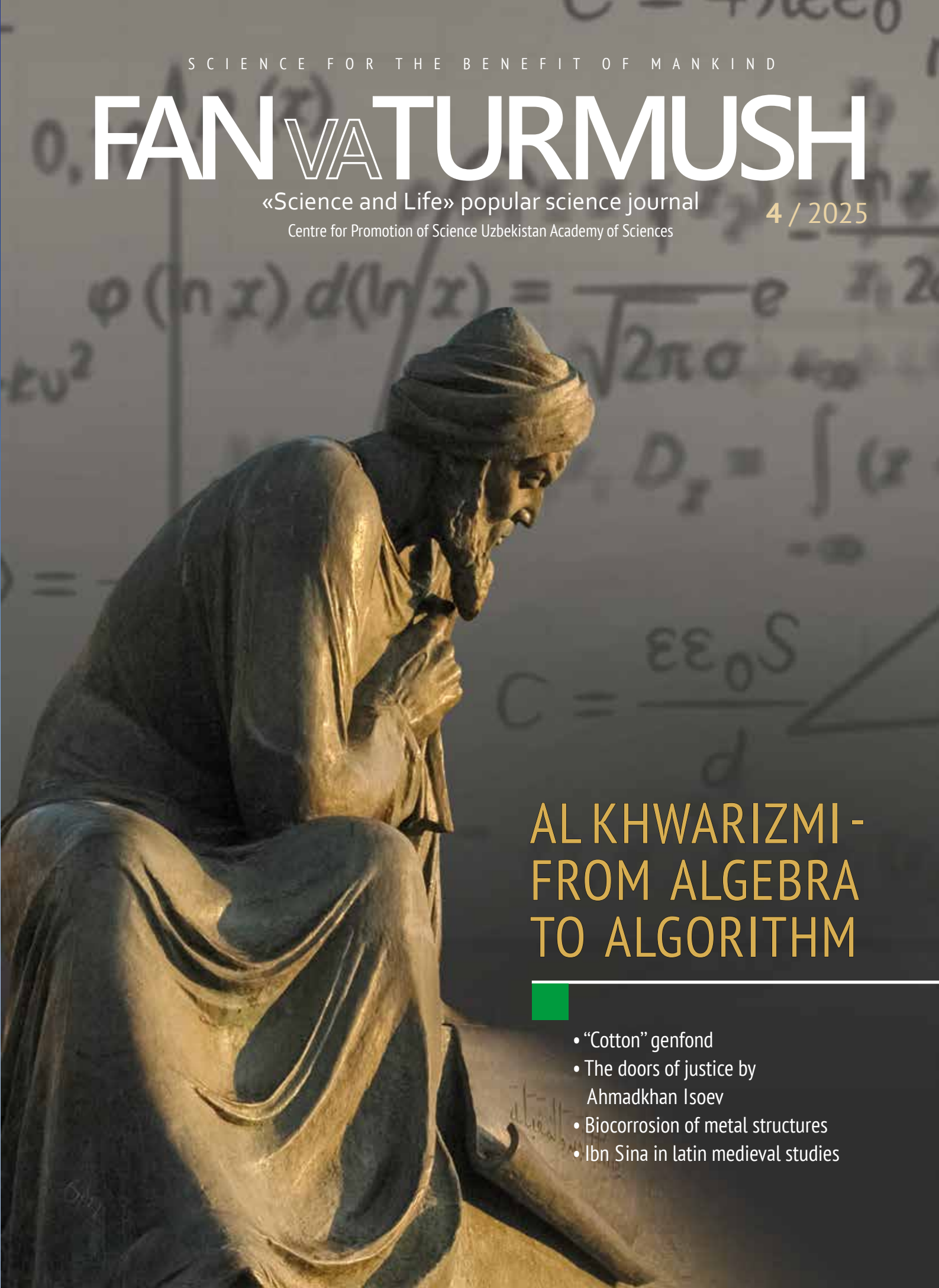

AL KHWARIZMI - FROM ALGEBRA TO ALGORITHM

- "Cotton" genfond
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EDITORIAL

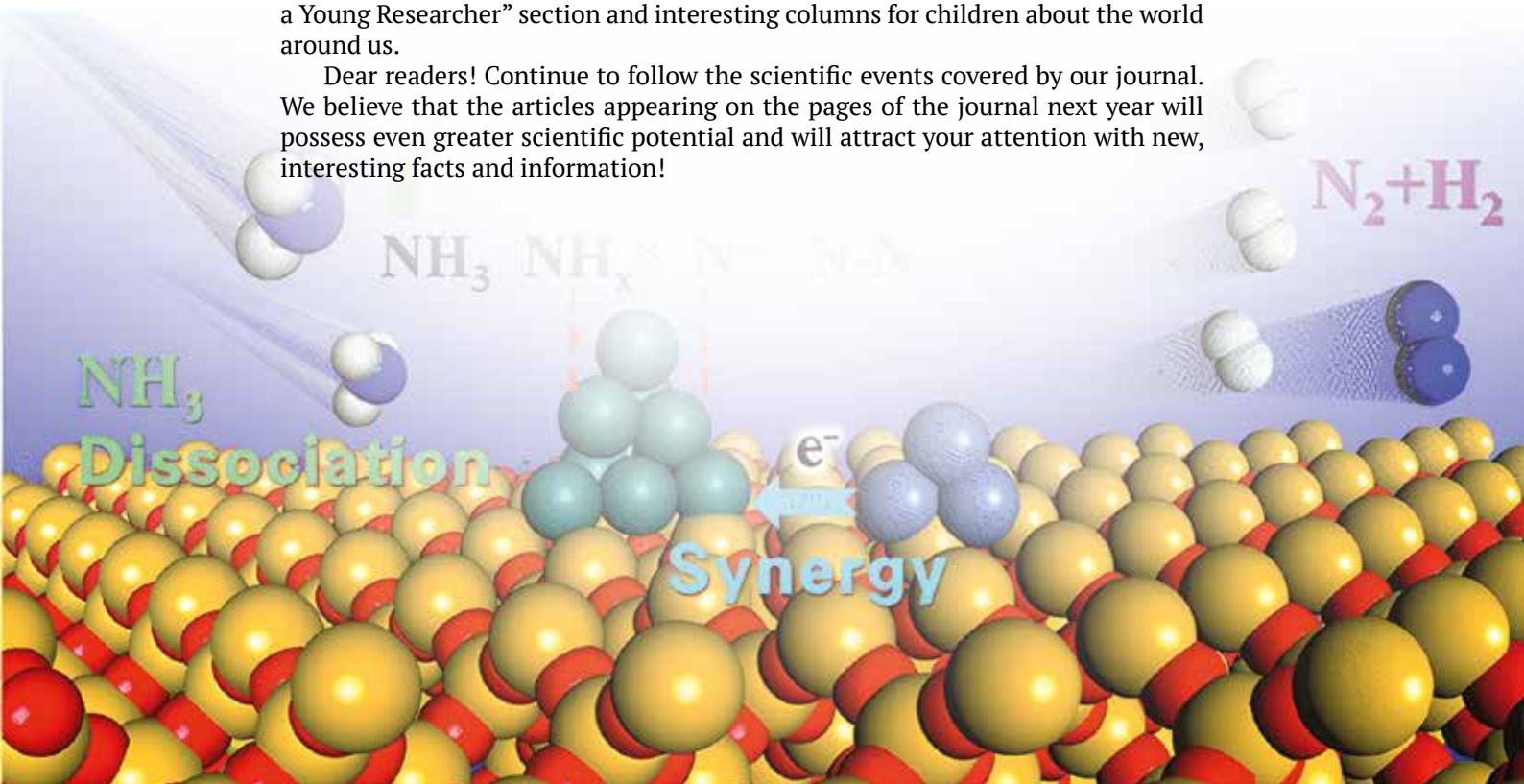
Dear readers!

This is the fourth issue of the journal for 2025. In it, we have attempted to highlight the most important events, scientific discoveries, interesting facts, and significant achievements in all areas of academic science and present them in an accessible and popular format.

The final months of last year were marked by important events aimed at supporting and stimulating the work of young scientists. For example, the "Cup of the President of the Uzbekistan Academy of Sciences" competition and the second "Eureka" competition for young scientists in the field of science and innovation were successfully held. In 2025, the geography of the participants of the "Eureka" award, established in collaboration between the Centre for Promotion of Science of the Uzbekistan Academy of Sciences and the company "Science and Innovation" with the active participation of the Ecological Party of Uzbekistan, expanded. This year, the competition was held not only among scientific organisations within the Academy of Sciences but also among young people throughout the country. Many young people who demonstrated their achievements and scientific potential in five important fields of science were awarded the Eureka Prize, along with valuable gifts and cash prizes. We devoted special attention to this event in our magazine.

One of the significant events for the Uzbekistan Academy of Sciences was the adoption of Presidential Resolution PK-390 "On measures to improve the activities of the Uzbekistan Academy of Sciences" in December 2025. The resolution outlined specific objectives, such as organising scientific research in priority areas identified by the Academy of Sciences until 2030, expanding the number of new scientific developments and commercialisation volumes, increasing the proportion of young people in the scientific staff to 60 per cent, and reintegrating the scientific diaspora operating abroad into Uzbek science. The fourth issue of the Fan va Turmush journal (2025) focuses on the following topics: in the field of exact sciences – a nuclear reactor, operating for 66 years and producing radioactive isotopes, and environmentally friendly solutions in the energy sector; in the field of natural sciences – biocorrosion of metal structures; in the field of information technology – the generation of chemical elements using artificial intelligence; in the field of social and humanitarian studies – the figure of Ibn Sina in Latin medicine and structures built abroad by the emirs of Bukhara, as well as the "Tribune of a Young Researcher" section and interesting columns for children about the world around us.

Dear readers! Continue to follow the scientific events covered by our journal. We believe that the articles appearing on the pages of the journal next year will possess even greater scientific potential and will attract your attention with new, interesting facts and information!



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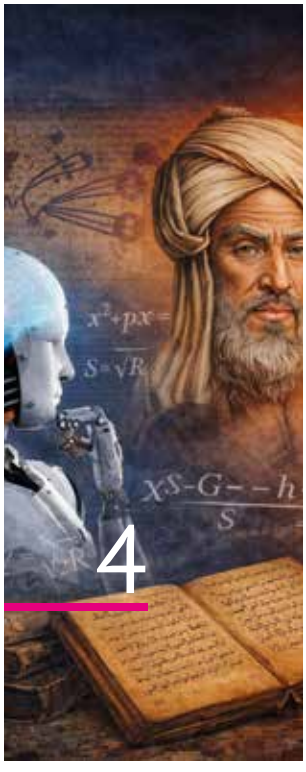


I. NUMBERS RULE THE WORLD

II. THE NATURE AND MAN

МИР ТЕХНИКИ И IT ТЕХНОЛОГИИ

VI. SOCIETY, HISTORY, CULTURE

HEADINGS:

“The Academy didn’t just follow trends—it shaped them”

Ayupov Shavkat Abdullayevich
President of the Academy of Sciences of the Republic of Uzbekistan, Senator, Hero of Uzbekistan

In 2025, one of the most significant events in the country’s scientific life was the publication of an interview with the President of the Uzbekistan Academy of Sciences, Academician Shavkat Ayupov, in the prestigious international publication “Pangea Globe” Newsweek. In it, Academician Shavkat Ayupov comprehensively analysed the role of the Academy of Sciences in the socioeconomic and social development of our country. In the interview, the author particularly emphasised the Academy of Sciences’ role in the creation of a unique Centre of Islamic Civilisation in Uzbekistan. Our journal presents an abridged version of this publication, agreed upon with the author.

Could you please introduce yourself and state your name and position?

I am Ayupov Shavkat Abdullayevich, a mathematician and the president of the Academy of Sciences of the Republic of Uzbekistan. At the same time, I am the director of the Institute of Mathematics of the Academy of Sciences.

What key factors contributed to the formation of the Academy of Sciences of Uzbekistan as the leading scientific institution of the country?

I will start with the fact that the Academy of Sciences was created in 1943, during the Soviet period, during the war. Two years ago, we celebrated the 80th anniversary of the Academy of Sciences. It generally occupies a central place in the country's scientific ecosystem, and this is not a coincidence.

Its leadership is due to a number of factors, both historical and structural. But the main thing is a stable focus on fundamental knowledge, strategic thinking and high personal responsibility of the scientific community to society and the state as a whole. I would like to especially note that the role and significance of the Academy of Sciences have significantly increased since 2017, thanks to the support of the President of the Republic, Shavkat Mirziyoyev, who was elected President of Uzbekistan at the end of 2016. In general, I would say that 2017 was a turning point not only in the life of the Academy of Sciences, but in the life of the whole state. This covers all areas of life, both in economics and in the spiritual, and in the support of science and education.

So, first of all, the Academy was and remains the basis of fundamental science. It was here that the leading scientific schools of the country were formed in the fields of mathematics, physics, nuclear technology, chemistry, molecular biology, human genetics, pharmaceutics, oriental medicine, art and archaeology. These schools played a decisive role in the formation of the scientific worth of Uzbekistan.

Secondly, the Academy is a center for the training of the scientific elite. More than 70 percent of PhDs and Doctors of Science went through the academic system. Here, not just professionals are formed, but also bearers of scientific culture, capable of formulating and solving tasks of high complexity, critical thinking and generating knowledge required in various sectors, from education to industry.

Thirdly, the Academy has always had strategic thinking. We were the first in the country to start systematic work on the development of priority scientific directions corresponding to the long-term needs of the state. This includes mathematics, which is like the language of all modern technologies; nuclear physics and radiation safety, which are of key importance for energy, medicine and industry; biotechnology and pharmaceutics, aimed at the development of domestic medicines; human genetics and population dynamics, which open opportunities for personalized medicine; and the art of science, oriental science and archaeology, which allow us to scientifically examine our culture and civilizational identity. The Academy has not just followed trends, it has formed them, laid theoretical and methodological foundations for the direction that today defines the scientific development of the country.

Fourthly, the Academy is constantly adapting to the challenges of time. We are introducing new mechanisms, scientific expertise and strengthening international cooperation. We are opening laboratories at the intersection of disciplines. We promote scientific diplomacy and actively participate in the formation of state scientific and technical policy.

Special attention is paid to the training of young scientists, the expansion of participation of women in science and the introduction of digital tools into scientific activity. And finally, the Academy of Sciences is an institutional support for the scientific sovereignty of the country. We unite scientific communities and serve as a point of consolidation of knowledge and expert analysis.

And most importantly, we preserve cultural thinking, which makes possible not only technological, but also civilizational development in Uzbekistan. In short, this is what the Academy does today, which is such an important component of our society.

What is the main mission of the Academy of Sciences today? What key programs and directions does it carry out at the moment?

Today, the Academy of Sciences of Uzbekistan is at the key stage of its development. Its mission is clearly defined not only by internal tasks, but also by national priorities designated in the Uzbekistan Strategy 2030.

We consider the Academy as an institutional support for the scientific sovereignty of the country. In this regard, its main mission is as follows. First, the creation, development and strategic application of fundamental scientific knowledge in the interests of sustainable social, technological and economic development of Uzbekistan, as well as integration into global scientific communities.

To implement this mission, we have defined two complementary directions. The first is to conduct scientific research to solve the problems of the country and region. The Academy of Sciences should be the

center of the generation of solutions, not only of knowledge.

We strengthen the applied component of science, directing it to support national priorities, namely agriculture, energy, health care, information technology, ecology and sustainable use of nature. Today, the country and the region face challenges that require a scientific response. From salinity of soil and lack of fresh water to the creation of competitive drugs, energy stability and the prevention of seismic risks. We are building scientific programs that address these challenges through specific research with measurable results.

And the second is integration into global scientific spaces. We believe that modern science is not at a deadlock. The Academy actively develops international cooperation, participates in multilateral projects and expands partnerships with leading scientific centers in Europe, Asia and the world. We give priority to the publication of authoritative international journals, to the exchange of scientists, to the attraction of foreign researchers to joint work, as well as to the training of young scientists to participate in global scientific conferences. We strive for the Academy to become not just a network of scientific institutes, but a single academy, a holistic system where knowledge is not only created, but also serves as a basis for making scientific decisions, technological breakthroughs and the development of scientific sovereignty in Uzbekistan.

Thus, the mission of the Academy of Sciences is not only the creation of new knowledge, but also the transformation of the very model of science in the country. From the development of efforts into a holistic system and the description of the world to the formation of solutions for the accumulation of knowledge, its application is for the benefit of the state and future generations. This is how I imagine the mission of the Academy.

What role does the Academy of Sciences play in the implementation of the project of the Center for Islamic Civilization in Tashkent?

For many millennia, civilizations of world importance emerged in the territory of modern Uzbekistan—large empires, magnificent cities and priceless architectural monuments.

The scientific and cultural heritage created by our great ancestors, which left an indelible mark on the history of mankind, is especially outstanding. Today, the scientific, historical and artistic works of these great minds are stored in collections, foundations, libraries and museums around the world. Respect for its history and culture, care for national and spiritual heritage, as well as the education of the younger generation in the spirit of national and universal human values, play a decisive role in the material and spiritual development of any society.

One of the most important steps in this direction was the adoption of the resolution of the President of the Republic of Uzbekistan on June 23, 2017, on the measures to create the Center for Islamic Civilization at the Cabinet of Ministers of the Republic of Uzbekistan. As I said, since 2017, not only science, but also spiritual development began in a completely different way. So, naturally, the Academy of Sciences of Uzbekistan plays a key role in the implementation of this project.

The Academy participates in the formation of a strategy for the development of the Center as a scientific and educational institution and sets the priorities of fundamental research and innovative projects. Such cooperation allows the Center to function not only as a cultural object but also as a large-scale research platform capable of stimulating the development of humanitarian, natural and social sciences within itself. Without the Academy of Sciences, it is impossible to present the scientific concept of museum exhibitions, guided by the opinion of experts and the public, and to organize a competition of ideas for the content of the hall.

The Academy of Sciences also participates in the establishment of partnerships with international organizations such as UNESCO, ISESCO, IRCICA and other international organizations. In addition, the Academy of Sciences is involved in the organization of major international forums, for example, the 8th Congress of the World Society for the Study, Preservation and Popularization of the Cultural Heritage of Uzbekistan (WOSCU) in 2024, and other scientific events, and provides the Center with expert support. Thus, the Academy of Sciences plays an active role in the scientific design of exhibitions and digital assets through the restoration of sources and the preparation of personnel for international cooperation and strategic development. The Center of Islamic Civilization is thus becoming an intellectual megaproject that embodies the tradition of science and education, which is the basis of the Islamic civilization in Uzbekistan.

What scientific directions are planned to be developed on the basis of the Center of Islamic Civilization?

As the name suggests, the Center of Islamic Civilization in Uzbekistan is conceived as a unique scientific, educational and cultural center, whose mission is the deep study, preservation and popularization of the rich Islamic heritage associated with the history of Uzbekistan and the Central Asia region as a whole. As part of its activities, the Center will engage in a comprehensive study of the history of the Uzbek people and the Central Asia region, and the intellectual,

scientific heritage of outstanding scientists, philosophers and theologians who were born or worked in the region. They include Muhammad al-Khwarizmi, Ahmad al-Farghani, Abu Nasr al-Farabi, Abu Ali ibn Sina, Abu al-Raikhan al-Biruni, Mirza Ulughbek, Imam al-Bukhari, Imam al-Tirmidhi, Imam al-Maturudi, Burhan al-Din al-Marginani and many others.

Special attention will be paid to the formation and development of scientific and religious schools. Thoughts on Islamic heritage and the analysis of the composition of scholars from Transoxiana (Mawarannakhr) the formation of classical Islamic science, theology and art are planned to develop and study traditional Islamic disciplines, such as "Fiqh,", "Tafsir" (the interpretation of the Qur'an), "Hadith", "Kalam", Islamic theology and others.

What scientific, educational, and cultural tasks are planned to be solved after the opening ceremony of the Center?

After the opening ceremony, the Center of Islamic Civilization in Uzbekistan will become a unique educational and cultural platform aimed at the comprehensive study, preservation and popularization of the rich Islamic heritage of the region. Its activities will cover a wide range of tasks, among which the following can be chosen.

The first is a scientific task. What is it? It is the study of Islamic science and culture. The Center will engage in an in-depth study of the contribution of Uzbek and Central Asian scientists to the development of world Islamic science and philosophy, such as Muhammad al-Khwarizmi, Ahmad al-Farghani, Abu Ali ibn Sina, Abu al-Raikhan al-Biruni, Ahmad al-Farwazi and others.

It is the creation of a scientific database. It will lead to the systematization and improvement of ancient inscriptions, documents, archival materials and artifacts associated with the Islamic heritage of Uzbekistan and the entire Islamic world.

