Ramiz Daniz

The scientist passed ahead of centuries – Nasiraddin Tusi

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Ramiz Daniz ***"The scientist passed ahead of centuries – Nasiraddin Tusi". "MM-S", 2013, 297 p***

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Writing about the remarkable Azerbaijani scientist Nasiraddin Tusi, who has a great scientific heritage, is very responsible and honorable. Nasiraddin Tusi, who has a very significant place in the world encyclopedia together with well-known phenomenal scientists, is one of the most honorary personalities of our nation. It may be named precious stone of the Academy of Sciences in the East. Nasiraddin Tusi has masterpieces about mathematics, geometry, astronomy, geography and ethics and he is an inventor of a lot of unique inventions and discoveries. According to the scientist, America had been discovered hundreds of years ago. Unfortunately, most peoples don't know this fact. I want to inform readers about Tusi's achievements by means of this work.

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Courageous step towards the great purpose

Ramiz Daniz

I'm editing new work of the young writer. This work is an explanation of innovations made by Nasiraddin Tusi in the field of astronomy. The author has explained role of Nasiraddin Tusi's scientific activity in realization of great geographic discoveries in ***"Christopher Columbus, Nasiraddin Tusi and discovery of America"*** written after his previous trilogy. He has written that, Nasiraddin Tusi's works were taken to Columbus's motherland – Italy, Columbus had analyzed them and went to Spain with those materials in order to organize his travel to India. N. Tusi's activity, which supported science in Western Europe and global discoveries, has been discovered in the work. I'm editing Ramiz Daniz's work ***"The scientist passed ahead of centuries – Nasiraddin Tusi".*** What made him to write this book? He has gathered a lot of materials about the scientist's activity and decided to write the second book about Nasiraddin Tusi. He named his work ***"The scientist passed ahead of centuries – Nasiraddin Tusi"***. People haven't been informed enough about works of the scientist written about astronomy, mathematics, geometry, ethics, pedagogy, philosophy and other sciences. So, the author wrote in the book: "… I began to investigate activities of genius personalities of Azerbaijan… Especially activity and

scientific heritage of the notable scientist of Azerbaijan Muhammad Nasiraddin Tusi are very interesting. Though he is an author of very significant scientific discoveries, he isn't known enough in the world". The author expresses his regret and writes that, Nasiraddin Tusi's works have been published by most scientists as their own works. Readers, please, be attentive! The well-known Pole scientist N. Copernicus, who lived 250 years before Nasiraddin Tusi, had written the scientist's theorem "Two circles, diameter of one of which is equal to half of the other one, are on one plane" in his work ***"Rotation of celestial spheres".*** For the first time, this theorem was proved by Nasiraddin Tusi and included in his work ***"Memories about astronomy"***. The wall quadrant used in the observatory of the Dane scientist Tycho Brahe was invented in Maragha observatory as well. Nasiraddin Tusi's devices and works had influenced the development of astronomy and mathematics in Western Europe, Chine and India. But these facts are unknown for us – N. Tusi's countrymen. So, Ramiz Deniz tried to give enough information about Nasiraddin Tusi by means of this work.

The author has used historical facts in order to describe Nasiraddin Tusi's activity. He has analyzed the development of cosmography in the world and mentioned

roles of Azerbaijani scientists and especially Nasiraddin Tusi in this field. He especially investigated Tusi's activity in fields of astronomy, mathematics and diplomacy. The author has proved that, devices invented by N. Tusi are kept in most museums of the world and they had a great role in the development of scientists all over the world. He has named one of headings of the book "N. Tusi's scientific achievements of global importance". He has mentioned that, N. Tusi's ***"Tahriru Uglidis" ("Recension of Euclid's Elements"), "Shaklul-qita"*** and ***"Collection of Counts"*** were basis for the development of geometry. The author has mentioned B. A. Rozenfeld's following thought in order to prove this assumption: "Nasiraddin refused to prove the postulate of parallelism by means of two axioms and postulates and used only one simple postulate and it was an important step for Lobachevski's proof". He has proved his ideas by means of 24 items written at the end of the book.

The work of the writer Ramiz Deniz has been written on the basis of rich materials and it explains influence of the Azerbaijani scientist on the development of astronomy, mathematics, geodesy, ethics, geography, philosophy and other sciences. The work has been written in accordance with ideas of patriotism.

Readers will have an opportunity to read interesting scientific facts very easily. But it is necessary to read it attentively. We name the fifth investigation work of the young innovator writer Ramiz Deniz "Courageous step towards the great purpose" and wish him great future of creation.

