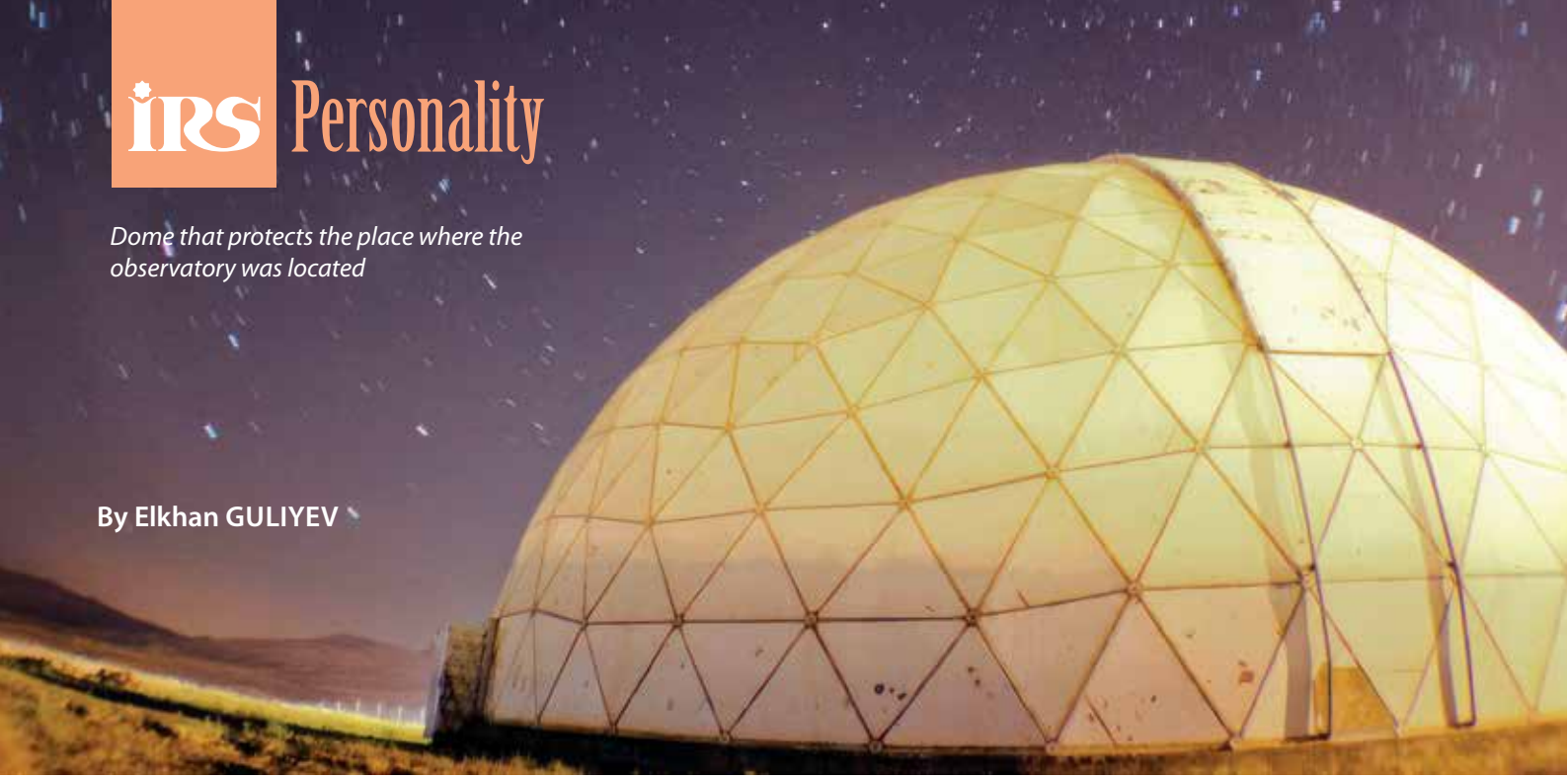


Dome that protects the place where the observatory was located

By Elkhan GULIYEV

KING IN LAND OF SCIENCE: scientist who brought stars to earth

Abu Jafar Muhammad ibn Muhammad ibn Hasan Nasir al-Din Tusi (1201-1274), an Azerbaijani encyclopedic scientist, statesman and «master of humanity», was born in Tus. The outstanding scholar is considered to be the founder and creator of the Maragha observatory. Having spent many years in the city of Tus, he was dubbed «Tusi». Although he was originally from the city of Saveh, located between Zanjan and Hamadan, the scholar was known as Tusi since he was born in Tus.