Further, it is interdisciplinary research. The Center will become a platform for the interaction of specialists in the fields of history, philosophy, religion, philology, art and natural sciences, as well as the support of doctoral students and young scientists. Research grants, internships and programs to support young scientists studying Islamic science and civilization will be created.

The next task is educational. What are the educational tasks? These are lectures, seminars and courses. The Center will organize educational programs for students, doctoral students and those with a wide range of interests. The topic will cover Islamic philosophy, ethics, science, law, history and modern Islamic thinking. This is the development of Islamic sciences in the education system.

The Center will cooperate with universities and academic institutions to implement the disciplines that reflect the scientific heritage of Islamic civilization into the curriculum. The Center will create online courses and educational platforms. In order to expand access to knowledge, the Center will launch remote learning programs available in several languages, including Uzbek, Arabic and English.

The next task is cultural. The Center will organize exhibitions. The Center will hold permanent exhibitions devoted to the history of Islamic civilization in Uzbekistan, as well as temporary exhibitions of manuscripts, artifacts and works of Islamic art.

Historical exhibits recently discovered by scientists at the Center will also be presented, as well as copies purchased at auctions in Sotheby's and Christie's, and facsimiles delivered from foreign museums and libraries. Cultural heritage will also be popularized. The Center will carry out large-scale projects in cooperation with the World Society for the Study, Preservation and Popularization of the Cultural Heritage of Uzbekistan, such as inscriptions on the monuments of Uzbekistan, cultural heritage of Uzbekistan at World Conferences, cultural events, festivals, book fairs and media projects.

The Center will promote Islamic art, music, architecture and traditions. This is a deepening of dialogue between cultures. It will contribute to the development of inter-religious, intercultural dialogue, positioning Islam as a civilization of knowledge, peace and progress.

Is there any country or organization that would like to partner with the Center?

The Center aims to establish ties with major scientific and humanitarian institutions and universities specializing in Islamic culture, history and languages. These include Al-Azhar University of Egypt, the Institute of Islamic Thought in Malaysia, Al-Qaraoui University of Morocco and the Center for the Development of Inter-religious, Intercultural Dialogue. The Department of Islamic Civilization plans to cooperate with organizations such as UNESCO in the field of preserving the intangible cultural heritage of Islamic civilization in Uzbekistan.

The scientific trip of the group of scientists of the Center for the Development of Inter-religious, Intercultural Dialogue in Spain in 2024 became especially significant. The presentation of the 542nd anniversary of the birth of Zahiruddin Muhammad Babur was a

great success and attracted representatives of the cultural and scientific circles of the two countries.

The National Library of Madrid became an important point of visit, another source related to the cultural history of Uzbekistan. Here, we were able to familiarize ourselves with the original manuscripts written by the Spanish ambassador, Luis González de Colombia, on the state of Amir Temur.

The 4th direction is the program of academic mobility, the planned invitation of foreign scientists and experts for lectures and seminars, the sending of young researchers from Uzbekistan to study abroad, and the organization of joint master's and doctoral programs.

Thus, the Center for Islamic Civilization in Uzbekistan is not only the keeper of the great heritage of the ancestors, but also a modern scientific and educational space that forms new perceptions of Islam as a religion and a knowledge of peace and creation. Thanks to the systematic approach based on scientific sources, historical facts and current achievements, the Center becomes an important platform for international dialogue, uniting scientists, researchers and cultural institutions around the world around the common aspiration to reveal the fundamental essence of Islamic civilization, its humanistic ideals and its significant contribution to world culture.

What is the main message you would like to share with the community and our readers about the Center for Islamic Civilization? What do you want them to take away from this conversation?

First, the central element of the Center's exhibition will be the Koran Hall, where the spiritual masterpiece of the Islamic world, the ancient manuscript of the Koran of the Khalif of Usman ("Mus'haf Usman"), will be placed. Around it will also be presented the most authoritative manuscript versions of the Koran, created in the era of the Samanids, Karakhanids, Khorezmshahs, Ghaznevids, Seljuks, Timurids, and other dynasties, as well as translations of the Koran into the Old Uzbek language.

There will be sections such as the Civilization before Islam, the period of the First Renaissance, the period of the Second Renaissance, Uzbekistan in the 20th century, New Uzbekistan-New Renaissance, as well as the Wall of Time and the Path to History, which are intended to connect different thematic zones of the Center into a single narrative. Historical exhibits, recently discovered by scientists of the Center, as well as facsimile copies brought from foreign museums and libraries, will also be presented. The exhibition will reflect large-scale projects carried out in cooperation with the World Society for the Study, Preservation and Popularization of the Cultural Heritage of Uzbekistan, such as inscriptions on cultural monuments and so on.

The essence of everything that is created in the Center can be expressed in the words of the President of our country, H.E. Shavkat Mirziyoyev—"Everyone who visits this Center should clearly see history and realize that Islam is, above all, a religion of peace, progress and tolerance, and the Uzbek people have made great contributions to world civilization."

Al-Khwarizmi

Shavkat Alimov,
academician

Nine years ago, a historic meeting took place between the President of Uzbekistan Mr. Shavkat Mirziyoyev and scientists from our country. We, the participants of this meeting, felt that the attitude toward science in our country is fundamentally changing; science is now given its rightful place.

After this meeting, it became clear that Uzbek scientists and scholars must conduct scientific research at a level worthy of their great ancestors. The foremost among them was the outstanding mathematician, astronomer, historian, geographer, and theologian Muhammad al-Khwarizmi.

Our great compatriot, the creator of algebra and the father of the "algorithm", left all of humanity an invaluable gift, which grateful humanity still uses today.

Al-Khwarizmi was born in 783 in Khorezm, then one of the centers of science and education in the East. Remarkably, he received his education in Khorezm. This means he didn't have to leave his home country to become a world-class scholar.

Before reaching the age of thirty, he was already an accomplished scholar, renowned far beyond the borders of Transoxiana. It can now be said with certainty that Al-Khwarizmi was essentially the first scholar from the region of what is now Central Asia to achieve worldwide renown. By the time Al-Khwarizmi's genius was revealed, another of our outstanding scholars, Al- Farghani, was only eleven years old, and the great Imam Al- Bukhari had not yet been born. Only a full century after Al-Khwarizmi would the brilliant Abu Rayhan Biruni and Ibn Sina appear on our blessed land.

Before Al-Khwarizmi, mathematics was primarily understood as geometry – the science of measuring the Earth, and even more precisely, measuring land.

Euclid's Elements, which laid out the foundations of geometry, was a classic. Even in the twentieth century, more than two thousand years after Euclid, mathematicians were often called geometers. When it came to calculations, for hundreds of years, ancient mathematics relied solely on numbers and not on formulas.

In those days, working with numbers and fractions required a great deal of skill and was beyond the reach of most people. Roman numerals were in common use in Europe, making it exceptionally difficult to perform basic arithmetic operations with them.

To make it clear what I'm talking about, I'll give one example in which it was necessary to perform simple calculations with Roman numerals.

During the ancient Roman Empire, the legions formed the backbone of the army. Each legion consisted of ten cohorts, each consisting of 555 infantry and 66 cavalry. Try answering this simple question: how many cavalry were in a legion? The answer is very simple: 66 multiplied by 10 equals 660. Now imagine doing the math while serving in the ancient Roman army. Using Roman numerals, you must find the product of LXVI and X. The answer, in modern notation, looks like this:

LXVI x X = DCLX.

Will a modern reader be able to understand anything from what's written here? How can we get from what's on the left of the equal sign to what's on the right?

If one uses Al-Khwarizmi's book on Indian counting, the problem can be solved by simply adding the 0 sign to the right of the number 66. Just add a zero!

Not only in Ancient Rome, but even in Medieval Europe, this was impossible, if only because they didn't have zero. Europeans learned about zero from Al-Khwarizmi's book. In his work, "Kitab al- jabr wa -l- muqabala", which translates as "A Brief Book on Completion and Contrast," the number 0 is called ṣifr , from which come the words "digit," "cipher," and later the Italian "zero", which became the name for zero in Western science. The familiar image of zero also appeared there. And that's exactly the introduction of the number zero also made it possible to move, along with the decimal number system, to negative numbers and the emergence of the ability to perform calculations also with negative numbers, which expanded the boundaries of the application of mathematics.

Europe, having become acquainted with the works of Al-Khwarizmi, was delighted, which cannot be said of the European clergy. Attempts were made to ban Al-Khwarizmi's books, but no bans could stop the spread of Al-Khwarizmi's progressive ideas. Today, the ideas expressed by Al-Khwarizmi in this book have become so ingrained in our lives that we cannot even imagine how things could have been otherwise.

The translation of the book into Latin began with the words: "Dixit Algorizmi" (Al-Khwarizmi said). After this, mathematicians around the world began calling any clear indication of what actions and in what sequence should be performed an "algorithm". Moreover, grateful contemporaries now increasingly and universally use the term "algorithm", named after this outstanding scientist, and algorithmization has become firmly established in our everyday lives.

Before Al-Khwarizmi, there were no equations in the modern sense. Inheritance problems were common, and to solve them, people tried to find whole or fractional numbers that satisfied all parties involved, through trial and error.

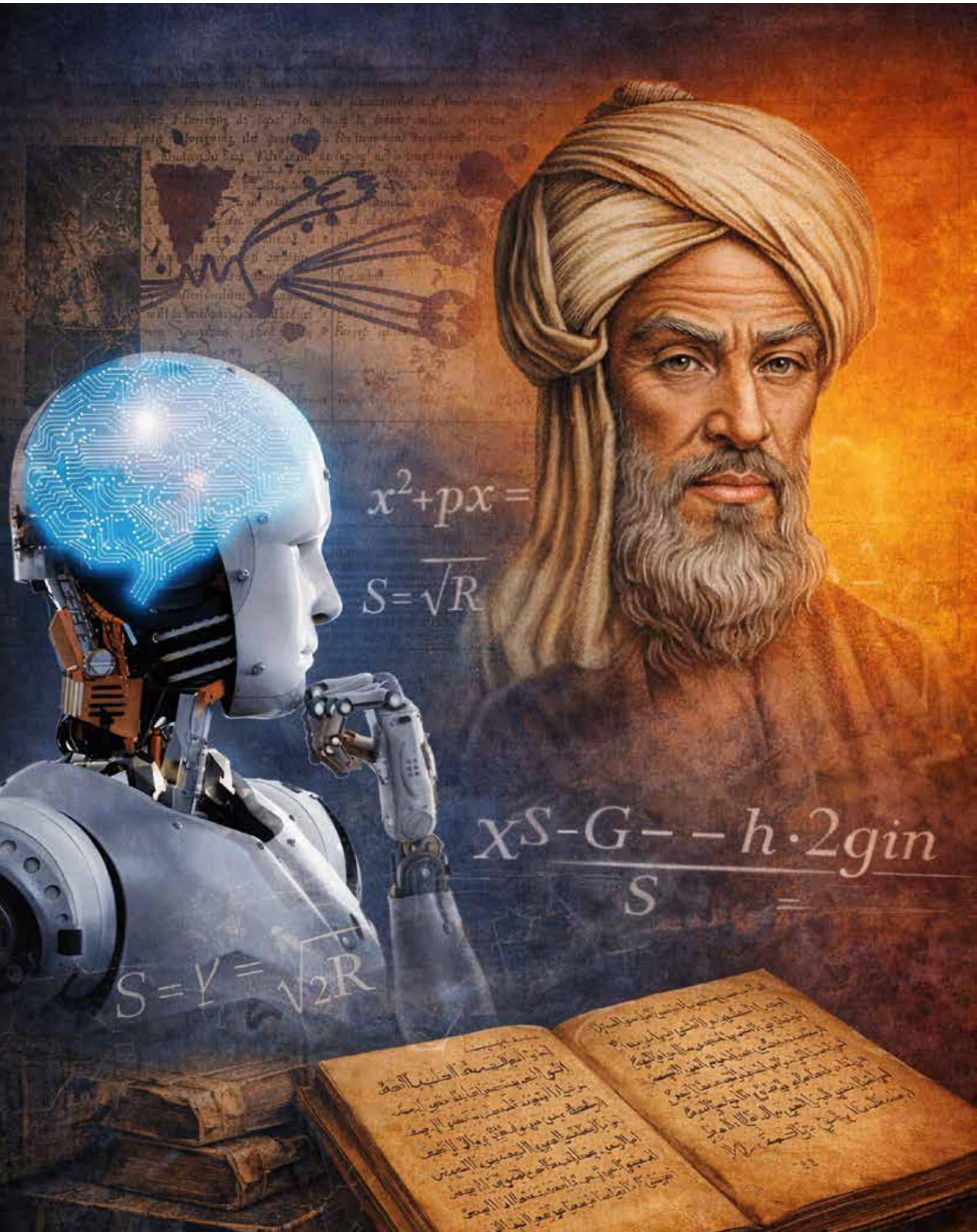
Al-Khwarizmi in his famous work "Kitab al-jabr wa -l- muqabala" was the first to establish the rules for solving equations now called first- and second-degree equations. After this great book was translated into Latin, Europe began searching for similar rules for solving third- and fourth-degree equations. The most renowned scholars engaged in this endeavor, holding open competitions among them that attracted large crowds. Finally, the eminent Norwegian mathematician Niels Abel put an end to this, demonstrating that such rules could not be created for equations of the fifth degree and higher. As is well known, there is no Nobel Prize in mathematics, but there is its equivalent— the Abel Prize in Mathematics, which was first awarded almost two hundred years after Abel's work.

It can be reasonably said that the theory of algebraic equations arose thanks to this outstanding treatise of Al-Khwarizmi.

When Al-Khwarizmi turned 44, he was asked to lead a project to more accurately measure the radius of the globe. He recruited the young Al- Farghani (not yet thirty years old) to his team and completed the task brilliantly. The most suitable location for such work is a flat surface equipped with deep wells. Al-Khwarizmi chose the Sinjar Desert near Baghdad, where he carried out the necessary measurements. Mathematical processing of the obtained results required calculating the sine of 1 degree with a high degree of accuracy, which Al-Khwarizmi's team accomplished. The accuracy of these calculations remained unsurpassed until the work of Mirzo Ulughbeg, six centuries later. Renowned historian of science George Sarton rightly called Al-Khwarizmi "the greatest mathematician of his time and, all things considered one of the greatest of all time".

I noted above that in December 2016, a historic meeting of the President of Uzbekistan with scientists took place. Two years later, an expanded meeting was held at the National University of Uzbekistan, where proposals from the country's leading scientists were heard and discussed in detail. Since then, significant changes have occurred.

First of all, I want to note that special attention was paid to the development of mathematics in our country. I have worked at many leading universities around the world, including the USA, Japan, Germany, and other countries, but I have never seen such an attitude toward mathematics as was demonstrated here. The Institute of Mathematics of the Uzbekistan Academy of Sciences received a magnificent building located near the Faculty of Mathematics of the National University; essentially, a unified academic and university mathematics complex was created. Mathematicians who come to us from various countries to


$x^2+px=$
$S=\sqrt{R}$
$S=V=\sqrt{2R}$

participate in mathematics conferences admire the new building of the Institute of Mathematics of the Uzbekistan Academy of Sciences.

The most significant change that has occurred is the emergence of a huge interest in mathematics among talented young people. Twenty years ago, scientific dissertations were practically nonexistent, but now young mathematicians from Khorezm, Karakalpakstan, the Fergana Valley, and all other regions of Uzbekistan are defending excellent dissertations in mathematics. As a result, our university has entered the top three percent of the world's leading universities in mathematics. This means that 97% of the world's leading universities, based on their mathematical training, are behind the Mirzo Ulugbek National University of Uzbekistan! And this is a remarkable global achievement for our mathematicians!

Years have passed, amazing changes have taken place in the life of our country, and the republic has become one of the most rapidly developing countries in the world.

The most important thing is that young people see their value and the opportunity to live a full life while remaining in their homeland, and this is invaluable. Of course, this is the result of the well-thought-out reform policies implemented in our country in recent years. I am confident that as a result of these reforms, our youth will have every opportunity to develop their talents, and we will be proud of our mathematicians, the continuers of the traditions established by such outstanding ancestors as the great scholar Al-Khwarizmi.

66 years in service: Uzbekistan's research reactor

Fakhrulla Kungurov,
doctor of Technical Sciences

As is well known, the Institute of Nuclear Physics of the Uzbekistan Academy of Sciences has been successfully operating a unique VVR-SM research nuclear reactor for 66 years, producing radioactive isotopes that meet international standards. With its help, a team of national nuclear scientists and engineers has carved out a niche in nuclear physics and nuclear technology, and even secured the country's strong leadership in the global radiopharmaceutical market .

The VVR-SM research nuclear reactor is not only the foundation for scientific research in nuclear and radiation physics, nuclear medicine, and radiopharmaceutical technology , but also an important, unique scientific facility, a national treasure, and a strategic resource for the country. As a large-scale facility with the capacity to produce a wide range of radioisotopes, the reactor helps treat cancer and endocrine diseases and generates millions of US dollars in revenue for the country's economy.

Building of the Research Institute of Nuclear Physics of the Uzbekistan Academy of Sciences

General view of the BBP-CM research nuclear reactor

The PWR-SM research reactor (pressure-water reactor, serial, modernized) was launched for scientific research in September 1959 in the township of Ulugbek near Tashkent on the grounds of the Institute of Nuclear Physics (INP) of the Uzbekistan Academy of Sciences. Initially, the reactor's capacity was 2 megawatts, but during modernization between 1971 and 1978, it was increased fivefold, reaching 10 megawatts, enabling the production of a wide range of radioisotopes. INP scientists also developed effective nuclear technologies that ensure the high quality of domestic radioisotope production.

To implement the industrial production of radiopharmaceuticals based on radioactive isotopes, the State Enterprise " Radiopreparat " was established at the INP in 1976. It produces radioisotopes not only for the domestic market but also for export to various countries worldwide, including the CIS, Europe, and America. Currently, the range of domestically produced radioisotopes for medical, scientific, and applied purposes exceeds 40.

Radioisotope products manufactured by Radiopreparat State Enterprise are of a high standard and certified according to international standards, making them in demand in many countries. For example, the Uzbek radioisotope iodine-125 accounts for up to 80% of the global market. This is no coincidence, as its purity is 10,000 times higher than that of its closest foreign analogues. This means the product is effective and safe for medical use, despite its higher price. This radioisotope is particularly effective in the treatment of endocrine thyroid disease. And this is just one striking result of the work of our scientists and nuclear industry workers.

Uzbekistan's nuclear scientists also produce a number of other important radioisotopes, including: lutetium-177 for the treatment of prostate cancer; samarium-153 for long-term pain relief in cancer patients; and iridium-192, used to test the quality of welded joints and other industrial metal structures without damaging them. It is especially noteworthy that over 95% of the radioisotope products produced by the nuclear reactor are exported. For example, in 2023 alone, foreign radioisotope deliveries contributed approximately $5.5 million to the Uzbek budget.

Radioactive preparations manufactured by the Research Institute of Nuclear Physics and the Radioactive Preparations State Enterprise

Dr. F. Kungurov and the reactor chamber compartment (in the background)

Meanwhile, the country's domestic needs are fully met by radioisotopes, which is, of course, a top priority.

At the same time, the reactor serves not only medicine and science, but also the jewelry industry. Since 2005, the INP of the Uzbekistan Academy of Sciences has regularly received batches of topazes from foreign customers for enhancement. These semi-precious gems, when exposed to irradiation, acquire a richer, deeper color, which is particularly prized by jewelers. This export activity, parallel to research, also brings in considerable income. Currently, several foreign companies send topazes to the Institute, where they are irradiated for coloring. Moreover, we ship approximately 1,000-1,300 kilograms of colored topazes to customers annually.

The PWR-SM research reactor's lifespan included a difficult episode when its operation was halted—it was threatened with closure during the reorganization of many academic research institutes. And then, in 2016, the reactor was also closed. The Institute was then divided into two parts: one, along with the reactor, was transferred to the Ministry of Emergency Situations of Uzbekistan, and its staff was tasked with decommissioning the reactor. It was expected to be completed within a year or two. However, scientists have proven that the reactor decommissioning process is quite complex and lengthy. First, it required colossal amounts of funds, including foreign currency, which were unavailable; second, it required resolving the issue of spent nuclear fuel; and third, it would take much longer—10-15 years, according to international estimates.

As a result, although the reactor was out of service for approximately a year, it was not decommissioned and was retained for further operation. However, it was during this period that its critical importance for domestic medicine and the lives of people in our country, as well as for seriously ill patients in other countries around the world, became clear.