The Associate Member of ANAS,
Doctor of geographical sciences,
Professor Eybali Mehraliyev

Preface

I got acquainted with the author of this book in June of 2002. The society of "Education" invited me to the scientific-practical conference about "Scientific services of Nasiraddin Tusi and N. Tusi in the activity of the writer and researcher Ramiz Gasimov (Daniz)" and offered me to make speech about his book ***"Christopher Columbus, Nasiraddin Tusi and discovery of America".*** To say the truth I was surprised when heard the author' name.

Probably, readers know that, R. Gasimov works in the Oil Refining Factory of SOCAR as a worker and isn't high-educated, but I don't want to speak about his autobiography. As the name of the book was too haughty, I investigated the author's previous activity and it turned out that, he is the author of several books and trilogy written in this field. After reading his books I asked myself: Who is R. Gasimov? Is he a writer or researcher and what does he want to gain? I understood that, he has his own style and tries to combine notions of "writer" and "researcher" and is the first author, who has achieved it. For example, he is a researcher in the above mentioned book and books used for this work prove it. Of course, most of issues mentioned in the book are disputable. But the author shouldn't be accused

for it as his purpose was to lay bare the truth by means of discussions and investigations.

R. Gasimov tried to describe different ages together. So, his books resemble scientific annals and historical adventure novels. This style can be considered one of new directions of our literature.

Of course, I'll not describe the book in the preface. But as the acquaintance with books starts in the preface, it will be advisable to describe main purposes of the book. The book, which is about Tusi's activity mainly, includes brief information about main results achieved in fields of geography, philosophy, astronomy, mathematics, physics etc., their history, conditions of development and authors of those results. The activity of the Azerbaijani traveler and researcher Sheikh Muhammadali Babakuhi Bakuvi has also been described in detail. It is important to know these facts in order to understand Tusi's activity. Thus, if you want to learn Tusi's activity, you should learn scientific-social conditions existed in the ancient time and middle ages and role of Eastern scientists in development of world. I think that, the author could overcome this difficult and honorable work.

He has described historical conditions of the age of Tusi, Hulegu khan's victory on Abbasids and mentioned that, he

used advices of scientists before attacking Baghdad. Other skills of Nasiraddin Tusi were discovered after being freed from prison. It turned out that, he was skilful organizer and statesman. He could get permission of the ruler of Mongolia for construction of Maragha observatory and organized this construction. Of course, previous inventions of the scientist had significant role in this achievement. The book includes detailed information about Maragha observatory and scientists, who worked there. The author has compared ***"Zij-i Ilkhani"*** and ***"Zij-i Ulugbek"*** and proved that, the first work wasn't worse than the second.

Scientific achievements of Nasiraddin Tusi also were mentioned in the book. The author has mentioned that, the scientist's ***"Tahriru Uglidis"*** was used as a source by most well-known scientists of Europe. According to the author, Tusi had developed trigonometry as an independent branch of science.

Geographical coordinates determined by Tusi by means of simple astronomical equipments were determined more precisely afterwards. It is known that, the world map was made in accordance with coordinates fixed in ***"Zij-i Ilkhani"*** and America was described on that map. So, R. Gasimov tries to prove that Columbus had used Nasiraddin Tusi's map during the discovery of America. Readers may

ask following question – Was it necessary to write such book about Tusi? The initial answer may be "No". But it is an unconsidered answer. Thus, how many Azerbaijanis have enough information about great Azerbaijani scientist Nasiraddin Tusi? Unfortunately, the answer of this question is certainly negative.

Investigations prove that, H. Mammadbayli's book is almost the only monumental work written about Nasiraddin Tusi. It turns out that, we can get the most detailed information about N. Tusi by means of the encyclopedia ***"Cambridge history of Iran".*** It is a great gap for Azerbaijani science. R. Gasimov gives interesting information about Tusi's activity in mentioned book. It shouldn't be forgotten that, he is a writer and has his own style. I think that, it is necessary to inform readers about the Azerbaijani scientist in an interesting and new way.

As it was mentioned above, the author tries to prove that, the map made by Tusi had an important role in discovery of America by Columbus. This thought should be proved by means of additional researches. So, the author has created new issue for researchers though he is a writer.

The author's style and morphology of sentences are satisfactory, don't tire readers and the book is read easily. All these facts prove that, the author is talented enough,

though he is not high-educated. But education could help him to work on more complicated issues.