A number of Nasir al-Din Tusi's works have been translated into the Azerbaijani language from Arabic and Persian. Moreover, the scholar's bibliography has been drawn up at the Institute of Manuscripts named after Muhammad Fuzuli of the Azerbaijan National Academy of Sciences.

The Ismailis kept N. Tusi, who was enjoying an ever-increasing fame, in the Quhistan fortress by their side. Tusi worked alongside Ulaaddin Mahammad ibn Hasan Ismaili and Nasir-ad-Din Abdurrahim ibn Abi Mansur for a certain period of time. He translated Abu Ali Ahmad ibn Mahammad ibn Yaqub Miskawayh's "Tahdhib al-akhlaq wa taṭhir al-a`raq" from Arabic into Persian on instructions from Nasir-ad-Din Abu Mansur. He also added two new chapters to the book, naming it "Akhlaqi Nasiri" ("Ethics of Nasir") to honor Abu Mansur.

Tusi, a world-famous scientist, is considered one of the greatest scholars of the Islamic world. During

the outset of the Mongol attacks, Tusi's scientific, public and cultural activity was of great importance from both the scientific-cultural and political viewpoints. Overall, it is worth mentioning that Tusi made a tremendous contribution to the culture of Azerbaijan and the whole Islamic world. Prior to the Mongol attack, Tusi was involved in scientific work alongside the Ismailis in Khorasan and Alamut either voluntarily or mandatorily. Shabankarai, a historian and scholar who lived during that period, wrote, "They kidnapped Khwaja (Tusi) and took him to the Mulhids' (Ismailis') place."

Prior to the Mongol attack on Azerbaijan, Mongke Khan ordered Hulagu Khan to send N. Tusi over to him after seizing the Ismaili fortress. This indicated that the scientist's wide acclaim had extended as far as Karakorum, the capital of the Mongol Empire. However, Hulagu Khan decided to keep him by his side after capturing the Alamut castle, having witnessed Tusi's particular scientific skills personally.

The Mongols held Tusi in esteem and appreciated his efforts. Their appreciation was primarily due to his excellent knowledge in the area of astrology and astronomy as the Mongols attached great importance to the astrological science and were fascinated with it during that historical period. Henceforth, Tusi started collaborating with the Mongols.

Nasir-al-Din Tusi. Artist N. Ismayilov

F. Rashid al-Din wrote that "Hulagu Khan had issued a decree on that date to build an observatory under the supervision and in a location suggested by Tusi, 'the master of humanity', in order to carry out observation of stars". Furthermore, Tusi chose Maragha for the project, which was followed by the construction of an observatory in line with high standards. Mongke Khan's intelligence and prudence as a ruler played a significant role in this regard. Mongke Khan even resolved some of the outstanding "Euclidean" issues on his own. He issued orders on the construction of a major observatory and instructed his brother to send Tusi to him after defeating the Ismailis. However, Mongke Khan, who was waging fierce battles at the time, assigned Tusi to undertake these efforts in Azerbaijan. The construction work was completed during Hulagu Khan's tenure. A number of scientists closely collaborated with Tusi as part of the project, including Mu'ayyad al-Din al-'Urdi, Fakhraddin Maraghayi, Fakhr al-Din Akhlati, Najmaddin Dabiran Qazwini and others.

Tusi launched the observatory construction in Maragha in April 1259. Moreover, nearly all of the waqf properties (i.e. assets donated or purchased for socially beneficial charitable causes) available throughout the provinces controlled by the Ilkhanids were handed over to Tusi. He visited Baghdad twice, namely, in 1263/662 and afterwards shortly before his death, to collect the equipment and books required for the observatory. Tusi brought a great number of such items back to Maragha.

Following Hulagu's rule, other scientists became involved to complete the project upon Abaqa Khan's instructions. Shortly thereafter, the Maragha observatory turned into one of the major centers of science in Azerbaijan under Tusi's leadership.

Another issue that is worthy of note is clarifying the person who initially put forward the initiative to establish the Maragha observatory. Historical sources tend to offer different views in this regard. However, Rashiduddin Fazlullah wrote in "Jameut Tawarikh" that "a decree was issued on the date in question that an observatory should be built in a location suggested by N. Tusi in order to carry out observation of stars and celestial bodies".