It's worth noting that people called the Radiopreparat State Enterprise and the Uzbekistan Academy of Sciences almost daily, asking, "Now what? Are we supposed to die?" Indeed, this nuclear reactor was the only one supplying the country with vital radiopharmaceuticals for the treatment of severe cancers and thyroid diseases. At the time, importing radioisotopes was considered, but it proved prohibitive.

Photos of semi-precious topazes: - natural colour (top); - coloured by irradiation in a reactor (bottom)

While a single dose cost $500 in Uzbekistan , it cost $2,500–$3,000 abroad, and with duties and shipping, up to $3,500.

To everyone's satisfaction, this suddenly critical situation was saved by the intervention of the President of Uzbekistan Shavkat Mirziyoyev: According to his decree, the Institute of Nuclear Physics was restored within the Academy of Sciences, the reactor was restarted, and production of the much-needed radiopharmaceuticals resumed. And today, of course, supplying the domestic market remains a priority. The country's medical clinics receive the necessary domestic radioisotopes first, and only then do foreign buyers receive them.

It should also be noted that the INP research nuclear reactor has not remained in its original condition. Over the decades of operation, the reactor has undergone significant modernization on numerous occasions. Most of these upgrades were made possible thanks to the support of the International Atomic Energy Agency (IAEA) and other international partners. Since 2017, the IAEA has supported the implementation of several major projects to refurbish the reactor, enhancing radiation and nuclear safety to a modern level, allowing for the continued safe operation of this unique facility.

In November 2024, an IAEA mission conducted a detailed inspection of the reactor's operating conditions, assessing its condition and safety. The experts particularly noted the high professionalism of the INP and Radiopreparat staff and the stable operation of the facility. Indeed, Uzbekistan's reactor is one of the most efficiently operated in the world. Meticulous work is currently underway to manage its aging: research and auxiliary equipment is constantly being updated, and special attention is being paid to its radiation protection and safety. This is why, following the inspection, Uzbekistan received a high rating and only a few recommendations: create a database of all reactor systems, plan replacement schedules if necessary, and consider seismic risks.

These projects are advancing not only from a technical perspective but also from a scientific perspective. Over the years, the Institute has developed a neutron radiography and tomography facility, which, among other things, helps study archaeological finds without damaging them. Projects are also underway for the mining industry, nuclear medicine, and agriculture. A look into the future has outlined realistic strategic plans to ensure the reactor's stable operation until 2040. Until then, radioisotope production and scientific programs will continue. However, this is not the end point: by that time, the reactor's support grid will require replacement due to natural wear. However, the team will prepare for this necessary upgrade to potentially extend the reactor's service life.However, despite extensive modernization, the unique research reactor will eventually require replacement. It celebrated its 66th anniversary in September. According to scientists and its maintenance staff, the reactor is a distinguished veteran of labor and their "grandfather"—a working retiree who continues to actively serve science and the public. The scientific community is already discussing the need to build a new, more powerful nuclear reactor in the country, with expanded capabilities for both scientific research and the production of an even wider range of in-demand radioisotopes.

Scientists sincerely hope that a solution and the necessary means for this lofty goal will be found. This is a vital tool for science, industry, and the people and organizations that use its radioisotope products. Such a project to build a new, more powerful, and more modern nuclear reactor would be a strategic investment not only in the development of nuclear science and medicine, but also in our country's economy and society.

The new reactor could undoubtedly provide Uzbekistan with future technologies based on technological innovation, digitalization, the use of neural networks and artificial intelligence programs, as well as maintain the country's status as one of the world's leading producers of high-quality radioisotopes and bring domestic scientists and technologists to the forefront in other related fields of science.

Biocorrosion of metal structures: Current Issues and Their Solutions

Mashkhura Mavloniy,
academician

As is well known, the global oil and gas production industry is currently suffering significant losses due to microbial corrosion of metal structures and equipment. Biocorrosion, or microbial corrosion, causes enormous economic damage across various industries, primarily oil and gas production and refining.

The process of biocorrosion of metal surfaces is accompanied by a sharp deterioration in the performance of oilfield pipelines, a decrease in their strength, and an increase in the rate of microcrack formation, ultimately necessitating their replacement. At the same time, the rational use of oilfield pipelines in a market economy is particularly important. This is explained by the fact that Uzbekistan's oil industry is one of the largest heavy industries, accounting for 96% of the country's primary fuel needs. Therefore, combating biocorrosion remains a critical issue in the system of measures aimed at increasing oil production and refining rates. Therefore, research into the characteristics of biodeterioration of metal pipelines and structures has now become a new, independent scientific field in Uzbekistan.

Research into the isolation and study of microorganisms from oil and metal structures used in the oil industry is currently booming in foreign countries. Therefore, domestic science also requires more in-depth research into these issues.

A key challenge in petroleum microbiology, one that must be addressed in the coming years, is the in-depth study of and protection of oilfield pipelines and storage facilities from bacterial corrosion, which significantly damages the oil production industry. This is because the metal pipes and equipment used by the domestic industry are significantly susceptible to corrosion. Moreover, biocorrosion affects both underground production well equipment and aboveground equipment and pipelines.

The aim of the research conducted at the Institute of Microbiology of the Uzbekistan Academy of Sciences in this area is to study the composition of biocorrosive microflora, as well as the creation of effective anti-corrosion preparations (inhibitors) and the study of their effect on sulfate-reducing bacteria that cause corrosion of oil field pipelines (oil storage facilities).

The study of biocorrosion, or biodeterioration, of oilfield pipelines and equipment emerged as a scientific field in the 1960s. At the end of the 20th century, the Organization for Economic Cooperation and De-

Microbiologically induced corrosion of pipelines

Corrosion of internal surface elements of oil pipelines

velopment (OECD), a group of 30 countries, established the International Committee on Biodeterioration of Metallic Equipment. According to international research, 50 to 70 percent of corrosion damage to metal equipment and structures is the result of microbial activity.

Research on microbiological corrosion of oil metal pipelines and equipment is actively being conducted in a number of oil-producing countries (Russia, USA, Ukraine, Azerbaijan and others). Identifying the characteristics of corrosion processes and studying their causative agents is also crucial for the safe operation of oil wells. However, scientific data on microbiological corrosion of pipelines and equipment is currently scarce, including in Uzbekistan.

Extensive research into the causes and causative agents of biocorrosion of metal equipment for various purposes is currently being conducted in the UK, Hungary, Japan, Poland, France, the USA, Ukraine and other countries.

Several years ago, surprising reports surfaced that microorganisms were proliferating in incredibly large numbers on the MIR orbital space station, devouring its unique equipment. Although the MIR station, along with its harmful microorganisms, has since deorbited and sunk in the Pacific Ocean, the problem of combating biocorrosion on spacecraft remains. Furthermore, it has been established that colonies of harmful bacteria have also established themselves on the International Space Station (ISS) and continue their destructive activity. In fact, cosmonauts have already discovered bacteria in some of the station's modules, which have begun to damage the ISS's cladding and metal equipment.

Research has shown that global damage from microbiological damage to metal materials, structures, and equipment on Earth and in space currently accounts for 2% of all industrial output worldwide. Moreover, given their long operational lifespans and safety requirements, the problem of microbial corrosion and the search for ways to prevent it is particularly pressing on space stations. Over a twenty-year period of research, scientists have discovered more than 250 different species of microorganisms living inside manned spacecraft. However, all of these microorganisms identified in spacecraft turned out to be of terrestrial origin and subsequently multiplied on space stations. Therefore, the sources of this space biocorrosion should be sought on our planet.

It should be noted that fundamental research on microbial corrosion in Uzbekistan was initiated in 2006 at the Institute of Microbiology of the Uzbekistan Academy of Sciences. This was due to the rapid failure of oil and gas pipelines caused by the destructive activity of sulfate-reducing bacteria, which increase the aggressiveness of soil and groundwater as a result of the production of hydrogen sulfide H2S [$_1$].

In the process of biocorrosion of metal in an environment of petroleum products, the following microorganisms are the most active:

– sulfate-reducing bacteria (multiply at the oil/water interface);

– actinomycetes (reproduce in the petroleum products themselves, using hydrocarbons as a nutrient medium).

The damage caused by bacteria is now well known, and the negative impact of microorganisms on oil production processes, from well drilling to the transportation of commercial oil, has been proven .

It has been established that preventing biocorrosion is much easier than dealing with its consequences. The primary means of combating biocorrosion is treating oil and gas pipelines with bactericidal agents. Since biological corrosion develops in high-humidity conditions, effective corrosion prevention methods for protecting materials include reliable waterproofing by impregnating them with natural or synthetic resins, painting, bonding, and adding bioinhibitors.

In order to further develop research work on biocorrosion, a scientific expedition of scientists of the Institute of Microbiology of the Uzbekistan Academy of Sciences was conducted from February 10 to 14, 2025, to one of the largest oil fields in Uzbekistan - Kokdumalak, with the aim of collecting samples of scrapings from the metal surface of operating devices, equipment, oil field pipelines, as well as for microbiological analysis of scrapings and isolation of hydrocarbon-oxidizing microorganisms into a pure culture.

The list of equipment, instruments, installations, and oil samples at the Kokdumalak field from which scientists collected scrapings included 20 items. Scrapings were taken from the surfaces of compressors, pumps, oil pipelines, oil storage facilities, and their tanks, as well as samples of the oil itself, oil-spilled soil, and petroleum bitumen. The scraping samples collected from each of the above-mentioned equipment, devices, and oil and bitumen samples were stored in 20 sterile penicillin vials.

Uzbekistan isolated 20-24 hydrocarbon-oxidizing bacteria strains from each scraping using a classical method and Raymond's selective nutrient medium. A total of over 350 hydrocarbon-oxidizing bacteria strains were isolated from February 20 to March 20, 2025.

Next, beginning on March 25, experiments began to study the cultural, morphological, physiological, and biochemical properties of each isolated pure bac-

Experiment on the effects of bacteria from the Japanese Kibo module on the International Space Station (JAXA/NASA)

terial culture. Microorganisms isolated from various locations within the oil storage facility, as well as compressor pipes, were identified to the species level, i.e., their systematic position was determined using D. Berger's classification system.

As a result of a comprehensive study, bacteria of 6 species were found in large quantities on the oil-contaminated surface of an oil storage facility: – *Desulfovibriodesulfiricans ; - Desulfovibrio vulgaris ; - Pseudomonas aeruginosa; - Acetobacterium woodii ; - Desulfotomaculum nigrificans* and - *Acetobacteraceti*.

These studies are currently ongoing, and after the completion of experiments to study 350 strains of hydrocarbon-oxidizing bacteria isolated by taxonomy in the 4th quarter of 2025, experiments were started using a special technique to search for the main or principal microorganisms – causative agents of bacterial corrosion of metal structures of oilfield equipment operating in the Kokdumalak and Northern Urtabulak oil fields – among hydrocarbon-oxidizing bacteria isolated in pure culture.

Thus, the results of research conducted by scientists at the Institute of Microbiology of the Uzbekistan Academy of Sciences will provide the basis for determining not only the composition of the main microorganisms and bacterial vectors that cause biocorrosion, but also for combating this phenomenon. This will also serve as the basis for a scientifically substantiated selection and recommendations for the use of the most effective bactericidal agents for each type of bacteria detected, with the aim of coating a specially selected composition of surfaces of oilfield, pipeline, and other equipment at major oil fields in Uzbekistan.

This will prevent the penetration of hydrocarbon-oxidizing bacteria into the metal, which causes biocorrosion of metal surfaces and, consequently, reduces their safe service life. These measures will extend the service life of expensive metal equipment without replacement, thereby creating significant economic benefits for the country's oil and gas production and refining industries.

Literary sources: 1. Andreyuk U.I., Bilay V.I., et al. "Microbial corrosion and its causative agents". Kiev: Naukova Dumka, 1980, 287 p.

The cotton gene pool collection – a unique entity

Marjona Muzafarova,
Head of the "Cotton Gene Pool" collection

The world's cotton collection represents a diverse collection of genotypes, agroecological traits, and characteristics used for creative, scientific, and economic purposes. This includes the unique collection of the Cotton Gene Pool, housed at the Institute of Genetics and Experimental Plant Biology. The first seed samples (152 samples) from this collection were recorded by F.M. Mauer in 1949, and the collection of wild, ruderal forms of cotton was subsequently expanded by Academician A.A. Abdullaev through expeditions to various countries. Currently, scientists worldwide have registered over 50 species of the genus Gossypium (cotton), and 23 of these wild trees and shrubs are used at our unique facility as source material for developing scientific, practical, and promising varieties (Figure 1). Today, drastic global climate change poses a serious threat to the environment, economy, and society. Agriculture is the leading sector of our country's economy, but much of our land

Creator of the Cotton Gene Bank, Academician A.A. Abdullayev

is located in semi-desert regions, meaning high temperatures, water shortages, and the negative impact of pests and viruses are contributing to declining crop yields.

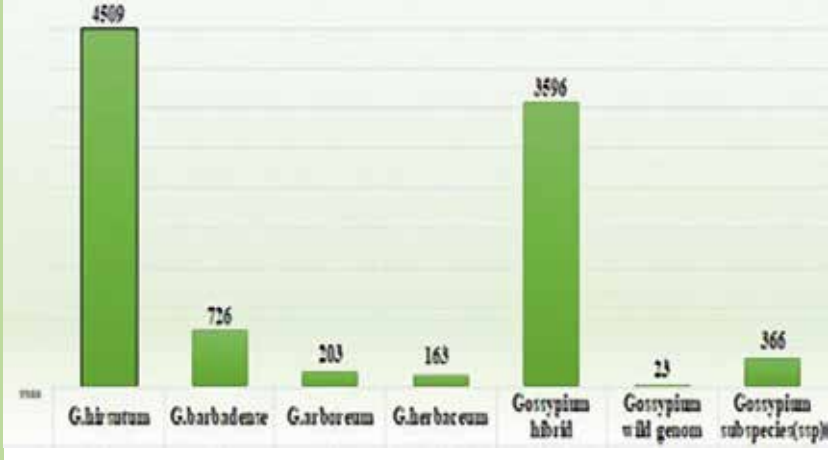
Figure 1. Rare species of wild cotton grown in permanent habitats in the Cotton Gene Pool collection

The Cotton Gene Pool collection of the Institute of Genetics and Experimental Plant Biology of the Uzbekistan Academy of Sciences, as a unique resource, is of strategic importance for the development of our country's agricultural sector. In recent years, this unique resource has been effectively utilised by industry specialists and our scientists conducting research. This collection serves as a source material for fundamental and applied projects (Figure 2).

The unique Cotton Gene Pool collection plays a vital role in our research scientists' development of promising varieties characterised by early maturity, high yield, high fibre yield, and responsiveness to environmental factors (soil salinity, low temperatures, high temperatures, drought, etc.). This is why it has attracted the attention of the Food and Agriculture Organisation of the United Nations (FAO).

Based on a comprehensive study of the gene pool and its effective utilisation, the digitised data obtained during the cotton germplasm inventory and data digitisation process were sorted, organised, and integrated into a MySQL system to create a database. The website www.cottongen.uz (based on the A-FA-2021-19 Practical Project "Creation of a digitised

FAO certificate and Gossypium genus – the basis for creating new cotton varieties



FAO certificate and Gossypium genus – the basis for creating new cotton varieties

Greenhouses with domestic varieties of cotton

database based on the inventory of cotton gene pool collections," funded in 2021-2023) was created using the PHP (PHP Hypertext Preprocessor) web programming language, which enables the creation of dynamic content linked to databases (Figure 4).

The Cotton Gene Pool collection is considered a national treasure of our country and remains an important foundation for future cotton research. This facility preserves samples of varieties adapted to the climatic and soil conditions of all regions of Uzbekistan as a genetic resource, ensuring their fertility does not decline over time (Figure 5).

The gene pool is not only a source of useful traits but also an important resource for creating promising varieties with a new genetic base. Wild species and new synthetic forms of cotton, which have high economic value, are effectively used not only in the institute's laboratories but also in many research institutes across the country. On this basis, many new varieties were created: AN-chillaki, Uzbekistan-3,

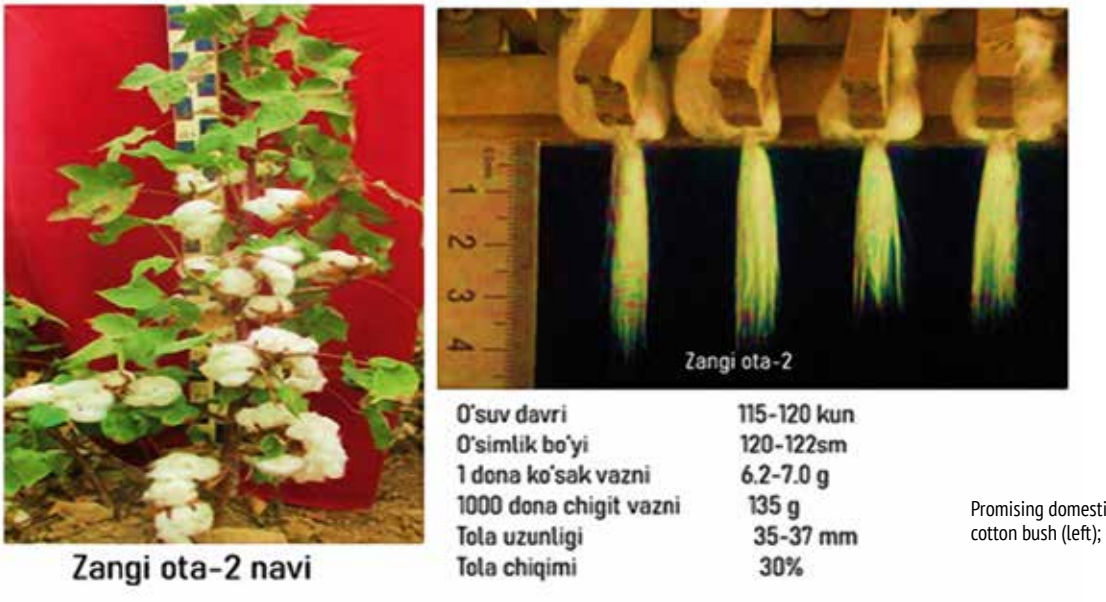
Greenhouse farming with cotton varieties used to create the database

Storage facility with samples of resource material (left) for creating cotton varieties (right)

AN-510, 512-516, Sharof-75, Besh-Kahramon, Hamkor, Nasaf, Kopaysin, Genofond-2, Zangi Ota-2, Niso, Mokhinur and others.

According to the performance indicators of this unique facility, over three years (2023, 2024, 2025), our researchers published 16 papers in domestic journals listed by the Higher Attestation Commission under the Cabinet of Ministers of the Republic of Uzbekistan, 8 in journals included in the Scopus and Web of Science databases, 6 at other reputable international scientific conferences, and 12 at local scientific conferences.

In conclusion, the research conducted in recent years at the Cotton Gene Pool is contributing to the creation of new genetic combinations, the enrichment of economically valuable traits in existing varieties, and the identification of strains resistant to stress factors. The results achieved in these areas have been recognised not only in the domestic but also the international scientific arena, confirming the scientific potential and breeding achievements of our scientists.



Promising domestic cotton variety Zangi Ota-2: - cotton bush (left); - cotton fibre samples (right)

Fe_2O_3 Nanocluster Catalysis for Ammonia Decomposition: Insights from Automated Reaction Mapping

Sapajan Ibragimov,
junior researcher of the
Khorezm Mamun Academy

Here in I have investigated interaction of NH_3 with Fe_2O_3, and single H transfer from NH_3 on Fe_2O_3 using artificial induced reaction search method. Initially, I have found 31 local minima and 33 transition state structures. Also, this investigation shows NH3 preferably adsorb on the two-coordinated Fe site than three-coordinated Fe site of Fe_2O_3.

Introduction

Right now, most of our energy still comes from fossil fuels, which are doing serious damage to the environment. Even though we've seen impressive growth in renewable technologies like wind and solar power, fossil fuel consumption keeps rising. The main reason? Green energy technologies are still expensive to implement[1].

Hydrogen offers another promising alternative beyond wind and solar[2]. People have actually known about hydrogen's potential as a clean energy source since the late 1800s, and over the years, we've gotten much better at producing H_2 from different sources. The big challenge we're facing today is figuring out how to store and transport it efficiently, mainly because hydrogen packs so much energy into such a small space.

This is where ammonia comes into play. Unlike hydrogen, ammonia can be turned into a liquid at relatively low pressure just 20°C, and storing it doesn't require nearly as much energy. This makes converting ammonia back into hydrogen a really valuable process[3,4].

There's another advantage too: we already produce massive amounts of ammonia. Using the Bosch-Haber process (developed by Fritz Haber and Carl Bosch over a century ago), ammonia has been manufactured as fertilizer for decades[5]. In fact, global ammonia production hit around 150 million metric tons in 2022 alone.