R. Gasimov is hard-working writer and so, we can wait for his next books soon. I wish him success.

The Associate Member of ANAS,
Doctor of technical sciences, oceanologist,
Professor Ramiz Mammadov

Ink used by scientists was compared
with blood of martyrs and
scientists' ink was heavier.
Prophet Muhammad

Development of the astronomy in ancient times

Perfect thoughts of sage people are guides to understanding processes, which were incomprehensible for ordinary people for hundreds of years. Almost all scientists have investigated the structure of Earth, biological, physiological and geological processes of the planet and tried to elucidate these global questions since the age of pharaohs'. Improvement of existing science branches, development of the education mechanism support formation of human thinking and increase of intellectual potential. It is impossible to deny that, scientists directly support realization of the dynamical phase according to laws of the nature.

We meet with names of notable personalities of ancient times and early middle ages – Aristotle, Platoon, Eratosthenes, Herodotus, Archimedes, Al-Biruni, Ibn Sina,

Euclid, Strabo, Hipparchus and others in encyclopedias published in every country of the world. Activities and scientific heritages of these scientists have been learnt by international experts and explained to the world community. But sometimes names of authors of significant scientific discoveries and inventions aren't mentioned properly.

After investigating activities of historical personalities having significant roles in intensive development of science, culture, art and literature, I understood that, most personalities' life and scientific heritage haven't been investigated and appreciated properly. I wanted to investigate activities of genius personalities of Azerbaijan. Especially activity and scientific heritage of the notable scientist of Azerbaijan Muhammad Nasiraddin Tusi, who is well-known in the Near East, are very interesting. Though he is an author of very significant scientific discoveries, he isn't known enough in the world. Enough attention isn't paid to scientific works of Tusi – well-known scientist and historical figure of his time, which had special role in development of most branches of the science and they have been forgotten as extinct volcano. That volcano erupted owing to the Professor Habibulla Mammadbayli about 50 years ago. That is, Nasiraddin Tusi, who hasn't been propagated enough because of investigators' indifference

and has been forgotten by most people, began to be remembered at the result of H. Mammadbayli's efforts.

It became clear that, Nasiraddin Tusi wrote masterpieces in fields of astronomy, mathematics, geometry and ethics, played a significant role in development of these sciences and passed ahead of well-known scientists for hundreds of years. He wrote most of his works in Arabic and Persian, but they have been translated into many languages. Unfortunately, only two works of the scientist – ***"Akhlagi Nasiri"*** and **"*Tahriru Uglidis*"** (2002) have been translated into Azerbaijani and presented to readers. It isn't difficult to notice brilliance of N. Tusi after reading ***"Akhlagi Nasiri"***, which is about topical problems of education and morality. This work is immortal, because though it was written 770 years ago, is still used as educational equipment for educating Muslim generations. That is, N. Tusi has a significant role in preparation of pure society in eastern countries. The scientist's works are more comprehensive for their topicality, essence and significance in comparison with works of previous well-known scientists. N. Tusi is one of important personalities of the Muslim Renaissance. He has combined three Renaissance zones of the Near and Middle East in his activity – Arab, Persian and Turkish.

Scientists usually use scientific heritage of their predecessors in order to develop their scientific investigations and discoveries.

Utilization of the ancient Arab culture has been developed since the age of Selevkies in the East unlike Italy and Western Europe, was continued till formation of Islam in the Near and Middle East, so peripatetism became an important criterion of the eastern thinking, philosophers began to be divided into its supporters and objectors, intensive polemics began to be made.

The genius scientist of the east – Nasiraddin Tusi defended peripatetic philosophy of Ibn Sina against criticism of the Muslim theologian Fakhraddin Razi, investigated the polemic about peripatetism between Ghazali and Ibn Rushd.[1]

Many scientists have benefited by Tusi's works and enriched their intellectual potentials using them as a source. Even some of them have demounted his works and published as their own achievements. In spite of it, serious efforts aren't made in order to propagandize N. Tusi and he is being gradually forgotten. That's why I do my best in

[1] Azərbaycan Beynəlxalq Universiteti. Nəsirəddin Tusinin 800 illik yubileyinə həsr edilmiş Respublika konfransının materialları. Bakı, 2001. Professor Y. F. Qaraməmmədlinin məruzəsi, səh. 267

order to investigate scientific activity, achievements and heritage of N. Tusi – honorary scientist of Azerbaijan and whole east.

First of all, I'll give some information about scientific achievements of several well-known scientists of ancient times as they are considered founders and improvers of all sciences, which were known then. Development of mathematics, geometry, philosophy, astronomy and geography was realized by them.