"Khwaja further chose the city of Maragha to do this job, which led to the construction of a high-level observatory," Fazlullah said.

Astronomical instrument of the Maragha observatory. Museum of Science and Technology of the Islamic World. Istanbul, Turkiye

Evidently, the above-mentioned source did not clearly specify whether the initiative to create the observatory was first put forward by N. Tusi or Hulagu Khan. However, a close look at further passages makes it clear that the idea of establishing an observatory in the Mongol-controlled territory was expressed even earlier by Mongke Khan.

"Mongolian ruler Mongke Khan was highly intelligent. He therefore passed a decision to establish an observatory during his tenure," the author said. He wrote further that Mongke Khan had instructed Hulagu Khan while seeing him off to Iran to arrange bringing over N. Tusi following the capture of the Ismaili castle. However, Hulagu's special appreciation of Tusi on the one hand and Mongke Khan's waging battles far from the capital city on the other led to the construction of the observatory in the city of Maragha in Azerbaijan.

Despite the above-mentioned facts, Dr. Shafa Kutubi, a researcher, concluded based on data provided by Mohammad ibn Shakir ibn Ahmad, who died in 764/1362, that the observatory construction was an idea initially expressed by Tusi personally. In his accounts, Kutubi wrote that when Tusi suggested creating an observatory, Hulagu Khan asked him about potential benefits and whether or not the project would allow "preventing future developments".

"In order to answer that, I would have to make a [practical] test," Tusi was quoted as saying. "Please, issue instructions to roll a copper-made boiler down from the highest point of the hill unbeknownst to everyone around."

The requested task was fulfilled. As a result, everyone was terrified except Hulagu Khan and Tusi, who knew exactly what was happening.

"The benefit of astrology is similar to this," Tusi commented. "Thus, people are aware of the developments before they occur. Therefore, they are never afraid of them. Fear is actually a sign of ignorance and lack of information."

Hulagu Khan, who was apparently convinced, reportedly accepted Tusi's offer.

According to Tusi's estimates, the timeframe for building an observatory with capacity to obtain accurate scientific data was 30 years. However, Hulagu Khan insisted on completing the facility within 12 years instead. In an effort to encourage Tusi and his fellow scholars to tackle the project, the Mongol ruler visited Maragha to comprehensively enquire about the construction operations in 1263.

Hulagu Khan had amassed a fortune that included legendary riches captured from the Ismaili fortress as well as Baghdad and other cities. Hence, he allocated

and handed over considerable funds to Tusi for the construction of the observatory. In addition, he entrusted Tusi with managing the waqf affairs (assets slated for charitable causes) of all Islamic countries. Hulagu Khan ruled that one-tenth of the funds acquired from the waqf assets would be spent on the observatory project. Tusi, in turn, properly ensured accurate and efficient management of these resources. In particular, he appointed a representative in each of the cities to collect one-tenth of the waqf property for this purpose. Moreover, Hulagu Khan issued strict orders to provide all the necessary cash and other resources.

Remarkably, astrologer Mu'ayyad al-Din al-'Urdi, who was one of Tusi's colleagues at the Maragha observatory, said "no one but Allah knew the amount of funds that Nasir al-Din al-Tusi received from Hulagu for the construction of the observatory".

"The construction work on the Maragha observatory was completed within 15 years. A book titled 'Zij-i-Elkhani' was written by Tusi and his co-workers and it was subsequently used for a long period of time," Urdi said.

Various devices and equipment used in observatory

According to historical sources, the Maragha observatory was equipped with the most advanced astronomical devices available at the time when it was put into operation. Those devices and equipment were referenced in Mu'ayyad al-Din al-'Urdi's "Muqaddima fi tashihi burhanul-Majesti" ("Introduction to correcting Al-Magest's argument"), a piece of tremendous scientific importance. He was one of the skilled engineers of the researched time period and one of the main members of the six-people-strong team who had been invited to cooperate with N. Tusi.