Here's the interesting part: ammonia can be broken down through a reverse Bosch-Haber process to produce nitrogen and hydrogen. This decomposition method was first introduced by L. Green[6] back in 1982, opening up new possibilities for hydrogen production.

$2NH_3 = N_2 + 3H_2$

The fundamental challenge with ammonia is that breaking its N–H bonds requires enormous amounts of energy—unless you have the right catalyst. That's why so much research has zeroed in on studying reaction kinetics at low pressures with various catalysts present.

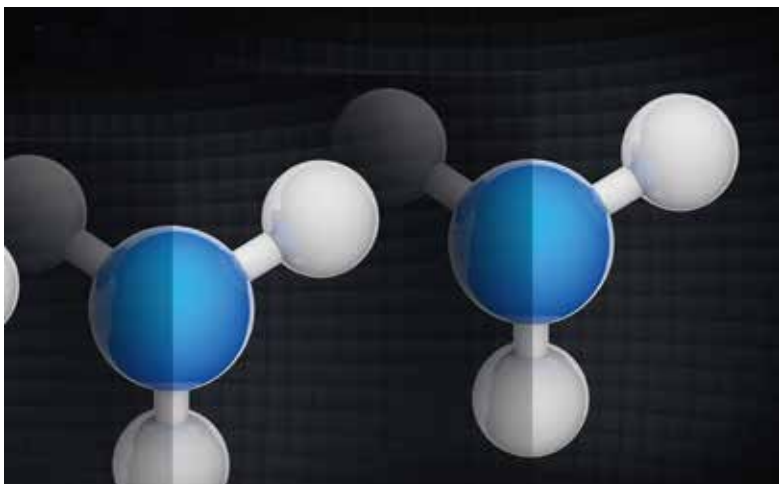
Platinum-based catalysts[7] have been the go-to choice for ammonia decomposition reactions. But researchers have also explored other metals like nickel, rhodium, tantalum, and iridium[8] to understand how ammonia breaks down under low-pressure conditions.

When scientists studied ammonia decomposition on an iridium surface—specifically Iridium surface[9] Ir(100)—they found an activation energy of 84 kJ/mol across temperatures from 200 to 800K and pressures ranging from ultrahigh vacuum up to 1.5 Torr. In another study, Andrea Di Carlo and colleagues[10] experimentally tested ammonia decomposition using a Ru/Al_2O_3 catalyst at pressures between 1 and 10 bar, achieving an activation energy of 117 kJ/mol.

W. Zheng[11] and team took things further by studying size-selected ruthenium clusters ranging from 1.9 to 4.6 nm. Their results revealed something important: these clusters showed high activity for ammonia decomposition, but the activation energy increased with particle size—from 79 kJ/mol up to 122 kJ/mol. This tells us that the size of the catalyst cluster plays a critical role in how well the decomposition works.

Here's what we've learned about ruthenium catalysts[12-14]: their effectiveness in breaking down ammonia doesn't just depend on the active site itself—the support material matters too. The downside? These catalysts are expensive and hard to come by, making them impractical for large-scale applications. The real challenge now is designing highly active catalysts that don't break the bank.

Plenty of research has explored different metals and their catalytic activities. Back in 2005, A. Boisen and colleagues[15] did a comparative study looking at



various metals (iron, cobalt, nickel, copper, and ruthenium) on the same support material. Iron is particularly interesting because it's the second most abundant element in Earth's crust and iron-based catalysts are already widely used in organic synthesis.

In this study, I investigated how ammonia breaks down step-by-step on iron(III) oxide clusters of different sizes—specifically Fe_2O_3.

We also examined how ammonia molecules attach to these clusters and measured the energy barriers involved when ammonia loses its hydrogen atoms at various active sites on the Fe(III) oxides. We believe our findings about how these small-sized iron(III) oxide clusters behave could provide valuable insights for designing more effective Fe_2O_3-based nanocatalysts in the future.

Computational details

Understanding the potential energy surface (PES) is crucial because it reveals how chemical reactions actually happen. In recent years, automated search methods have become increasingly popular for efficiently mapping out all possible reaction pathways on the PES. But here's the challenge: creating a complete map of reaction paths is usually extremely difficult, except for the simplest molecules like diatomics or triatomics.

A major breakthrough came in 2013 when Maeda and Morokuma[16] introduced the Global Reaction Route Mapping (GRRM) strategy, which uses the Artificial Force Induced Reaction (AFIR) method to systematically explore chemical reaction mechanisms. The core concept behind AFIR is straightforward: it pushes (or pulls) two or more molecular fragments together by minimizing the following AFIR function[17]:

$$F(Q) = E(Q) + \alpha \frac{\sum_{i=A} \sum_{i=B} \omega_{ij} r_{ij}}{\sum_{i=A} \sum_{i=B} \omega_{ij}}$$

$$\alpha = \frac{\gamma}{\left[2^{-\frac{1}{6}} - \left(1 + \sqrt{1 + \frac{\gamma}{\varepsilon}}\right)^{-\frac{1}{6}}\right] R_0}$$

The external force term in Equation 2 deliberately disturbs the adiabatic Potential Energy Surface. This disturbance helps us discover more approximate transition states and local minima that we might otherwise miss. The force parameter α in Equation 2 is defined as:

The model collision energy parameter γ in Equation 3 represents an approximate upper limit for the barrier height that the AFIR function can influence in the system.

For our investigation of ammonia decomposition catalyzed by iron trioxide, we used the Single Component Artificial Force Induced Reaction (SC-AFIR) method[18] interfaced with the Gaussian 16 program[19]. We set the model collision energy parameter at γ = 300 kJ/mol for the entire system. In simple terms, when γ is large enough to overcome the energy barrier, the AFIR minimization produces an approximate product structure as a local minimum on the AFIR function.

Once we identify these approximate transition states and local minima, we can refine them using the Locally Updated Planes (LUP) method—this time without the artificial force—to obtain accurate product and transition state structures.

Results

In this research, we systematically explored how ammonia decomposes on Fe_2O_3 cluster catalyst . Our approach started by using the AFIR technique to search for approximate reaction pathways between NH_3 molecules and the most stable forms of Fe_2O_3-clusters. We then refined these AFIR pathways using the Locally Updated Plane (LUP) method without artificial force, focusing only on the minimum energy path.

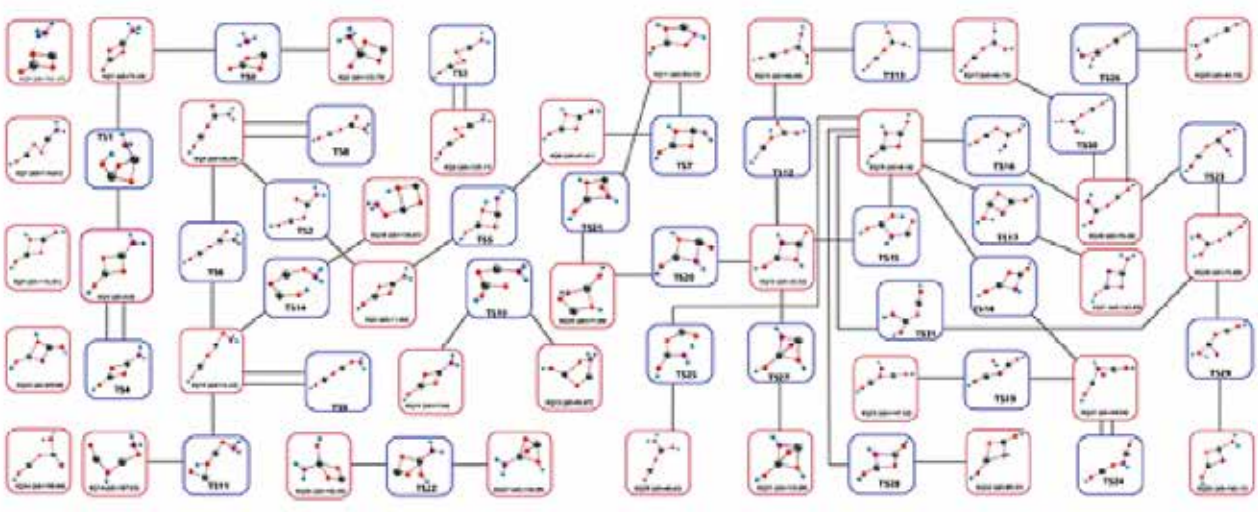


Figure1. Reaction Route Map for adsorbed NH_3 geometries on Fe_2O_3.

Figure 1 shows the reaction path network for NH_3 reacting with Fe_2O_3, which involves 33 local minima (pink) and 31 transition state structures (blue). It can be seen that, reaction route map gets too complicated for large structures. We didn't just map out adsorption and hydrogen transfer pathways—we also tracked how molecules migrate between different adsorption sites and undergo isomerization. This is important because a single Fe_2O_3 unit offers multiple energetically favorable sites where NH_3 can attach. Specifically, there are two Fe-O-Fe oxo bridge sites and two terminal oxygen sites where hydrogen atoms can transfer from the adsorbed NH_3 on the Fe* site to oxygen sites on the Fe_2O_3cluster.

Our findings show that NH_3 can bind to the iron site in several different configurations, each with its own binding energy.

his figure shows an energy profile along the intrinsic reaction coordinate (IRC path) for ammonia decomposition on an Fe_2O_3 cluster. The purple line traces the energy changes as the reaction progresses, with molecular structures shown at key points. The reaction shows a double-well potential with significant energy barrier in the middle. The reaction energies are given in kJ/mol, shows starting point of the reaction has energy about 65 kJ/mol. However, transition state shows energy peak at approximately 180 kJ/mol. Overall reaction is endergonic in the forward direction requiring 112.11 kJ/mol energy to overcome the barrier. Also this result reveals that the product state is significantly more stable than reactant state.

Figure 3 shows complete reaction pathway for catalytic H transfer on the small Fe_2O_3. As it was mentioned, there are two active sites that NH_3 interact with. It can be seen from this result the adsorption of NH3 on three-coordinated Fe site has higher energy than two-coordinated Fe site. Therefore, NH3 preferably adsorbed on Fe two-coordinated site of Fe_2O_3.

Conclusion

I have investigated catalytic H transfer from adsorbed NH_3 on Fe_2O_3 using Artificial Induced Reaction Search technique to search for approximate reaction pathways between NH_3 molecules and the most stable forms of Fe_2O_3clusters. This results reveal that NH_3 preferably interact with two-coordinated Fe site than three-coordinated Fe site of Fe_2O_3. This findings provides inside into new catalyst design using new computational automated method for effective H_2 production from ammonia.

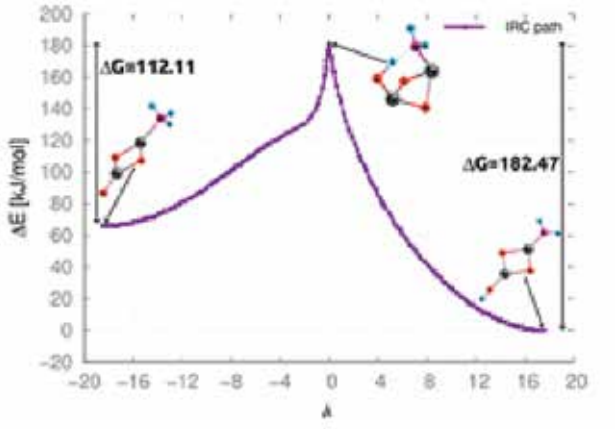


Figure2. IRC path for H decomposition on Fe_2O_3.

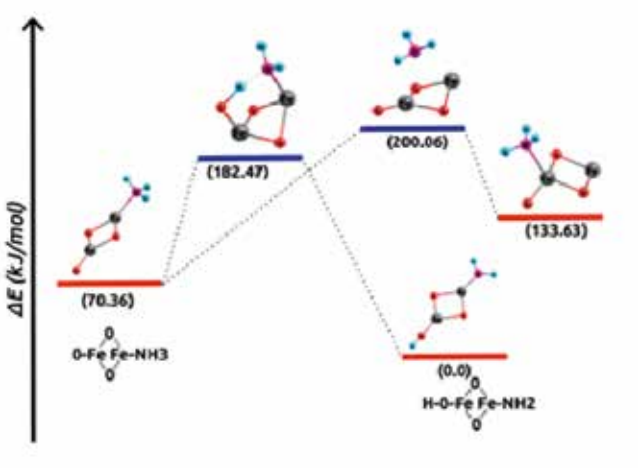


Figure3. Two different reaction pathways for H decomposition Fe_2O_3.

Covering three centuries of history in one sentence (using the example of biruni's work)

Umida Kuranbaeva,
PhD in History

As a result of our research, it has been proven that to date the scientific heritage of Abu Rayhan al-Biruni (973-1048) consists of 184 works. Of these, 150 were written by the scholar himself, 9 were translated and commented on by him, and 25 works were dedicated to him. However, only 33 works by Biruni have survived to this day. Considering that 80 per cent of Biruni's scientific heritage has not yet been studied, it is likely that these figures will change. Because out of the 113 works that Al-Biruni listed in his work "Fihrist-i-Kutub Muhammad ibn Zakariya ar-Razi" (List of the Works of Muhammad ibn Zakariya ar-Razi) [1:10; 2:28-44; 9:230-241], 89 were mentioned in various works written by him, as well as in the works of other authors and in medieval bio-bibliographical works.

Biruni's Works Reflecting Historical Events

Biruni's historical works are not mentioned in his "Index" of his own works. Only scholars who have classified and studied Biruni's works have established that he wrote 3 works on history and 6 on chronology and ethnography [10: 250]. Of these works, only two have survived in their entirety, and part of one has reached us as part of another work. Below are some of Biruni's works that touch on historical issues:

1. "Kitab fi akhbar al-Mubayyaza wa al-Qaramita" ("On the News of the People in White Garments and the Qarmatians") [5:93b]. This work has not reached us. Its title and summary are given only in Chapter VIII of "Athar al-baqiya an al-qurun al-khaliyya" ("Monuments of Ancient Peoples", hereinafter "Athar al-baqiya"). Therefore, it can be said that this book was written before 1001-1004. "Kitab fi akhbar al-Mubayyaza wa al-Qaramita" provides fairly detailed information about Muqanna, the leader of the rebellion that took place in Maverannahr in 769-783. This work is recommended in the book "Athar al-Baqiya" as additional literature. Biruni notes that he translated the information contained in it from a book into Farsi, but does not specify from which one [6: 244-247];

2. From the book "Mashahir al-Khawarazm" ("Famous People of Khorezm"), only one chapter has come down to us in the work "Tarihi Mas'udi" ("History of Masud") by Abu-l-Fazl Bayhaqi (995-1077). This passage reflects the domestic and foreign policy of Khorezm in 1016, 1018-1020. In particular, valuable information is provided on the relations and diplomatic ties between the Arab Caliphate, the Ghaznavids, the Karakhanids, the Seljuqs and the Khwarazmshahs Mamunids [3: 25-27];

3. The work entitled "Kitab tarikh ayyam as-sultan Mahmud wa akhbar abih" ("The Book of the Days of Sultan Mahmud and News of His Father") has not reached us [3: 25-27]; 4. "Athar al-Baqiya" is recognised by scholars as a work devoted to chronology [10: 250]. In fact, this work contains information about

A copy of the manuscript "Kitab al-Tafhim li Awa'il Sinat al-Tanjim", kept at the International University of the Silk Road

A mosaic of history: an image of Abu Rayhan Beruni on the wall of a hall dedicated to the great figures of Central Asia. Centre of Islamic Civilisation of Uzbekistan

the history of the peoples of the ancient world, in particular the Greeks, Romans, Slavs, Persians, Indians, Arabs, Egyptians, Sogdians, Khorezmians, Turks and other peoples. The work was written between 1001 and 1004 and is dedicated to the ruler of Gurgan, Qaboos ibn Vashmgir (976-981, 998-1012). It consists of an introduction and 21 chapters;

5. The work "Kitab Tahrir Ma Li-l-Hind Min Maqula Maqbula Fi-l-Aql Aw Marzula (The Book Explaining the Teachings of the Indians Acceptable or Rejected by Reason, hereinafter referred to as India)" is included in the chapter of Fihrist (Index) entitled *"My Works Related to Various Beliefs"*. The book was written under the orders of Sultan Mahmud of Ghazni (998-1030) and completed in 1030. The work consists of an introduction and 80 chapters covering historical events, such as the Arab and Turkic invasions of India [7: 51-53]. Biruni's book "Kitab at-tafhim li avo'il sina't at-tanjim" ("Book of Explanation of the Fundamentals of the Art of Astronomy", hereinafter referred to as "Tafhim") was written for his student Rayhona. In its structure, "Tafhim" consists of 8 chapters and 530 questions and answers. This book is included in scientific literature as a work of an encyclopedic nature. The sixth chapter of "Tafhim" is devoted to chronology, which supplements the historical information provided in "Athar al-Baqiya" [8: 79].

Statue of Al-Biruni at the United Nations Office in Vienna

Illustration from Al-Biruni's Chronology of Ancient Peoples
Copy from Tabriz, 1307 CE

Biruni's style in writing historical works

Biruni's works are of great value for the study of the history of Central Asia and are a particularly reliable source for covering the chronology, ethnography, toponymy, linguistics, culture and history of the Sogdians, Khorezmians, Tokhars, Kidarites, Turks and other peoples who lived in this region. In presenting historical issues, the scholar often attached importance to the following sequence: chronology, duration and interrelation of events, accuracy of the information provided, names and coordinates of places, the full name of the ruler, and his detailed genealogy.

For example, in Athar al-Baqiya, there is a sentence: *"After the people of Khorezm renounced [Islam], Qutayba ibn Muslim conquered Khorezm for the second time and appointed Askajamuk ibn Azkajawar ibn Sabri Sakhr ibn Arsamukh as ruler over the Khorezmians. The Khosravid dynasty lost power, and they were only called rulers, since their rule was passed on by inheritance. The dates, according to Muslim custom, were transferred to the Hijri calendar"* [4: 71]. In these four lines, Biruni briefly described the history of Central Asia from the 7th to the 10th centuries. An analysis of the events presented in this sentence shows the following:

- *After the renunciation of the inhabitants of Khorezm [from Islam],* that is, in 684, one of the commanders who began the first military campaigns of the troops of the caliphate, Salm ibn Ziyad (died at the end of 692), as Tabari reports in his work "Tarikh-ur-rasul wa-l-muluk" ("History of the prophets and kings"), was the first to move to Khorezm and concluded a peace treaty with it in exchange for a large tribute [11: 51]. According to Biruni, this is how Islam came to this land, but over time, the Khorezmians turned away from the faith;

– *After Qutayba ibn Muslim conquered Khorezm for the second time*, that is, after the Khorezmians violated the terms of the peace treaty concluded in 684, in 712 Qutayba ibn Muslim (669–715) occupied Khorezm for the second time [11: 115]. As stated in Tabari's Tarikh-ur-rasul wa-l-muluk and Balazuri's Futuh al-buldan (Conquest of Cities), the *rebellious* Khorezmshah Khurrazad was killed, whose real name was not Khurrazad (son of the Sun), but Azkajawar ibn Sabri (died in 712), a Khorezmshah from the Afrighid dynasty, a descendant of Khosrow [12: 219–221];

– *[Qutayba] elevated to the throne of the Khorezmians Askajamuk ibn Azkajavar ibn Sabri*, i.e. Qutayba ibn Muslim elevated to the throne the heir of Azkajavar ibn Sabri – Askajamuk ibn Azkajavar, the son of the governor. In 712, the state of the Khorezmshahs was divided into two parts, the northern of which, with its centre in Gurganj, was ruled by an Arab governor – the emir. The center of the southern part was Qiyat, where the Afrighid dynasty of the Khorezmshahs ruled (305-995);

– *The Khosrawid dynasty lost power, and they were only called rulers, since their rule was passed on by inheritance*. Here we are talking about Afrig, the heir of Keykhosrov (Kavi Khusraw), the son of the legendary Khorezm king Siyavush ibn Keykaus, and his dynasty. The Afrighids are said to have become vassals of the Arabs in 712, lost power, and retained only the title of *shah*;

Speaking about the fact that the *dates, according to Muslim custom, were transferred to the Hijri calen-*

dar, Beruni says that in 712 in the northern part of Khorezm under the rule of the emir with the centre in Gurganj, the calendar was transferred to the Hijri, and in 995 the emir of Gurganj attacked the possessions of the Khorezmshahs Afrighids with the centre in Qiyat, killed the last Khorezmshah Abu Abdullah Muhammad (d. 995) and occupied the southern part of the state, thus completely transferring the calendar to the Hijri in the united state of the Khorezmshahs in the 10th century.