Following questions have been causing people to think since the beginning of civilization on Earth: how did life start on Earth, what is the shape of the Earth, does the Earth have more water than land? At first they thought that, the Earth was only a small territory. But when they began to travel from one settlement to another, understood that it isn't as small as they imagined.

After new settlements and geographical areas were discovered, people began to think that, the Earth is endless. This opinion appeared because there weren't high-speed vehicles in ancient times. All distances were overcome by feet. So scientists of ancient times carried out scientific investigations in order to get information about the shape and area of the Earth.

As years passed, people's thoughts about the Earth and Sky changed. So, astronomy and geography began to be developed and number of scientists investigating these fields began to increase.

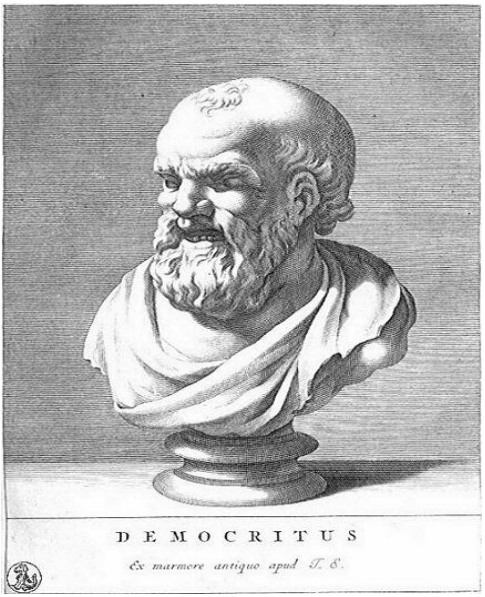
In ancient Babylonia people thought that, the Earth was swollen round island and sailed in the ocean, the universe stood on the Earth as a durable stone, planets and stars had been stuck on it and the Sun revolved around them.

It is known that, scientists of ancient Babylonia could determine solar and lunar eclipses in 18^{th} century BC. It is obvious that, it was necessary to know elements of trigonometry for it. It means that, geometry, mathematics and astronomy had developed in Babylonia.

Scientists as Heraclitus, Democritus and Pythagoras tried to determine movements of celestial bodies in ancient Greek before Aristotle. The Greek thinker Heraclitus (544-470 BC) thought that, the world developed comprehensively.

Democritus thought that (460-370 BC), the universe consisted of infinite number of worlds including collision of atoms. He mentioned that, some worlds formed newly, some were in the stage of development and others disintegrated. Democritus thought that, the Milky Way

consisted of many stars. That's why cosmic explosions occurred in the universe.[1]



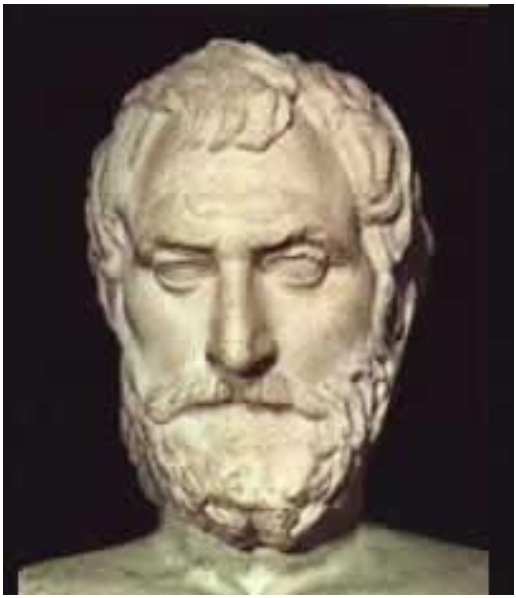
Democritus (460-370 BC)

The Greek scientist Pythagoras (580-500 BC) had got lessons of Hermodamast, philosophers Ferekid and Fales (founder of the first school of philosophy).

Fales, who had received his first education in Egypt, had learned to determine solar and lunar eclipses and geometry

[1] Д. К. Самин. Сто великих научных открытий. Москва, «Вече», 2002. стр. 257

there. He was able to determine the distance between the coast and stopped ship exactly. Fales and his students played special role in spreading knowledge of mathematics and astronomy learned by them in Egypt in Greece.



Fales Miletus (640-556 BC)

The student of Fales, well-known geographer and astronomer Anaximander taught Pythagoras everything he knew (640-556 BC) in Miletus.