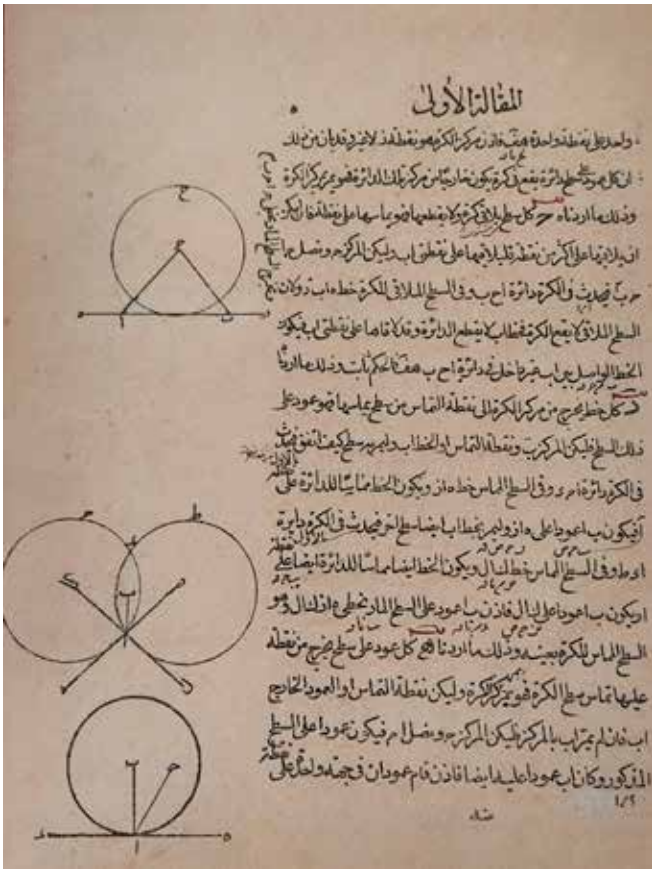
The introductory part of the mentioned piece of work says "the tools and devices developed by ancient scientists for observation purposes were either fragile or insufficiently accurate".

"Those devices were unsuitable for the work being done in terms of their structure," the scientist wrote. "At the same time, they were considered unusable from the practical point of view. Therefore, most of them remained unused. We chose only the useful items. Improving some of the defective equipment, we introduced a number of supplements and changes."

Urdi provided relatively sufficient information in the mentioned writings regarding the basic idea behind the operation of all devices. Some of the words used for observation devices and transliterated from Arabic and Persian include "rabi-yaliba", "zatal-haqq", "alqatu inqilabin", "dastqahi-shunasayi mil falakul-burj", "halqatu etidalin", "zatur-rabiin", "zatul-ustuvanin", etc.

A globe is the only tool of the Maragha observatory currently stored at the Mathematisch-Physikalischer Salon in Dresden, Germany. The sphere was made by Mu'ayyad al-Din al-'Urdi, whose name is indicated upon the item.

In addition to his achievements in various fields of science, N. Tusi's efforts contributed to the Azerbaijani and Islamic culture in two other ways. Preventing the elimination of refined books in the mentioned historical period, Tusi made an incredible contribution not only to the Islamic culture but possibly the world culture overall. As a result of these efforts, hundreds of thousands of scientific works and books were preserved, which resulted in the creation of a great library featuring a staggering number of items. According to the first-ever written sources of that period, 400,000 books were stored in the Maragha library alone.



Manuscript of Nasir-al-Din Tusi's "Si Fasl" (30 chapters). M. Fuzuli Institute of Manuscripts, Azerbaijan National Academy of Sciences. Baku, Azerbaijan

Globe of the starry sky made in the Maragha observatory. 1279. Physical and Mathematical Museum of the State Art Collections of Dresden (Germany). The globe is made of bronze and inlaid with gold and silver

N. Tusi wrote that numerous books brought from Sham, Baghdad, Mosul and Khorasan were sent to the Maragha observatory on Hulagu Khan's instructions.

Tusi also enjoyed the kindness and respect of Hulagu Khan, wielding extraordinary influence. He skillfully used this privilege and subsequently saved a number of renowned scientists from death. Following these developments, Tusi served in the Ilkhanid Palace for the rest of his life, leaving no stone unturned to facilitate the development of Azerbaijani and Islamic culture.