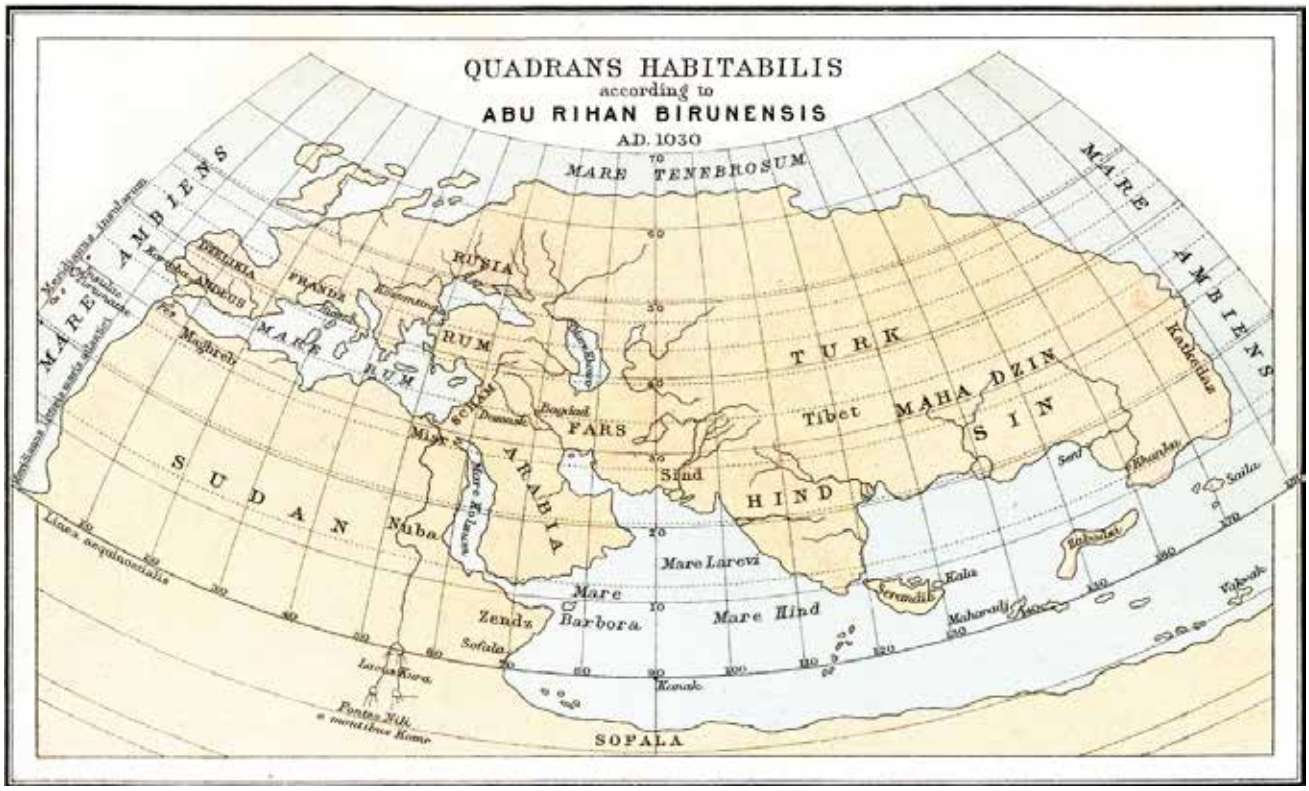
Conclusion. The works of Abu Reyhan Biruni are an invaluable source for studying, along with the exact and natural sciences, also social and historical sciences. In his works, he covered in detail the historical processes that took place in Central Asia and adjacent regions. Biruni's historical information is distinguished not only by the presentation of details of specific events but also by their analysis, identification of cause-and-effect relationships. This approach of the scientist remains relevant for modern historical research.

In his works, Biruni left important information about the culture, language and ethnic composition, and economic and political processes in the lives of ancient peoples. His works, combining historical chronology, astronomy and ethnography, are of great importance for the study of the history of the peoples of Central Asia, including the geopolitical position of Khorezm, Sogd, Turan, India and Iran in the Middle Ages.

One of the important aspects of Biruni's historical research is that he critically analysed existing sources and compared written and oral sources of different peoples. In particular, information about the times of the Khorezmshahs and Ghaznavids, the political role of the Turkic peoples and the processes that followed the Arab invasion are considered some of the most reliable historical evidence of that period.

Biruni's historical works cover the pre-Islamic and Islamic periods and are an important source shedding light on the interrelationships, mutual cultural influences, customs and social structures of the peoples of Maverannahr, India and the Middle East. His works such as Athar al-Baqiyya, Kitab al-Hind and Mashahir al-Khawarazm are extremely important for historical science, serving as the basic material for filling historical gaps and developing new approaches. Therefore, Biruni's contribution to the development of historical sciences is invaluable, and his legacy is still of great importance for scientific research today. His approach, based on objective and scientific analysis, has not lost its relevance in modern historical methodology.

Al-Biruni's description of the world map



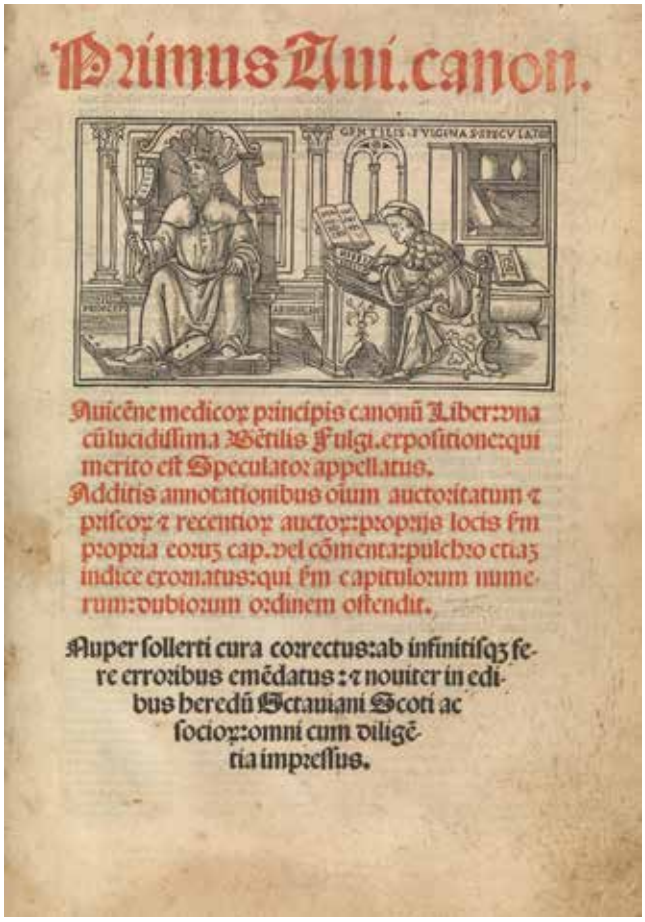
Interpretations of the figure of Ibn Sino in latin medieval studies

Otabek Makhmudov
PhD in History

To date, many works of varying levels have been published throughout the world dedicated to the life and work of Ibn Sina (980-1037), as well as the scientific legacy he left behind. If a bibliography of such studies were compiled, their total number would exceed ten thousand. Without questioning the place in the history of science occupied by the great thinkers our country produced, it should be noted that the scholar from among our ancestors who was studied with the greatest interest by European scholars was Ibn Sina. This interest only intensified and never waned, not in the 12th century, when his works were first translated into Latin, not in the second half of the 15th century, when these translations began to be published, not in the second half of the 18th century, when Oriental studies emerged as an independent branch of scholarship. Some European historians considered Ibn Sina, whose name in Latin was pronounced "Avicenna," one of their own scholars, while others identified him (who was originally from Bukhara) with the rulers of Seville and Cordoba. This situation is typical of European historiography from the 14th to early 16th centuries, and is also observed in the works of other Central Asian scholars whose works were translated into Latin in the second half of the 11th to the 13th centuries. The results of our research on this issue were published in our previous work. However, the primary focus of these studies was on explaining why Latin-language sources presented Muslim Eastern thinkers as European scholars. The brief conclusion is that translators working in the second half of the 11th to the 13th centuries had no information about the authors of the works they translated. For this reason, the translated text contains no additional information about the author's identity.

As a result, Western scholars of a later period, who did not speak Arabic and had no access to Arabic sources, assumed that Alcoarismi (Muhammad al-Khwarizmi), Albumazar (Abu Mashar Balkhi), Alfraganus (Ahmad Farghani), Alpharabius (Abu Nasr al-Farabi), Alkindi (Ya'qub al-Kindi), Avicenna (Ibn Sina), and other scholars of the Muslim East, who were listed as authors in the translations, were European scholars. A striking example of this is the fact that Ibn Sina was considered a native of Seville, and al-Balkhi was considered an Athenian. Furthermore, the lack of information about the authors in the text of the translations also prompted some European historians to attempt to create an artificial biography of the author. As a result, Latin-language sources created in the 14th – early 16th centuries contained information based on fiction and legends about the personalities of thinkers of the Muslim East.

Among the Latin sources providing information about Ibn Sina, the earliest historical work is Giacomo Filippo Foresti's (1434-1520) Supplementum Chronicorum Orbis, ab initio mundi ad annum 1482 (Supplements to the Chronicle of the World: from the Creation to the Year 1482). Completed in 1482 and consisting of 15 parts, this work devotes special attention to Ibn Sina's activities and contains information about the scholar's biography. However, much of the information on this subject is extremely confusing, and some is completely inaccurate. In particular, Ibn Sina is presented in the work as a scholar from Seville


Primus Aui.canon.

Auicēne medicoꝝ principis canonū Liber: vna cū lucidissima Bērilis Fulgi. expositione: qui merito est Speculator appellatus.
Additis annotationibus oium auctoritatum & priscoꝝ & recentioꝝ auctoꝝ: propria locis sm propria eoꝝ cap. vel cōmenta: pulchro etiaꝫ indice ornatus: qui sm capitulorum numerum: dubioꝝ ordinem ostendit.

Nuper sollerti cura correctus: ab infinitisqꝫ fere erroribus emēdatus: & nouiter in edibus heredū Octauiani Scoti ac socioꝝ: omni cum diligētia impressus.

The First and Second Treatises of Avicenna

Three great ancient teachers of medicine: Galen, Avicenna, and Hippocrates (Medical book from the early 15th century)

(*Avicena quoque Hispalensis*). It is surprising that the author claims that Ibn Sina was *the king of Bithynia*, a historical region in northwestern Asia Minor, and that he *was poisoned by Ibn Rushd, but Ibn Sina at the end of his life executed Ibn Rushd* (*Avicena… Bythinie regem, et ab Averoi medico venenatum tradunt, sed antequam periret ipse illum Averoim interfecisse*).

Notes on Ibn Sina's biography are also found in the work of the German chronicler Hartmann Schedel (1440-1514) entitled "Registrum huius operis libri cronicarum cum figuris et imaginibus ab inicio mundi" ("A collection of chronicles enriched with figures and images: from the creation of the world to the present"). In particular, the author devotes special attention to the personality of Ibn Sina, and along with recognizing him as a famous physician, he describes the scholar as *the king of Cordoba (regem de Cordoba*). In addition, the work notes that *al-Ghazali, al-Farabi, and Ibn Sina, who lived in different eras, were contemporaries and lived during the same period as Ibn Rushd* (*Algazel etiam et Alfarabius videntur fuisse contemporanei Avicennae, qui fuerunt tempore Averrois*).

The following work is by the French astrologer and philosopher Simon de Fares (1450-1499), entitled "Recueil des plus célèbres astrologues et quelques hommes doctes" ("Collection of Famous Astrologers and Scholars"). Since this work is based on the aforementioned book by G.F. Foresti, it also contains misconceptions and errors about the scholar's identity. For example, the work describes Ibn Sina as *the king of Seville* (*Avicena regem de Hispalensis*). Another part of the work, the original edition of which is currently held in the National Library of France under the No.

Galen, Avicenna, and Hippocrates

Avicenna and Gentile da Foligno

Fr.1357, also states that Ibn Sina was an astrologer.

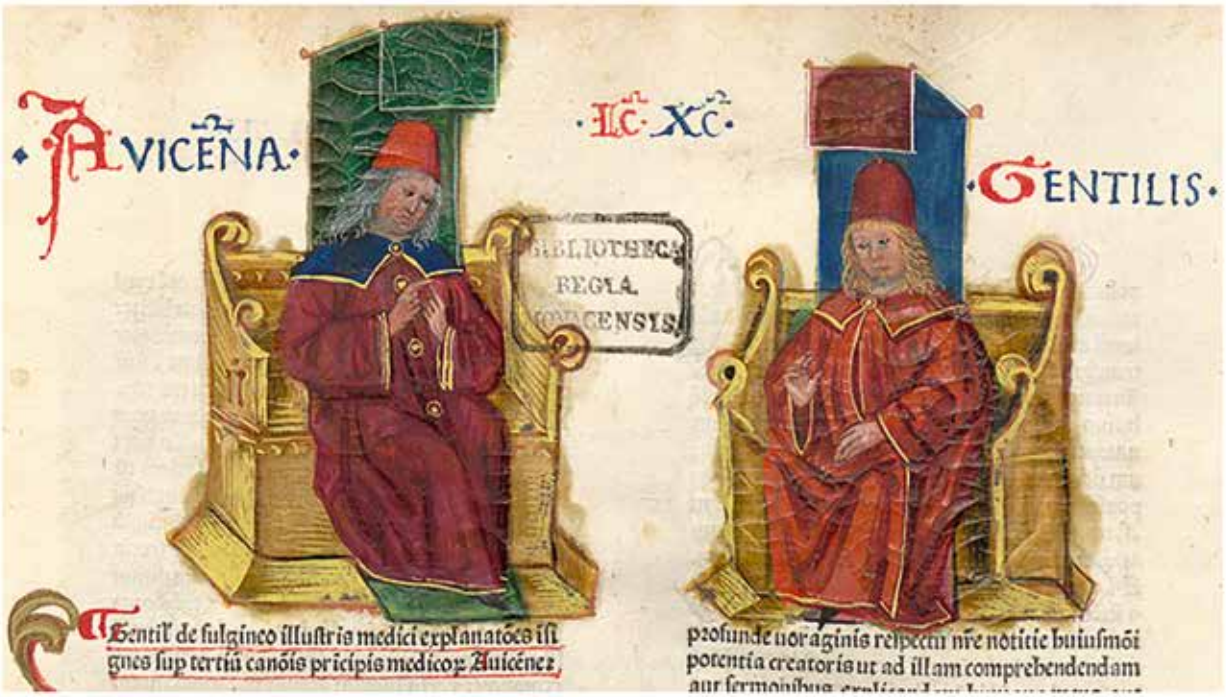
The above information indicates that European historians were not directly familiar with the biography of Ibn Sina, and when presenting the information they resorted to further development of events through artistic fiction, characteristic of Western chronicles of the Middle Ages.

The most common fiction in Latin-language sources, often associated specifically with Ibn Sina, is the depiction of the scholar as a European king. This fiction is reflected not only in the text of the sources but also in their illustrations. For example, in a woodcut by an unknown author, executed in the early 15th century (Fig. 1), Ibn Sina is depicted at the centre as a crowned monarch, seated between two renowned ancient physicians, Hippocrates (460–370 BCE) and Galen (129–216 CE). This image is well known to historians of science and orientalists in our country. Our historians associate the depiction of Ibn Sina as a monarch in paintings created in Europe during the Middle Ages with his recognition in the West as the "king of physicians." However, as analyzed above, Latin sources indicate that in the Middle Ages, the figure of Ibn Sina was viewed in the West as a figure of a nominal king who was engaged in medicine and, mainly, philosophy.

One of the first depictions of Ibn Sina as a king in European sources appears in a 1320 copy of Liber Canonis, a Latin translation of the "Canon of Medicine" created in 1180 by Gerard of Cremona. This portrait (Fig. 2), painted by an unknown artist, was previously unknown to the scientific community in our country and region.

During our research, we discovered a copy of the same translation, housed in the French National Library under the No. Ms. Lat. 14023 fol. 769 v., in which

Commentary on Ibn Sina's Canon of Medicine by Italian physician Gentilis de Fulgineo, 1477. (Welcome Library)



Interpretation of Avicenna's third book, "Canon of Medicine".
Evidence of the large-scale transfer of knowledge from the Islamic world to Europe

The beginning of the book "Rural Goods", 12th century, author Pierre de Crescenzi.
Italian translation, 1490

Title page with rubrication in the style of Avicenna.
The present codex, 1523

Ibn Sina is depicted wearing a large crown, typical of European kings, and clothing made of red and dark green velvet. It's worth noting that this image, although based on fiction, is extremely unique.

Another depiction of Ibn Sina, enthroned and wearing a crown, can be found in the 1520 edition of Liber Canonis and its commentary by the Italian physician Gentile da Foligno (1290-1348), published in Venice. An engraving on the inside cover of this edition depicts Ibn Sina seated on a throne, wearing a crown and holding a scepter in his right hand (Fig. 3-3a).

The first edition of Gentile da Foligno's commentary on the Canon of Medicine, entitled Expositio super tertio Canonis Avicennae, published in Padua in 1477, contains a color image of Ibn Sina dressed as a European priest but seated on a throne (Fig. 4-4a).

An image of Ibn Sina wearing a crown and holding a scepter also appears in the work "Herbarius Moguntinus" ("Herbarium of Mainz"), published in Vicenza in 1491 by an unknown author (Fig. 5 - 5a). On the inside cover of this work, which contains information on approximately 100 medicinal plants and their medicinal value, Ibn Sina is depicted next to Arnaldo de Villanova (1235-1311), one of the most renowned medical scholars of his time. The subject of this painting is the same as that of Gentile da Foligno's depiction: "Arnaldo de Villanova writes down what Ibn Sina said."

The next image of Ibn Sina wearing a crown appears in the 1523 edition of the Canon of Medicine, published in Venice, where he is depicted wearing a crown over a turban (Fig. 6). Some sources claim that this engraving was created in the 18th century by the famous German artist Georg Paul Busch (c. 1682-1759). However, this image was first published in the 1523 edition (Fig. 6a). The composition created for the inside cover of the publication includes portraits of 10 outstanding scientists from different eras, arranged in two columns. The left column, from top to bottom, depicts scientists who made significant contributions to the development of medicine: Hippocrates, Galen, Ibn Sina, Razi (865-925), Yuhanna ibn Musawayh (777-857). The right column features portraits of famous philosophers: Plato (427-347 BCE), Aristotle (384-322 BCE), Theophrastus (370-288 BCE), Ibn Rushd (1126-1198), and Diogenes (412-323 BCE). It is noteworthy that Abu Bakr al-Razi and Yuhanna ibn Musawayh are depicted in the paintings as "easterners," typical of the traditions of the Muslim East, while Ibn Sina, who worked in practically the same region as them, is depicted as a "westerner." This composition was repeated in the 1544 edition in the format of eight characters (Fig. 6b) (without Diogenes and Musawayh). However, in this edition, the columns were reversed.

Images similar to those shown above also appear in many other Latin editions of various books and works by Ibn Sina, published before the second half of the 16th century. Although in some of them he is depicted without a crown, he is given a Caucasian facial structure and dressed in Western clothing (Fig. 7-7a).


De A. Theuet, Liure VII. 620

ABOALIS AVICENNE, MEDECIN.

Chap. 134.

CAVSE de la neceſſité aucuns ont dit treſ-à propos qu'il failloit honorer le Medecin puis que ceſt luy qui (parlant humainement & ſuiuant la proportiõ qu'il faut auoir aux ſecondes cauſes) peut nous remettre la vie au corps, ainſi que ie me ſouuiens auoir ailleurs declaré aſſés amplemẽt. Et neãmoins ie trouue par le prouerbe, qui trotte en la bouche d'vn chaſcun, que la chance eſt bien virée, dautant que, ſuiuant iceluy,

MMMMm iiij

Abu Ali ibn Sina (Avicenna) – physician. Illustration from the book by A. Tieu, chapter 134. 16th century

So, why was Ibn Sina "crowned" and recognized as a king/monarch in Europe? Was it because, as our Uzbekistani historians claim, the scientist was considered the "king of doctors" in the West?

In this regard, our opinion is as follows: it was not the original manuscripts of Ibn Sina's works that reached Europe, but rather those copied by the scholar's contemporaries or later copyists. In these manuscripts, the scholar's name is often accompanied by the words "Sheikh ul-Ra'is" (chief of the sages) or ar-Ra'is (chief). Gerard of Cremona, the main translator of Ibn Sina's works, repeatedly wrote this word as *"Rahis* " and *"Rase"* and used the word *"Rex* " as its Latin translation. Translated from Latin, this word means *a high-ranking person, "noble* ." At the same time, this term also means *"king"* and *"prince* ." In our opinion, the words *"rex Avicennae* " used in the translation were read by some European historians as *"king Ibn Sina*". The fact that the text indicates that the place of translation was *Hispania* (Spain) led to Ibn Sina being called the king of Cordoba or Seville.