As is known, drastic changes took place in Azerbaijan from the cultural, social, political, economic and ideological points of view following the Mongol attacks, in particular, the Ilkhanid era. A number of cultural, social and religious traditions were abolished and replaced by idol-worshipping beliefs and the rites endorsed by Genghis Khan. Meanwhile, numerous mosques, madrasahs and public institutions funded based on endowments were destroyed and considerable movable assets and real estate were appropriated. However, it was remarkable how Tusi managed to substantiate and explain the importance of restoring Islamic endowments in Azerbaijan to the Mongol rulers. Nevertheless, it is beyond doubt that restoring a host of scientific and cultural institutions devastated in the aftermath of the Mongol attacks would have been unfeasible without the efforts of such prominent personalities like Tusi in the mentioned period.

In addition to astrology and observatory research, scientists were engaged in teaching other sciences in the facility. The availability of a large laboratory in the Maragha observatory indicated that it was a major scientific and academic center. Hulagu Khan ordered to send the books delivered from Sham, Baghdad, Mosul and Khorasan to the Maragha observatory. Ibn al-Fuwati, a well-known historian, who left behind numerous valuable works, was in charge of the library.

As regards the scholars employed by the Maragha observatory, Tusi drew the most outstanding scientists of that time period to the scientific activities. Tusi possessed significant scientific and spiritual capabilities as well as financial resources to pursue these endeavors. Therefore, the scientists invited to cooperate with him were eager to work at the Maragha observatory. The list of well-known scientists who closely collaborated with Tusi at the observatory included, among others, Qazwini Katibi, Ruknaddin Astarabadi, who hailed from Mosul, Fakhr Khalati (from Tiflis), Mu'ayyad al-Din al-'Urdi (from Damascus), Fakhr Maraghayi (from Mosul), Muhyiddin Maghribi, Qotb al-Din Shirazi, Shamsaddin Shirvani, Kamaladdin Iji, Husamaddin Shami, Najmaddin Usturlabi, Sadraddin Ali ibn Nasir-al-Din Tusi, Najmaddin Ali ibn Mahmud Katibi Baghdadi, as well as a scholar known as Gumanji or "Fumanji Xing Xing" from China, Ibn Fuwati Kamaladdin ibn Abdurrazzaq ibn Ahmad Sheybani, Khwaja Shamsaddin ibn Muhyiddin ibn Arabi and Asiladdin Hasan ibn Nasir-al-Din Tusi.

Evidently, some of the mentioned scientists, including Gazwini Katibi, Fakhr Khalati, Fakhr Maraghayi and Shamsaddin Shirvani, had left native Azerbaijan for other countries to continue their studies. The fact that Tusi invited those scientists to Azerbaijan from abroad indicated his great empathy and appreciation of his fellow citizens. On the other hand, Tusi sought to ensure that Azerbaijan's scientific potential and prodigies served their own nation exclusively. In my opinion, such a trend and efforts are continued in present-day Azerbaijan.

As for the fate of the Maragha observatory, it continued operating during the epochs following Tusi's death. According to available sources, the Ilkhanid rulers, in-

cluding Abaqa Khan, Ahmad Tekudar, Arghun Khan, Geykhatu, Baydu, Ghazan Khan and Oljaitu, showed at least some interest in the activity of this great scientific research center. Ghazan Khan's efforts should be particularly emphasized in this respect. Apart from repeatedly visiting the Maragha observatory, he was possibly impressed by its achievements and decided to build a similar scientific center in Tabriz. However, his plan never came to fruition.

According to early historical sources, the Maragha observatory was mainly active 10 to 15 years from its inception. Furthermore, the inactive facility was preserved for 45-55 years, the sources said. Its importance started to decline gradually in this period. Nuzhat al-Qulub author Hamdallah Mustawfi Qazvini argued that the observatory was dilapidated in 1339.

Iranian scholars recently conducted new research regarding the Maragha observatory. Having reviewed available historical sources, they comprehensively studied the construction design of the observatory. According to the outcome of their research, the structure was perfectly suitable for studying all astronomical issues, such as defining the astronomical situation in the daytime and at night, as well as detecting the location of constellations throughout the year. It was also slated for creating images of the earth, researching the height of the North Pole and other significant scientific issues.

N. Tusi remained committed to his scientific activities till the end of his life (672/June 1274). Following the death of the world-renowned scientist, most of the scholars who closely cooperated with him continued working with Asiladdin, his son. Certainly, all these efforts were successful owing exclusively to N. Tusi, an esteemed scholar and encyclopaedist who wielded significant influence in the Mongol court.

Astronomical instrument of the Maragha observatory. Museum of Science and Technology of the Islamic World. Istanbul, Turkiye

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