Engraving by Giacomo Franco (1550–1620) depicting Galen, Avicenna, and Aetius alongside Hippocrates in an edition of his works prepared by J. Mercuriale (1530–1606) (Published by Giunta (Venice, 1588)

In Europe, comparative studies of the texts of translations created in the second half of the 11th to the 13th centuries with their Arabic copies or other Arabic-language sources began at the end of the first quarter of the 16th century. Of particular importance in this process is the work of Johannes Leo de' Medici (1494–1554), entitled "De viris quibusdam Illustribus apud Arabes" ("On Some Famous Men Among the Arabs"). The author, who was proficient in Arabic and Latin, compared sources in these two languages and, in his work, attempted to write biographies of scholars of the Muslim East. Leo de' Medici, relying on Arabic sources, including the work of Ibn Khallikon (1211–1282) "Wafoyat al-a'yan wa anba' az-zaman", refutes the myths about the personality of Ibn Sina, widespread among Latin authors, and makes corrections to the Latin biography of the scholar. In particular, the author emphasizes that *Latin writers call him* [Ibn Sina] *the king of Cordoba* [or Seville, Bithynia], *which is incorrect, since there is no information about this in the sources* (*Et quod dicitur inter latina lampentes quod Rex chordube fuerit, mendacium est, quoniam non inuenitur apud scriptores eius uitae latina lingua*).

It's worth noting that Leo de' Medici, unlike biographers of his time, was the first to clearly and precisely identify the region where Ibn Sina worked, stating that he *died in Hamadan, Persia, but that he was not born there*. Leo de' Medici's work is particularly noteworthy as a book in Latin containing information on 31 medieval Muslim scholars. Furthermore, this work was the first attempt to identify the Latin translations of Muslim scholars' names common in Europe and thereby reconstruct their actual biographies.

Furthermore, this work, the original manuscript of which is preserved in the Medici Laurentian Library in Florence under the No. Ms. Hist. Litt. 7/68 Bl., asserts that the translator of scholarly works is guilty of disseminating fabricated information in Latin sources depicting Ibn Sina as a king (*In culpa magis est qui librum Auicenne in latinum transtulit*), and points to the correct solution to this problem. However, Leo de' Medici failed to clearly substantiate his position on this matter. We have outlined our thoughts on this matter above.

As a result of the identification of the names and works of Muslim Eastern scholars by Arabists such as Leo de' Medici, Muslim Eastern scholars, including Central Asian thinkers who had been portrayed in Europe as Western scholars, began to be perceived as Eastern scholars again from the late 16th century. For this reason, in the next edition of the Canon of Medicine, published in Venice in 1595, Ibn Sina was depicted for the first time as an Eastern Muslim scholar (Fig. 8-8a).

The results of the analysis of Latin sources allowed us to draw the following conclusions on the issue under consideration:

Firstly, the reason why Ibn Sina is described as a monarch in Latin sources is that European scholars, unfamiliar with the true biography of the scholar, actually considered him to be a real king until the beginning of the 16th century;

Secondly, the reason why the myth of King Ibn Sina entered into scientific circulation in Europe was the word "rex" (king), which was used as a Latin translation of the word ar-Rais, used to glorify the scientist;

Thirdly, the widespread idea in our domestic literature that Ibn Sina was figuratively perceived in the West as the "king of doctors" and that for this reason the scientist is depicted wearing a crown is the result of a one-sided view that is not supported by an analysis of Latin-language sources.

Illustration for Avicenna's treatise "The Canon of Medicine" — Svetlana Boiko

On Images on the Tombstones of the Daud-Ata Mazar

Bakhtiyor Babajanov
Doctor of Historical Sciences

As early as the late 1980s, during a survey of inscriptions (epigraphy) on tombstones at the famous Langar Ata *mazar* in Kashkadarya (Chirakchi District), I discovered on one of the tombstones an image of a sabre and a water jug (*aftoba*) used for ritual ablution. This was an isolated case. However, only two years ago, during an examination of Arabic-script epigraphy at the Daud Ata *mazar* in the Kungrad District of the Republic of Karakalpakstan, twelve tombstones dating to the second half of the 19th and the early 20th centuries were identified. These tombstones, made of brown sandstone, feature images of weapons (rifles, knives, sabres), a vessel for ritual ablution (*aftoba*), women's jewelry, and other objects (Fig. 1).

At the same time, wall paintings were discovered inside several mausoleums from the same period, depicting imitations of *suzani* embroidery, as well as images of a *samovar* and a tray with four teacups placed on saucers (Fig. 2). These drawings are amateur and rather schematic in nature. Of particular interest is the discovery on the floor near the entrance of a horse skull and a cloth doll shaped like a small child. Nearby were partially decayed remnants of food in a plastic bag (Fig. 3).

The presence of a horse skull inside the mausoleum is evidently not accidental and recalls numerous nomadic burials in which warhorses were buried alongside the deceased. Although it is hardly possible to speak of a direct continuation of this tradition, the similarity in meanings allows us to consider the persistence or periodic revival of cults of totem animals that played an important role in the life and economy of society—in this case, nomadic ethnic groups inhabiting the territory of present-day Karakalpakstan.

As for the appearance of cloth dolls at necropolises, the custodian of the *mazar* explained that they are made and left in cemeteries and mausoleums by women whose small children (or grandchildren) have fallen ill, or by young women suffering from infertility, who thus ask the spirits of saints for a child. Similar customs among the peoples of Central Asia have been described by ethnologists.

The images on the tombstones and within the interiors of the Daud Ata necropolis mausoleums resonate strongly with similar drawings found on memorials in modern Kazakhstan, the Caucasus, and the Pre-Caucasian steppes. Researchers of Caucasian materials tend to believe that images on tombstones primarily served as markers of the gender and professional identity of the deceased. However, such an approach somewhat simplifies and limits our understanding of the meanings behind the visual presentation of these religious (!) artifacts. In other words, a memorial artifact bearing an inscription or image

Wall paintings, Aitman Mausoleum (after restoration). Photo by D. Mederova

Steles No. 7 and No. 15 of the Daud-ata necropolis.
Photo by D. Mederova

Gravestone No. 77 in the Daud-ata necropolis.
Photo by D. Mederova

Gravestone No. 90 in the Daud-ata necropolis.
Photo by D. Mederova

becomes more than a work of art or a mere object of ethnographic observation.

In the cases presented here, these images may be perceived as a visualized component of pilgrimage to graves (*ziyarat*). For example, the image of a vessel for ritual ablution carries an obvious religious meaning, most likely associated with the well-established legal prescription in all *madhhabs* concerning the "final ablution" of the deceased in order to "appear before the Almighty" in a state of ritual purity. At the same time, the set of images of weapons and related objects on a tombstone evokes associations with the personal qualities of the deceased—his valour, military courage, the prestige of the lineage from which he originated, and so forth. Thus, such reliefs on stone tombstones (among other functions) serve as reminders of the religious and, more broadly, social ethics of the deceased as examples worthy of imitation. Consequently, they may be interpreted as a means of maintaining social ethics, as well as clan and historical memory.

Moreover, we may speak of the direct "participation" of funerary artifacts in the performance of religious practices (as both social and religious acts), since during pilgrimage the images on tombstones literally appear before the eyes of the conditional "viewer" performing the ritual of *ziyarat*. Not only their visual meanings are important, but also their social effects. In other words, the desire to decorate graves (and especially mausoleums) can be understood as a custom intended not so much for the dead as for the living. This includes the descendants' desire to visually confirm the social status of the family or clan, or simply and clearly present symbols of the family's economic well-being and the piety of their ancestors as persons worthy of veneration.

It should be recalled that images on tombstones and especially in mausoleums evoke impressions familiar from more ancient funerary traditions whose origins go back to pre-Islamic times and which persisted, in one form or another, into the Islamic era. Recent studies, for example, show that burials of the 13th–14th centuries, primarily of the aristocracy and middle class of Islamized nomads of Eurasia (the Kipchak steppes and the Pre-Caucasus), invariably included grave goods: weapons, jewelry, cauldrons, and other utensils.

Therefore, the depiction of household objects on the interior walls of mausoleums appears to be genetically linked to nomadic burial customs involving weapons, jewelry, and inventory. One of the historians of Amir Timur (1370–1405), Ibn Arabshah, left valu-

Exterior and interior of mausoleum No. 32
in the Daud-ata necropolis.
Photo by B. Useinov

Exterior and interior of mausoleum No. 32 in the Daud-ata necropolis.
Photo by B. Useinov

able information about the construction and interior decoration of the mausoleum and crypt of *Sahibqiran*, today known as the Gur-e Amir in Samarkand. According to him, immediately after Timur's burial, the deceased's gold-embroidered garments were placed

Drawings in the interior of mausoleum No. 32 of the Daud-ata necropolis.
Photo by B. Useinov

on his grave, the floors were covered with carpets, and the walls of the mausoleum were hung with richly decorated weapons, military equipment, gold and silver vessels, and other items he had used during his lifetime.

When Shah Rukh Mirza (ruler of Khorasan, 1377–1447) captured Samarkand in 1409, he ordered that all weapons, clothing, and other items be removed from the mausoleum and transferred to the treasury. Ibn Arabshah explains this decree by Shah Rukh Mirza's adherence to Sharia, considering such customs questionable from a religious standpoint. Nearly a century later, a historian of Bukhara also briefly mentioned the burial ritual of Ubaydallah Khan (1511–1539), whose mausoleum walls were likewise adorned with his weapons and other belongings. The most rigorous members of the Bukhara ulama insisted on their removal, interpreting the custom as a violation of religious norms.

Setting aside the assessments of Ibn Arabshah and the Bukhara *ulama* with their strict religious purism, it is worth recalling the ancient customs of Turkic and other peoples to place weapons, jewelry, and household items in graves. Archaeologists frequently find such burials, including in the territory of present-day Uzbekistan, and usually interpret these practices as a tradition of sending the deceased into the afterlife "with their weapons and provisions."

At the very least, the resurgence of such customs during the Islamic period compels us to interpret these written accounts as conservative and symbolic atavisms, whose invisible thread stretches back into antiquity. Alternatively, we may speak of a natural revival (inheritance?) of ancient traditions—providing

Drawings in the interior of mausoleum No. 32 of the Daud-ata necropolis.
Photo by B. Useinov

the deceased with a minimum of comfort in the other world. In any case, in the confrontation between ancient customs and religious prescriptions, the latter retained a dominant role in shaping burial structures, rituals, and forms of veneration. Nevertheless, ritual practice itself (modes of veneration, forms of tombstones, etc.) has always preserved ancient—here, pre-Islamic—traditions that blended with religious prescriptions, introducing a certain degree of syncretism into religion.

As the American anthropologist Meredith McGuire aptly stated, "the practice of any religion is a complex mixture of traditional beliefs, norms of dominant religious teachings, and personal improvisations of social groups."

It should be noted that descriptions of the "decoration" of the mausoleums of Amir Timur or Ubaydallah Khan are rare instances recorded in written sources. However, the inertia of ancient customs manifested itself to varying degrees in the funerary practices of Mawarannahr, especially among Turkic clans.

In later periods, the custom of hanging weapons and clothing on the walls of mausoleums was transformed into stylized drawings of these objects. Thus, we may speak of continued traditions that persisted despite the prescriptions of canonical religious doctrines, whose perception and interpretation varied across societies. For this reason, scholars of Islam speak of local forms of Islamic practice that were more tolerant of customary law (*urf wa adat* – customary law).

It should also be recalled that relief "petroglyphs" depicting household objects or weapons on decorated

Horse skull and rag doll in the interior of mausoleum No. 32. Photo by B. Useinov

stone tombstones are clearly visible and immediately catch the eye of visitors to such *mazars*. Consequently, this group of images was intended for a potential viewer, especially during collective pilgrimages (*ziyarat*). The subjects of these drawings are simple and easily recognizable, though they undoubtedly remain within the interpretive domain of folk art anthropology.

A second type of imagery—paintings and reliefs—is located inside mausoleums, access to which is extremely limited. These images are literally hidden from public view and therefore can hardly be inter-

Interior of mausoleum No. 47 in the Daud-ata necropolis. Photo by B. Useinov

Facade of mausoleum No. 47 in the Daud-ata necropolis.
Photo by B. Useinov

preted in the same social contexts as the images on tombstones.

Inaccessibility to public view (concealment from the eyes of strangers) once again brings to mind pre-Islamic burials with weapons, inventory, etc., in which the objects that the deceased was "gifted" with were also hidden from view (buried/walled up) along with the deceased. Thus, this custom is deeply rooted in ancient notions of "provisions for the afterlife," to which the deceased was accustomed in this world. In this sense, the images within the interiors of closed *mazars* are intended, conditionally speaking, not for the living but for the dead, and therefore may be regarded as conservative and symbolic atavisms whose invisible thread also stretches back into antiquity. Alternatively, they may represent a natural and periodic revival of ancient traditions—providing the deceased with a minimum level of comfort in the other world.

At the same time, another interpretive context should not be excluded when considering these colorful images shrouded in the semi-darkness of mausoleum interiors. This concerns the status of the inner quarters of dwellings, into which outsiders are forbidden to enter. It is no coincidence that among many Turkic peoples (especially nomadic ones), both a dwelling and a burial place (together with its superstructure) are designated by the same term, *jöy/jay*. This once again encourages us to perceive the inner chambers of the "final dwelling" as closed to outsiders' eyes, yet arranged as comfortably as possible, both in terms of everyday utility and minimal but vivid aesthetics—that is, decorated in full accordance with the standards of residential interiors.

In other words, one may speak of a certain utilitarian dimension in the meaning of these images. Such an interpretation does not alienate us from the contexts and meanings invested by the creators (craftsmen, architects) and their presumed patrons when sending their deceased into the "other world." If we accept the most straightforward explanation—the desire to equip one's ancestor in the "otherworldly room" with items of comfort (*samovars*, cups with saucers), clothing, elements of interior aesthetics (images of carpets and *suzani*), and even jewelry—then we must acknowledge the very earthly (and thus social) motivations of the creators and patrons of the images within mausoleums.

This is especially evident given that these customs were repeated over centuries, as indicated by rare descriptions in sources and, above all, by surviving mausoleums of the 19th and early 20th centuries.

Structures built by the Bukharan emirs abroad

Emir of Bukhara Said Abdulahad Khan in Livadia, Crimea, 1909

Zilola Khamidova,
chief specialist of the Bukhara State Museum-Reserve

In particular, the buildings constructed by the last emirs of Bukhara have been well preserved to this day. Palaces and mosques were built by skilled craftsmen of their time according to carefully thought-out designs, combining various Eastern, Moorish, and Arabic styles, as well as a number of other styles. These structures have lost none of their beauty to this day.

Between 1885 and 1910, Emir of Bukhara Said Bakhodir Abdulahad Khan frequently traveled to St. Petersburg, Moscow, and Crimea with his family and courtiers. The emir began constructing residences, choosing the most beautiful locations with fresh air and mineral waters, in resort towns such as Yalta, Kislovodsk, Pyatigorsk, Zheleznovodsk, Orenburg, Krasnovodsk, and Astrakhan.

Archival sources indicate that Emir Abdulahad Khan financed the construction of hotels, *taqyas*, *khanaqas*, *rabats*, residential buildings, shops, madrassas, and mosques in Mecca and Medina. At the beginning of the 20th century, the total value of property donated by the Emirate of Bukhara to the cities of Medina, Mecca, and Istanbul was 735,000 gold rubles.

According to available information, Emir Abdulahad Khan personally oversaw the construction of two hotels (hostels) for pilgrims in the cities of Mecca and Medina. The hostel built by the emir in Mecca is located on Shamil Street, and the hostel in Medina is located on Babul Mosque Street. Furthermore, Emir Abdulahad Khan, who enjoyed the trust of the Russian tsars, received permission from the rulers of Russia to construct Muslim buildings and structures in various cities across vast Russia. Emir Abdulahad Khan also built a mosque in St. Petersburg, the capital

The Summer Palace of the Emir of Bukhara

The palace complex of the Emir of Bukhara in Yalta, on the grounds of the Yalta sanatorium

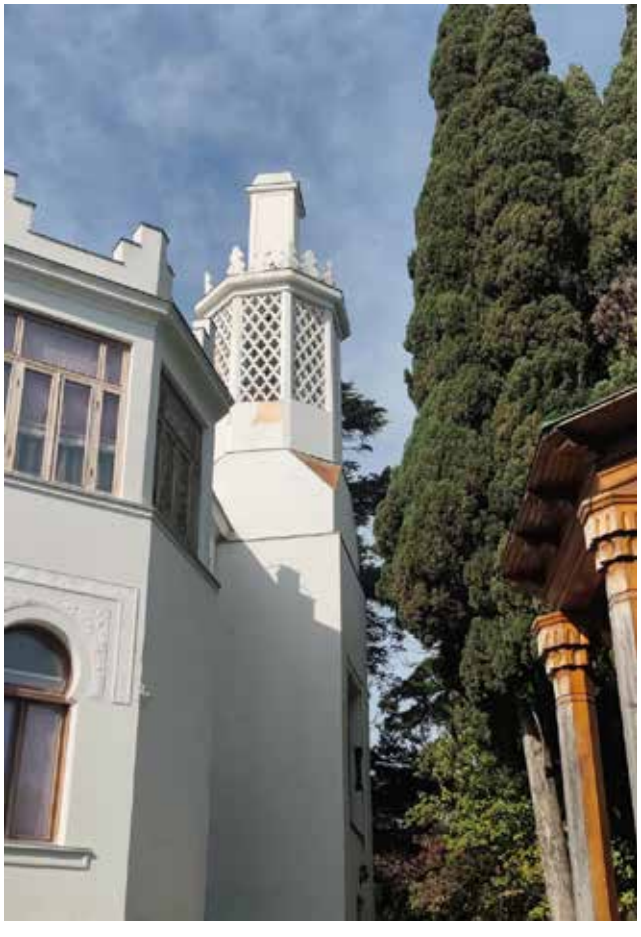
of Tsarist Russia, so that Muslim merchants and travelers could perform prayer, one of the main duties of a devout Muslim.

In 1881, Prince Abdulahad Khan, son of Emir Muzaffar Khan, who was present at the coronation ceremony of the Russian Emperor Alexander III (1881-1894), appealed to the Tsar for permission to build a mosque. However, for various reasons, this proposal remained unanswered. The issue was revisited 13 years later, when Abdulahad Khan had already ascended the throne. A plot of land was allocated for the construction of a cathedral mosque, and a competition was held among renowned architects to design the best mosque. Construction work began according to the design of the renowned architect N.V. Vasiliev. Vasiliev was assisted by S.S. Krichinsky and the architect A.I. von Hohen. Under the supervision of these venerable architects, the mosque was built in the Moorish style, also combining Baroque, Empire, and Arabic styles; with the participation of skilled craftsmen from Bukhara and Russia. Construction work continued until 1914. The Emir of Bukhara donated a valuable hand-woven carpet measuring 400 square meters for the mosque's central hall. The mosque's 39-meter dome and 48-meter minarets on either side add to its special beauty and grandeur.

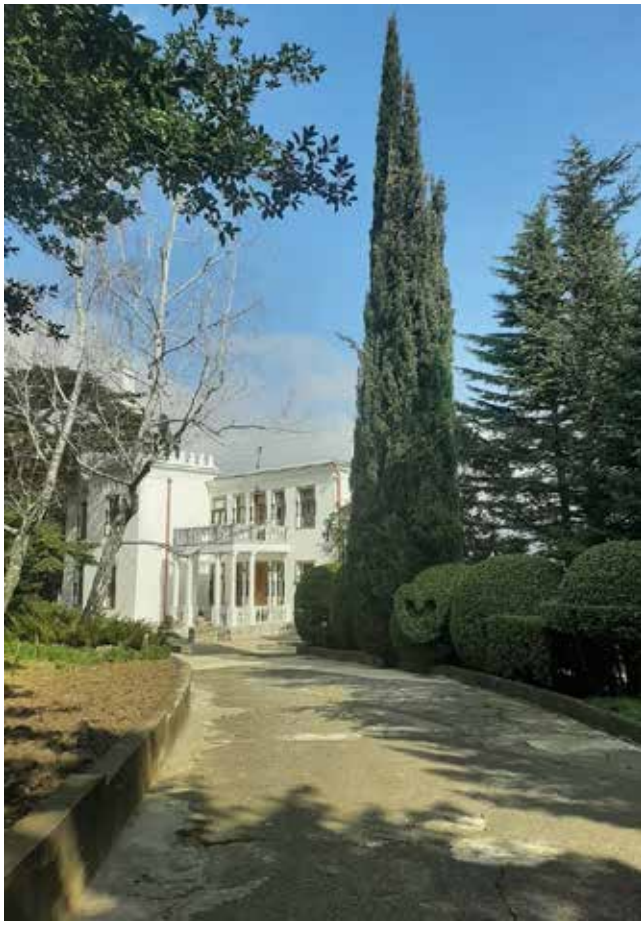
Time has taken its toll on this magnificent building. In the 1950s, fragments of the majolica decoration on the lower sections of the north and east portals were lost.

Religious rites in the mosque resumed on January 18, 1956. In 1968, by decision of the Leningrad City Council Executive Committee, the building of the cathedral mosque was placed under state protection as an architectural monument.

Since 1956, the Cathedral Mosque has been used by the Muslim community of St. Petersburg as a religious and educational center. The mosque's interior has been preserved to this day: the first floor houses



The Summer Palace of the Emir of Bukhara



The Summer Palace of the Emir of Bukhara

a large hall where men pray, the second floor is reserved for women, and the third floor houses Sunday schools (madrasas) where Arabic and Tatar languages are taught, as well as the fundamentals of Islam.

However, the building itself has survived to this day, having suffered the loss of some elements and also undergone reconstruction.

To this day, this mosque serves the Muslim community of St. Petersburg and visitors to the city for Friday prayers. Even after centuries, this mosque retains its splendor. It serves as a reminder of our homeland to our compatriots abroad and as a way to educate those from other countries about the culture and strength of our country.

And the palace of Emir Abdulahad Khan in Yalta was built on a high hill two kilometers off the Black Sea and was a three-story building. To build a luxurious and beautiful palace, the emir hired foreign engineers. The palace was designed by the renowned architect N.G. Tarasov and built using a combination of Moorish and Oriental styles. Dozens of skilled craftsmen from Bukhara were sent to Yalta to decorate the palace in an oriental style. This palace has also survived to this day in excellent condition. Dear reader,

Mosque in Saint Petersburg, Russia, 1921

Interior view of the Friday Mosque on Petrogradsky Island in Saint Petersburg

during your trip to Yalta, be sure to visit this palace, built by our compatriots!

Another palace of the Emir of Bukhara, in the city of Zheleznovodsk in the North Caucasus, has also been remarkably well preserved to this day. Although not very large, the palace was built in a unique oriental style and is surrounded by an iron fence decorated with Arabic patterns. Lion statues flank the main entrance gate. The exterior of the palace is also adorned with a Moorish-style arch, lancet windows at the top, traditional mosaics of white and blue glazed ceramic tiles, and a balcony surrounded by carved wooden partitions. To give the palace its unique appearance, skilled craftsmen were brought from Bukhara and Khorezm. Construction of the palace began during the reign of Emir Abdulahad Khan and, after his death, was completed during the reign of his son, Emir Said Alim Khan. The palace was gifted to the imperial family. This palace, too, has retained its beauty to this day.

Among the ancient structures that have survived to this day is the palace in St. Petersburg, built by the Emir of Bukhara, Abdulahad Khan, in the final years of his life. The site for the palace was allocated in 1910, and construction was completed in 1913–1914. The palace was built in honor of the emir's heir, Said Alim Khan.

Located at its current address, 44b Kamennoostrovsky Prospekt, the site belonged in the early 1890's to French citizen G.A. Gonet, who planned to construct a two-story building there for the production of bronze art objects. In the 1890s, ownership passed to Cornet E.A. Stobeus. In early 1910, Emir Said Abdulahad Khan decided to purchase the site and build a house there. Emir Abdulahad Khan did not live to see the construction of this palace. He died in 1910 from a serious illness.

The palace was built in the Empire style according to the designs of the renowned architect S.S. Krichinsky. The building's façade is decorated with distinctive round (rusticated) columns.

Along with the buildings constructed by the last emirs of Bukhara in the oriental style, structures built in a combination of other styles still survive.

The Palace of the Emir of Bukhara (Greater Yalta).
Photo: S. Afanasyev

The role of ecological values in environmental protection

Umida Tajieva,
PhD in History

Today, government agencies and civil society institutions in our country strive to combine their efforts to find solutions to environmental protection issues, the rational use of natural resources, and their restoration. The active participation of the general public is particularly crucial in this process.

In accordance with the Decree of the President of the Republic of Uzbekistan "On Approval of the Concept for Improving the Environmental Awareness of the Population until 2030," a comprehensive system of measures aimed at raising the environmental awareness of the population has been implemented. The goal of this Concept is to demonstrate that nature conservation is an important task for every person, to foster a sense of caution and responsibility in the relationship between nature and humans, and to instil in the population, and especially young people, a love for nature and respect for laws governing nature management. To effectively implement the Concept, a roadmap for 2025-2026 was developed, outlining a set of 73 specific measures. Furthermore, the establishment of target indicators in six priority areas aims to foster a generation of citizens with a developed environmental culture and mindset. To address these challenges, it is necessary to develop a legal and methodological framework to enhance the population's environmental awareness, as well as further improve the system of training, retraining, and professional development for personnel.

Technological progress, urbanisation, industrial expansion, and the irrational use of natural resources lead to the degradation of land, water resources, the atmosphere, and biodiversity. In such a dangerous situation, the development of environmental culture and values in society must begin, first and foremost, with the family, which is the first link in the development of a person. In accordance with the Concept for Improving the Environmental Culture of the Population by 2030, special attention will be paid to developing environmental education in the family. Environmental values instilled in families encourage people to live in harmony with nature and make responsible decisions throughout their lives. In fact, the root of environmental problems lies in the human race's carelessness and consumerist mentality. Therefore, it is important to prepare future generations to conserve natural resources by instilling in children a healthy environmental mindset.

Environmental education and upbringing play a vital role in protecting nature, using natural resources rationally, and improving environmental conditions. The environmental situation and the specific uses of nature in different countries are largely linked to the level of environmental awareness and environmental culture of the population.

Environmental values are understood as a system of ethical, aesthetic, philosophical, and practical views expressing a responsible and respectful attitude toward nature, its resources, flora and fauna, and the ecological balance. These values encourage people to recognise the impact of their activities on the environment and consider environmental protection a social duty.

One of the most pressing challenges facing humanity in the modern era is the growth of environmental threats and the growing disregard for the environment. The worsening of modern environmental threats is forcing humanity to

Republican Environmental Championship "New Tree – New Breath"

Concept for improving the environmental culture of the population by 2030

Photo: Art Station

fundamentally rethink its relationship with nature. Environmental awareness is developing sustainably not only through modern technological or political means, but also through historically established environmental values, beliefs, customs, and traditions.

Respect for nature and views on its conservation, which developed in Uzbekistan long ago, are today recognised as a rich source of environmental culture. National values, traditions, and customs play an important role in the system of environmental education in shaping a person's overall worldview.

As is well known, Zoroastrianism deified fire, earth, water, and air, and their desecration was considered a grave sin. The Avesta emphasises the need for a rational attitude toward nature and its gifts, as well as the benefits of agriculture. Earth, water, air, and fire were revered as sacred elements of the universe. Those polluting the environment, streets, and public spaces were subject to severe punishment.

Modern researchers point out that religious sources, particularly the Quran, hadiths, and Sufi treatises, contain ideas offering solutions to environmental problems. Sacred sources call on us to protect the environment, treat animals with compassion, and care for plants. Harmony between man and nature, as well as the connection between spiritual purification and the environment, also play an important role in Sufism. Sufis such as Yusuf Hamadani and Jalaliddin Rumi viewed nature not only as a material but also as a spiritual space.

Through folklore, rituals, and traditions associated with water, environmental culture was passed down from generation to generation. Ethnographic studies show that attitudes toward water are an integral part of national identity. This is one of the important factors in the formation of environmental culture. Environmental culture represents a conscious and responsible attitude toward nature and the environment. It encompasses environmental knowledge, values, skills, and practical activities. The primary goal of raising environmental culture is to foster environmental awareness in society and strengthen responsibility for environmental protection and sustainable development.

In conclusion, it should be noted that environmental protection today is a complex issue with not only ecological but also social, moral, and legal significance. In the context of the global environmental crisis, depletion of natural resources, and the increasing negative impact of human activity on nature, the development and strengthening of environmental values is a key factor in sustainable socio-economic development. From this perspective, solving environmental problems solely through technological or economic measures is insufficient; it is also necessary to instil in people a sense of environmental responsibility and respect for nature.

Environmental awareness, formed on the basis of national values and historical experience, contributes to the establishment of balanced relations between

Republican Environmental Championship “New Tree – New Breath”

society and nature and the preservation of a healthy and sustainable environment for future generations. In this regard, the preservation and development of environmental and natural values should remain one of the priority areas of state policy, the education system and the development of civil society.

In Tashkent, more than 400,000 trees have been included into an electronic database

“Doors of justice” by Ahmadkhon Isoyev

Shokhzod Khushvaktov,
master’s Degree

The role of Samarkand artists in the visual arts is becoming increasingly evident. In particular, similarities in colour palettes and formal criteria based on specific views can be seen in the works of Khurshid Khalilov, Nuriddin Isaev, Ramiz Khojaev, and Akhmadkhon Isoyev. At the same time, it is worth noting that Samarkand artists strive to create a balance between local flavour and modernity, combining their cultural and ethnic characteristics in their artistic creations. Such local characteristics are increasingly reflected in contemporary Uzbek art. This process can also be observed in the works of Karakalpak artists.

The language of metaphor and hidden meaning is becoming an important experimental tool, defining the characteristics of contemporary Uzbek painting. This distinctive artistic style is characteristic of the paintings of Samarkand artist Akhmadkhan Isoyev. Elements and attributes of ethnic symbolism play a prominent role in his works, interpreted in muted colours and creating an atmosphere of mystical unreality.

Isoyev’s work clearly conveys the unique visual characteristics of Samarkand’s ancient culture. The distinctive aura of his paintings is not the result of random aesthetic choices but rather of a deeply thoughtful and heartfelt approach to the ethnocultural and artistic heritage of his native land. This ethnocultural layer is inextricably linked not only with historical memory but also with contemporary social realities. The world of his paintings is shaped by the historical and cultural layers of the East, which largely determine the moral, social, and aesthetic qualities of Akhmadkhan Isoyev’s paintings. The appeal to the everyday life and culture of the East as an ethnographic object (L. Bure et al.) or an exotic land (A. Nikolaev, A. Volkov, and others) was observed in the work of a number of Russian and local artists as early as the early 20th century. In contrast, in A. Isoyev’s paintings “Hayot” (“Life”) and “Bezovta” (“Anxiety”), the phenomenon of the Eastern worldview as a cultural and socio-moral space, perceived and experienced from within by the artist himself. Often these observations, characteristics and assessments appear pessimistic and are painted in negative tones. Such are his works, “Nafs” (“Insatiability” - 2022), “Qurbonlik” (“Sacrifice” - 2022), “E’tiqod” (“Faith” - 2023), “Adolat eshigi” (“Doors of Justice” - 2024) and others.

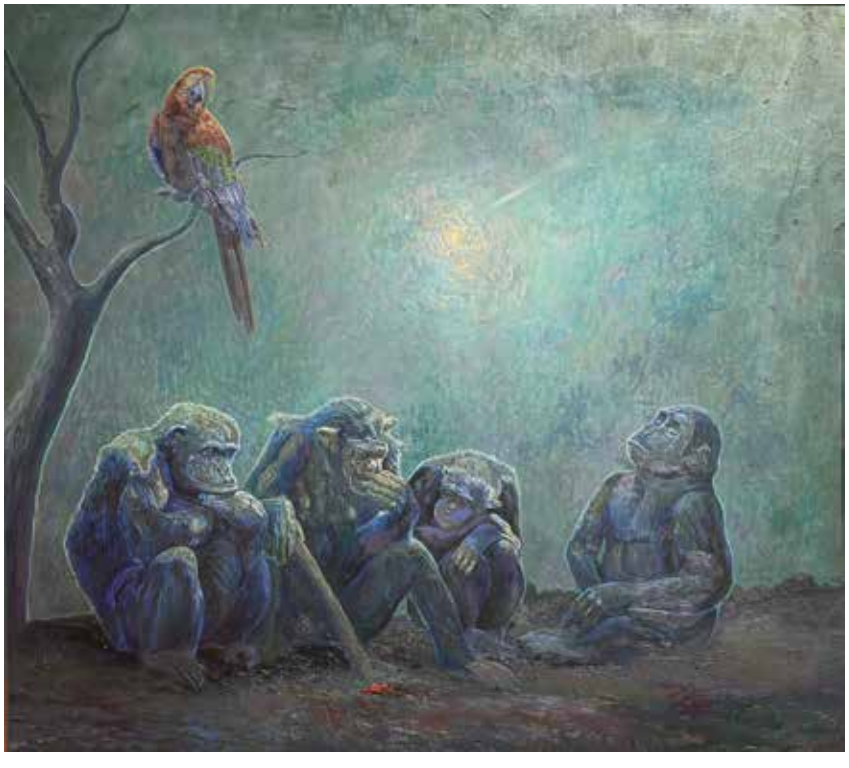
Isoyev’s creative credo emerged within the framework of contemporary art as a cultural and ethnic language that expresses the inner spiritual state of society. As a result, narrative or immediate plot elements and their interrelations are of primary importance in Isoyev’s works. It is through these

Anxiety. 120×160 cm, oil on canvas. 2024

Life. 120×150 cm, oil on canvas. 2024

Lust. 90×120 cm, oil on canvas. 2022

Sacrifice. 66×80 cm, oil on canvas, 2022



_____. 90×100 cm, oil on canvas, 2023

formal means of expression that he embodies the cultural state of contemporary society, historical continuity, and the search for identity. A. Isoyev's work is dominated by his individual vision of contemporary events and human characters.

At first glance, Akhmadkhon Isoev's works may seem surreal and fantastical, but they are all based on real life, on real human situations. The artist's visual language is constructed through clear, symbolic elements. In his works, he used everyday details as visual equivalents of concepts such as justice, faith, passion, and sacrifice. In these works, the viewer is confronted with questions of morality. These symbols are vaguely drawn, yet they are nevertheless legible. Without referencing any religious truth or generally accepted rules, the artist defines this as a moral test. The human image, as interpreted by A. Isoyev, is often depicted as absent or alienated. This absence is an artistic reference to the loss of responsibility, not the loss of identity. In the works "Beamal" (2023), "Nafs" (2022), and "Adolat" (2022), the replacement of humans with animals, mechanical beings, and inanimate objects demonstrates the destruction of anthropocentrism. If a person renounces moral choice, they also lose their superiority as a social individual.

In recent years, the artist's work has undergone significant changes. Although the symbolism remains, they are no longer signs bearing a clear meaning but have transformed into images of state. Now, instead of asking, "What do the works imply?", the question arises, "In what state am I in front of this painting?"

The heart that is near
110x150, x/m. 2025

Fragment of the painting "Faith". 100×120 cm, oil on canvas. 2023

This reflects the profound significance of postmodern thinking—meaning lies in experience, not in symbols.

While abstract ethical questions dominated the artist's work from 2022 to 2024, in his recent work, these aspects take on a more materialised, real-world quality. No longer does the artist question justice or faith, but rather reveals the inner emptiness of a mind that lives without them. "Dialogue" (2025) is not a conversation, but a space of disunity; "Face" is not a person, but the dissolution of identity; "Heart Beside Me" (2025) is not a symbol of love, but a faint, trembling presence of intimacy.

From a technical perspective, this evolution is also evident. In his early works, form and composition were controlled, and figure and space were clearly distinguished. In his later works, contours blur, colours merge, and the boundaries between space and figure disappear. The artist combines the spirit of Fauvism with the experimentation characteristic of Cubism. Perhaps in this way, the artist is exploring the abstract forms of human nature. A. Isoyev strives to make people feel an idea, rather than display it. In this process, colour also changes its function. Whereas previously colour carried a semantic load, now it creates a psychological atmosphere. Colours do not convey information but create psychological pressure. Light, meanwhile, appears more as an opportunity than a symbol for guidance. This is consistent with the widespread Islamic belief that "guidance is not obligatory."

The evolution of A. Isoev's style is reflected not in the exchange of these themes, but in the level of its internal complexity. If we trace the chronology of his research, his latest works exert a powerful intellectual impact through silence. The artist's work reflects a shift from symbolic critique to existential reflection. In contemporary art, an artist's identity is often not linked to geographic or ethnic characteristics but rather to their cultural and spatial experience. A. Isaev creates works that reflect a space formed in an Islamic environment and imbued, at the level of everyday consciousness, with religious rituals, moral norms, and symbolic thinking. This sense of belonging is expressed not through external influences or embellishments, but rather through an internal cultural memory and way of thinking.

Isoyev interprets Islamic symbols not as ready-made truths or means of identification, but as a field of problematic and open questions. He does not depict faith but rather demonstrates how complex, ambiguous, and internal a process living within faith has become. The freedom of technique, the blurring of form, and the absence of a direct conveyance of meaning are among the most important signs of the artist's creative maturity.

In conclusion, it can be said that this artist's work lies at the intersection of cultural memory and contemporary postmodern thinking. The artist neither rejects tradition nor presents it as absolute truth. In a sense, he also retains utopian notions of a future society. As a result, his work embodies one of the most important principles of contemporary art: asking questions, maintaining uncertainty, and providing opportunities for inner reflection.

Eureka – the Choice of Young Scientists

Alo Isakova,
Executive Secretary
of the Science Promotion Center

Science is a multifaceted concept. Science encompasses everything in our world and the universe. Science doesn't just answer questions; it enables many fantastic ideas to become reality. Science is a means of communication, the transfer of information, and the foundation for the development and understanding of the world around us.

In recent years, our country has created extensive opportunities for young scientists engaged in science. The Centre for Promotion of Science of the Uzbekistan Academy of Sciences (hereinafter referred to as the Centre) has also made supporting young scientists a priority. To this end, the "Eureka" competition was organized to encourage and stimulate young scientists aged 18 to 40. The "Eureka" competition was first held in 2023 as an experiment. Over 50 young scientists participated in the competition. Of these, 15 successfully passed the tests and were declared winners. The Centre received several proposals to organize this event on a larger scale. To this end, this year, at the initiative of the Centre and under the auspices of Science and Innovation LLC, the "Eureka" competition was organized at the national level. Previously, only young scientists working at research institutes and centers within the Uzbekistan Academy of Sciences participated in the competition. However, this year, higher education institutions under the Ministry of Higher Education, Science, and Innovation were also included. Thus, applications for participation in the "Eureka" competition began to arrive from across the country. This is undoubtedly a positive development. For the convenience of applicants, a website was created: https://evrika-academy.uz/.

The competition included several nominations in various fields of science:

1) Numbers Rule the World (physics, mathematics, astronomy);

2) Nature and Man (chemistry, biology, zoology, geography, geology, seismology, medicine);

3) The world of technology and information technology (nanotechnology, engineering innovation, artificial intelligence, robotics);

4) Society, history, and culture (archaeology, history, ethnography, philology, economics, law, and art);

5) A special prize for the most talented female and young women scientists working in all of the above fields.

In total, approximately 600 applicants from across the country registered for the preliminary stage. In the second stage, 50 talented young scientists from research institutions of the Academy of Sciences and higher education institutions of the Ministry of Higher Education, Science, and Innovation were selected. The final, third stage took place at the Academy of Sciences. During this stage, special attention was paid to question-and-answer sessions, presentations, and projects submitted by applicants. The significance of the young scientists' contributions to the advancement of science, as well as to the development of new methods and advanced technologies, was determined based on the level of their scientific achievements and

EUREKA 2025 Award Statue

The EUREKA 2025 awards ceremony. Director of the Centre for Promotion of Science of the Uzbekistan Academy of Sciences, Academician A. Khakimov

Zukhra Israilova, first-year postgraduate student at TSUULL, won second place in the "Active Young Women Scientists" category of the EUREKA 2025 award

the potential for future application of their research. Thus, a total of 15 winners were selected in five fields. An additional category, "Best Innovative Project," was established at the initiative of the organization "Science and Innovation" for promising projects, and five individuals were recognized as winners in this category. On November 12, 2025, the following young scientists were awarded the prizes at the awards ceremony:

- in the nomination "Numbers Rule the World" following places were taken -

1st place - Madaliev Murodil Erkinjon o'g'li, 2nd place - Bakhtiyor Nurullaevich Madaminov, 3rd place - Diyorbek Ziyodullo o'g'li Isakov;

- In the "Nature and Man" category: 1st place - Bekhruz Sherboevich Khabibullaev, 2nd place - Fozil-jon Mamaraim o'g'li Turakulov, 3rd place - Gulyakhon Gafur qizi Eshbekova

- In the "World of Technology and IT" category: 1st place - Rustam Khojakhmat o'g'li Tovashov, 2nd place - Sapajan Zakirovich Ibragimov, 3rd place - Alisher Kalbaevich Sharipov;

- In the "Society, History, Culture" category: 1st place - Mokhinur Olim Akhmetjanova, 2nd place - Nilyufar Zaynobiddin qizi Abdurakhmonova, 3rd place - Nilyufar Fayzullakulovna Mamatkulova;

- In the special nomination for girls and young women – 1st place - Makhliyo Mukhammadievna Kozieva, 2nd place - Zukhra Mukhsin qizi Israilova, 3rd place - Muattarkhon Rasuljon qizi Tokhirjonova;

Special prizes in the "Best Innovative Project" nomination were awarded to young scientists Idrisov Khusanjon Abdujabborovich, Kosimov Jakhongir Avlokulovich, Normurodov Dilshod Abdurazokovich, Sayfullaeva Gulkhayo Ikhtiyor qizi, and Yakhyaeva Shakhnoza Ernazar qizi.

Nilufar Abdurakhmonova, a young professor at National University of Uzbekistan, is the winner of the second prize in the EUREKA 2025 award in the category "Society, History, Culture".

Murodil Madaliyev, research fellow at the M.T. Urazbaev Research Institute of Mathematics and Computer Science of the Uzbekistan Academy of Sciences, is the first-degree winner of the EUREKA 2025 award in the category "Numbers Rule the World"

The awards ceremony, held in the Uzbekkino Renaissance building, was attended by winners from all regions of the country, prominent scientists, representatives of the scientific community, and more than 500 young researchers. At the suggestion of the ceremony participants, it was decided to consider the possibility of holding a similar competition at the regional level, inviting young scientists from the fraternal republics of Central Asia to participate.

Winners of the EUREKA 2025 award in the category "Society, History, Culture": 1st place — Akhmetjanova Mokhinur, 2nd place — Abdurakhmonova Nilufar, 3rd place — Mamatkulova Nilufar

Festivals on the way to the development of handicrafts

Nafosat Egamberdieva,
PhD student

In recent years, special attention has been paid to the development of traditional crafts in our country. An important legal basis for the development of this sector is the adoption of Decrees and Resolutions of the President and the Government of the Republic of Uzbekistan on holding the International Festival of Decorative and Applied Arts in Kokand, the International Festival of Gold Embroidery and Jewelry in Bukhara, the International Festival of Traditional Textiles «Atlas Bayrami» (Silk Festival) in Margilan, the International Ceramics Forum in Rishtan, and other events.

In 2025, the 3rd International Crafts Festival in Kokand and the 2nd International Ceramics Forum in Rishtan were held with great fanfare. Furthermore, in November of that year, Khiva hosted its 1st International Carpet Exhibition, which included an International Scientific Conference. International events play a vital role in preserving national crafts, further developing them, promoting them internationally, and enhancing our country's tourism potential and image.

3rd International Crafts Festival in Kokand

In accordance with Decree No. PF-5841 of the President of the Republic of Uzbekistan «On measures to hold the International Festival of Decorative and Applied Arts» dated October 3, 2019, the International Festival of Decorative and Applied Arts has been held in Kokand every two years. The 1st festival in Kokand in 2019 received widespread public attention, attracting approximately 1,000 artisans, as well as approximately 100 art scholars and specialists. In 2021, the 2nd International Festival was cancelled due to the COVID-19 pandemic and was held in 2023, also receiving high praise and enthusiastic responses from national and local experts and the artisans themselves.

The scale and results of 3rd International Festival of Decorative and Applied Arts, held in 2025, demonstrated the growing interest in this forum among international artisans and specialists, confirming its status as an important stimulus for the development of domestic handicrafts. In his congratulatory message to the participants of 3rd International Festival of Decorative and Applied Arts and the International Ceramics Forum, the President of the Republic of Uzbekistan emphasized the importance of the festival and its role in the development of the industry:

«Our country encourages the development of crafts sector, which is an integral part of the rich cultural heritage, national traditions, and values shaped by our people over many centuries, serving as a spiritual bridge between the past and the future. As a result, this sector is becoming one of the most important sectors of our economy. This is confirmed by the fact that excellent opportunities are being created for artisans, craftsmen, designers, and young artisans, and extensive work is underway to bring their products to the global market and promote them as national brands.»

It should be especially noted that in the cities and districts where this industry is developed, 11 craft development centres have been created, the annual production volume exceeds 1 trillion 500 billion soums, and the export of products to various countries of the world is constantly expanding.

The 3rd International Festival of Decorative and Applied Arts was held in Kokand from September 19 to 21, 2025. The event was attended by 278 foreign guests from 70 countries, as well as nearly a thousand skilled artisans, applied arts masters, specialists, scientists, and distinguished guests from our coutry. The areas surrounding the «Urda Oldi» (The Square in front of the Palace) Square, where the festival is taking place, featured not only various craft exhibitions but also displays of handicrafts, works of fine and applied art, antique craft tools and their manufacturing processes, feature films and documentaries, books, albums, and photographs related to this industry. Demonstrations of national costumes, performances by wits and comedians, folklore ensembles, and tightrope walkers further enhanced the impression of the festival's grand scale.

The festival program included a ceremonial procession of participants, an exhibition and fair of local and international artisans, and an international scientific conference on «Global Practices for the Preservation and Development of Traditional Crafts.» The festival program also included a fashion show featuring international and Uzbek artisans and designers and the presentation of the beautifully published book-album «Crafts of Uzbekistan.»

The festival's closing ceremony included a formal awards ceremony for the winners and runners-up. The event was attended by State Advisor to the President of the Republic of Uzbekistan Khayriddin Sultanov, President of the World Crafts Council Saad Al-Qaddumi, and Khokim of the Fergana Region Khayrullo Bazarov, the Minister of Culture Ozodbek Nazarbekov, Chairman of the Republican Association «Khunarmand» Rasuljan Mirzaakhmedov, and Khokand City Mayor Marufjan Usmanov. It's worth noting that artisans with disabilities were invited to the festival, their work was recognized, and cash prizes were awarded.

The winners of the competitions held as part of the festival were awarded diplomas, statuettes, and the following cash prizes by the Organizing Committee:

In the Best Craftsman category - $15,000;

In the nomination "The youngest craftsman" - 10,000 US dollars;

In the nomination "Best Master of the Craft School" - 10,000 US dollars;

In the nomination "Continuer of an ancient dynasty" - 5000 US dollars;

In the nomination "Craftsman who revived an ancient craft" - 5,000 US dollars.

By decision of the World Crafts Council, the cities of Andijan and Shahrikhan were awarded the status of «World Crafts Cities.» According to the results of the International Crafts Festival, the flow of tourists to the city of Kokand increased tenfold, the number of artisans increased 3.5 times, and the number of hotels increased 2.5 times.

The International Forum of Ceramicists is held in Rishtan every two years in accordance with the Resolution of the President of the Republic of Uzbekistan No. PK-5229 dated August 23, 2021 «On holding the International Forum on Ceramic Art and Exhibition and Sale of Pottery Products.»

The 2nd International Forum of Ceramicists also served as a unique platform for creative dialogue

and master classes for young artists. More than 100 renowned potters from 26 countries participated. The forum also included the opening of the Rishtan Museum of the History of Traditional Ceramics. Rishtan, renowned throughout Central Asia as a center of pottery, has been awarded the status of «World City of Crafts.»

The forum's program, as part of the «International Forum of Ceramicists and Ceramic Exhibition», also included a pottery competition, master classes by international and local artists, exhibitions, screenings of feature films and documentaries about ceramics, and workshop tours.

The pieces created by Rishtan's master potters are distinguished by their original design, striking blue and white color scheme, and rich ornamental motifs. Today, these traditions are carried forward to a new level. The International Pottery Centre was founded here. Hundreds of young people are currently learning pottery in Rishtan.

The followers of such master potters as Ibrohimjon Kamilov, Bobojon Nishanov, and Sharafiddin Yusupov are successfully developing traditional ceramics in Rishtan and the surrounding villages. The masterfully crafted works of Alisher Nazirov, Rustam Usmanov, Shokirjan Akhmadjanov, Ravshanjan Tajiddinov, Tokhir Khaidarov, Mukhayo Sattarova, and Yuldashali Palvonov received high praise from international experts and forum guests.

All this testifies to the great attention that our country pays to the development of ceramic art, which is an integral part of our rich cultural heritage, national traditions and values.

International Carpet Exhibition in Khiva

On October 18-19, 2025, the Arda Khiva tourist complex in the ancient city of Khiva in the Khorezm region hosted the international exhibition and festival «Carpet Shine.» The festival's goal was to showcase the millennial art of carpet weaving, the symbolic meaning of traditional patterns and ornaments, and their integration with contemporary design.

The exhibition brought together artisans, designers, and entrepreneurs from across the country, as well as carpet weavers, industry specialists, and art

historians from Kyrgyzstan, Kazakhstan, Tajikistan, Turkmenistan, Azerbaijan, and Afghanistan. The event included master classes and academic discussions, including a craft fair and a display of Khorezm ethnic costumes.

The International Scientific and Practical Conference «Uzbek Carpet Weaving: Traditions and Innovations» discussed advanced techniques, natural dye technology, export opportunities, and new trends in carpet weaving. Master classes were held at the Ichan Kala State Museum Reserve, including carpet weaving exhibits, workshop visits, demonstrations of the carpet weaving process, and hands-on training with artisans.

Following the two-day international carpet weaving festival, the most active participants in various categories were identified.

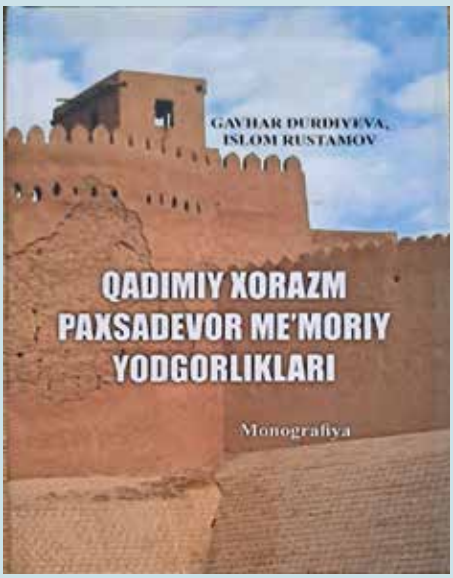
First place in the category «Master who revived an ancient form of carpet weaving» was taken by master weaver Ilkhom Davletov from Margilan.

Despite his young age, Afasadik Suleymanov from Azerbaijan, distinguished by his talent, hard work, and love for the art of national crafts, took first place in the «Youngest Craftsman» category.

Master Madrahim Matkarimov (Uzbekistan) took first place in the nomination “Best Carpet Weaver”.

The International Exhibition «Carpet Shine» has become an important step toward preserving and enhancing the international prestige of carpet weaving traditions, which have long been a national treasure in our country, conducting scientific research, and awakening interest in traditional carpet weaving among the public and foreign tourists.

Exhibitions and festivals are crucial for the creative work of artisans. At such events, they sense the value and worth of their work and draw inspiration from it. Moreover, the socio-political and economic significance of international cultural events and festivals is invaluable – they shape a country’s image and play a vital role in promoting national values globally.



Technology of brown coal enrichment using gravity-flotation method

Scientists from the Institute of General and Inorganic Chemistry of the Uzbekistan Academy of Sciences have published a monograph entitled "Technology of brown coal enrichment using the gravity-flotation method."

This monograph is devoted to the technology of gravity-flotation enrichment of brown coal and scientifically substantiates the technological solutions developed in collaboration with specialists from JSC Uzbekkumir, as well as the composition and chemical processes of brown coal, its processing, and methods for improving efficiency. Experiments conducted on samples of low-quality coal from Angren deposits revealed the possibility of separating mineral impurities, reducing moisture and ash content, and increasing the calorific value by 15-30%.

The monograph demonstrates the advantages of gravity and flotation methods, as well as the effectiveness of the composite flotation reagent SFKM-2 developed by the authors. The compliance of enriched coal with environmental requirements, the use of waste in the construction industry, and the reduction in production costs determine the economic and practical significance of this technology. This technological solution will enable the efficient use of existing low-quality coal reserves in Uzbekistan and ensure energy independence.

Adobe architectural monuments of ancient Khorezm

A very important monograph on the topic "Adobe architectural monuments of ancient Khorezm" was published at the Durdona Publishing House by Doctor of Architectural Sciences, Professor Gavkhar Durdyeva, head of the laboratory "Testing and restoration of building materials of historical architectural monuments of the Southern Aral Sea region" of the Khorezm Academy of Mamun of the Uzbekistan Academy of Sciences co-authored with researcher Islam Rustamov .

It is widely known that Khorezm has long been a center of statehood, science, culture, and civilization, and it was in this oasis that adobe buildings and structures (built using the "*pakhsa*" technology) played a key role in shaping the culture of urban development. The theoretical and practical foundations of modern construction and architecture were laid in the region during this period. More than 100 architectural structures from that period have been preserved in the oasis to this day.

The results of source analysis and research show that the impact of external atmospheric conditions on adobe buildings does not diminish over time. Consequently, year after year, these monuments disappear. Today, adobe architectural monuments are subject not only to natural influences (earthquakes, floods, termite infestations, strong winds, climate change—strong cold and warm air currents, freezing and thawing of mixtures) but also to the negative consequences of human activity (technological impacts, groundwater levels, fluctuations due to transport infrastructure, deteriorating operating conditions, etc.).

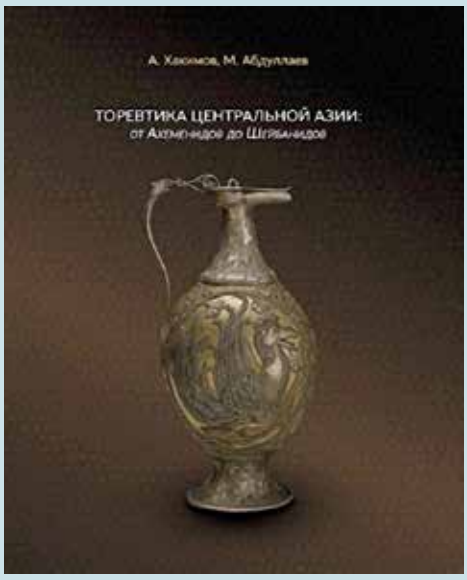
The effective use of adobe monuments in the development of the tourism sector is also of great importance for the economic development of our country. Therefore, it is important that tourists be able to see the 3,000-year-old walls of these monuments in their original form.

As architectural monuments built from clay in the Khorezm region are deteriorating and disappearing due to environmental impacts and human activity, it is crucial to study their history, assess their technical condition, and create a database for their preservation and restoration.

Fauna of vertebrate animals of the Syrdarya and Jizzakh regions

Scientists from the Vertebrate Laboratory of the Institute of Zoology of the Uzbekistan Academy of Sciences have published a collective monograph dedicated to the fauna of terrestrial vertebrates common in the Syrdarya and Jizzakh regions and their monitoring system. This monograph contains descriptions of 260 species, monitoring methods, and an assessment of the regions' conservation needs based on indicator species.

This monograph is a new, scientifically based guide for biologists, ecologists, zoologists, and conservationists, as well as a resource for teachers and students at relevant higher education institutions. This publication marks another important step toward the in-depth study and sustainable management of Uzbekistan's wildlife.



Toreutics of Central Asia: from the Achaemenids to the Sheibanids

A new monograph entitled "Toreutics of Central Asia: from the Achaemenids to the Sheibanids" has been published. It was prepared by scientists from the Institute of Art History of the Uzbekistan Academy of Sciences, Academician of the Uzbekistan Academy of Sciences, Doctor of Art History, Professor Akbar Khakimov and Doctor of Art History, Senior Researcher Masharib Abdullaev.

This publication is based on the results of previous research and analysis of new materials—artifacts of the cultural and artistic heritage of Central Asia. These artifacts were acquired by Uzbekistan at auctions in London and from private galleries for the exhibition and collections of the Center for Islamic Civilization in Uzbekistan. Most of the discovered artifacts are related to toreutics. The main idea of the book is to study the evolution of forms, the semantics of motifs, and the evolution of style in gold, silver, and copper objects in Central Asia from ancient times to the era of the Uzbek khanates.

The monograph was published by the Art Vernissage Publishing House.

Biological Miracle

Freezing Solid

The most remarkable thing about wood frogs happens not in the summer when they transform from tadpoles to frogs, but in the winter when they hibernate.

The northern forests of Alaska and Canada have some of the most dramatic temperature ranges in the world. Summer days stretch to 24 hours and temperatures can climb into the 90's. Winter brings some of the earth's coldest temperatures: it is not unusual to have temperatures of minus 50 degrees Fahrenheit. Prospect Creek, just south of the Brooks Range, had the coldest temperature ever recorded in Alaska—minus 80 degrees Fahrenheit. Almost certainly, there were hibernating wood frogs near Prospect Creek when that record was set.

This is the winter world in which the wood frog must survive. Remember, frogs are cold blooded, so their body temperature is about the same as the surrounding air. How do these delicate little creatures endure the intense, protracted, iron-cold subarctic winter?

This mystery has intrigued scientists for a long time. Biologists have studied wood frog hibernation and what they've learned is truly astonishing.

Most frogs survive northern winters by hibernating deep under water, in ponds, lakes and streams—they are cold and dormant but their body temperature never falls below freezing.

Wood frogs have a different strategy. They hibernate by nestling down into the leafy litter on the forest floor. The leaves, duff and overlying snow give some insulation from extreme cold, but the frogs are not protected from subfreezing temperatures as they would be if they chose the underwater strategy.

Researchers have found that wood frogs spend the winter frozen! This amazing strategy allows wood frogs to become active very early in spring, because the land thaws and warms more quickly than the ice-covered lakes The newly active frogs can mate and lay eggs in small ponds and even in melt water pools that dry up by midsummer. By contrast, frogs that hibernate underwater take longer to become active, so they must breed later. These frogs need permanent water that won't dry out.

For most other animals, survival depends on protecting themselves from any condition that could freeze their flesh. Why is freezing so dangerous? Several things can happen: If ice crystals form inside an animal they can puncture blood vessels. When blood freezes, there is no mechanism to deliver oxygen and nutrients to organs, so extreme metabolic damage

occurs. And ice severely injures cells by drawing out water and causing dehydration, scrambling the interior structure of cells and fracturing the cell walls. The result is pervasive and deadly internal damage.

Yet wood frogs have evolved ways to freeze solid for up to eight months each year. They've accomplished what would seem to be a biological miracle. How do they pull this off?

At the beginning of winter, ice quickly fills the wood frog's abdominal cavity and encases the internal organs. Ice crystals form between layers of skin and muscle. The eyes turn white because the lens freezes.

At the same time, the wood frog's liver produces large amounts of glucose that flushes into every cell in its body. This syrupy sugar solution prevents the cells from freezing and binds the water molecules inside the cells to prevent dehydration.

So on the one hand, the wood frog's body allows ice to form around the outsides of cells and organs; and on the other hand, it prevents ice from forming inside the cells--thus avoiding the lethal damage suffered by most animals when they freeze.

What does a hibernating wood frog look like? There is no muscle movement. No heartbeat. No breathing. For the entire winter, the wood frog is like a lump of hard, frigid, icy stone carved in the shape of a frog. But it's alive, in a state of suspended animation.

In spring, the wood frog thaws from the inside outward. First the heart starts beating. Then the brain activates. Finally, the legs move.

Nobody yet understands what starts the wood frog's heart after being frozen and inert for the entire northern winter. Once the frog is fully thawed, it heads off through the woods to find a breeding pond or other suitable water.

The wood frog is completely undamaged by conditions that would be fatal to nearly all other animals.

Wood Frogs and Humans

Glucose in the wood frog's blood keeps it from freezing during the extreme arctic winter temperatures. This is the same as the blood sugar in all vertebrate animals, including humans.

Hibernating wood frogs can tolerate blood sugar levels 100 times higher than normal without the damage suffered by human diabetics when their blood sugar is only 2 to 10 times above normal. Understanding how frogs can do this might provide valuable knowledge to help in the management of high blood sugar in people with diabetes.

Also, the wood frog's ability to withstand freezing may help researchers discover how human organs used for transplants could be frozen and thawed without damage. This would increase the allowable time between removing an organ from a donor and implanting it within the recipient, which could make many more transplants possible.

Researchers are also interested in how the wood frog's body can stop blood circulation and start it again many months later without blood clots or other injuries. Understanding the mechanism which allows this could be valuable for treating people after their blood flow is temporarily halted by heart attack or stroke.

Gates of the Arctic National Park and Preserve /https://www.nps.gov/gaar/index.htm/

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