Some scientists mentioned that, Anaximander (VI century BC) was an author of the first world geography

map. Probably, he determined sides of the horizon and then fixed poles of the Earth on the map by means of them.[1]

Pythagoras was in Lesbos Island, Phoenicia, Egypt and Babylonia in that period and could enter the building, where historical documents had been kept.

Pythagoras learned astronomy, astrology, medicine and mathematics with the teaching method of Hadley scientists

[1] И. П. Магидович, В. И. Магидович. Очерки по истории географических открытий. I том. Москва, «Просвещение», 1982. стр. 126

Pythagoras (580-500 BC)

when he was in Babylonia.[1] He opened his school in Croton in Sicily Island and declared that, the Earth was round. Pythagoras mentioned that, there were ten planets in the universe. Nevertheless only the Sun, the Moon and five planets were known then (besides the Earth).

[1] Д. К. Самин. Сто великих ученых. Москва, «Вече», 2002. стр.8

Pythagoras mentioned that, the Earth was round and was in the air without any bearing. Aristotle (384-322 BC) had written length of the equator in his work "About the sky" and noted that the Earth radius was equal to 10000 km. He thought that land, water, air and fire were formed of ether and were located on each others as a sphere.

Greeks thought that, the land was surrounded by the ocean and its waters circulated around the Earth as an eternal whirlpool.[2]

Aristotle and his predecessors rejected ideas about the Earth's rotation about its own axis and its revolution in the universe. They explained it as following: if the Earth rotates about its own axis, wind can carry along everything on the Earth towards the west.[3] Scientists had several arguments about it.

There is no doubt that hypothesises and scientific proofs of ancient times on the astronomy and the Earth's structure simplified work of future scientists. Several works of Aristarchus (320-230 BC) have remained still. He could determine angular size of the Moon and the Sun. Besides it, Aristarchus tried to calculate the distance to the Moon and

[2] Н. А. Кун. Легенды и сказания Древней Греции и Древнего Рима. Москва, «Правда», 1990. стр.25

[3] Д. К. Самин. Сто великих научных открытий. Москва, «Вече», 2002. стр. 257

the Sun. According to his calculations, the distance between the Earth and Moon is equal to 19 Earth radiuses. The distance to the Sun is 19 times more than this distance. As the scientist took the distance between the Earth and Sun into consideration, he was obliged to mention that, stars and the Sun don't change their places in the space and the Earth revolves round the Sun. Archimedes also explained his thought about it. Thus, Aristarchus explained his thoughts about the Earth's revolution round the Sun before Nicolaus Copernicus. But he couldn't prove it scientifically unlike the Pole scientist.

It was necessary to develop mathematics, astronomy and geography in order to achieve mentioned scientific goals. Well-known scientists as Aristotle, Hipparchus, Ptolemy, Euclid, Archimedes and Eratosthenes played matchless role in improvement of this field. Even the smallest scientific achievements were considered great discovery for experts at that time.

Very interesting achievements were got in the field of ancient geography in V-IV centuries BC. Main achievements of scientists were results got in investigation of the Earth's shape and the theory about the unity of the world ocean. For the first time, Parmenides declared that,

the Earth was spherical (V century BC), but his idea was scientifically weak.

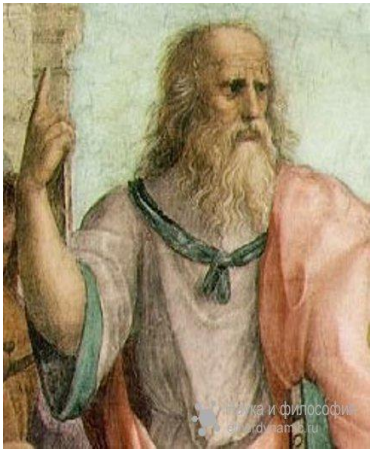
According to the German scientist D. B. Ditmars, for the first time, astronomer, geographer and philosopher Eudox Knidli (408-353 BC) proved that, the Earth was round.[1] Probably, he used the term "horizon" and determined geographical latitude for the first time. Some historians and geographers think that the equator's length was determined by Eudox too. Though the length determined by him was so great – 400 thousand stades (if we consider that, 1 stade is equal to 157.5-176 meters, this length was equal to 63-70 thousand kilometers), it was an important step made in this field.

His arguments were as following: As the Earth was seen round in the Moon during a lunar eclipse, the Earth's surface became wider when ascending a mountain, view of stars changed when going towards the South or North (Aristotle had used this method (384-322 BC)), it wasn't difficult to understand that, the Earth was round.

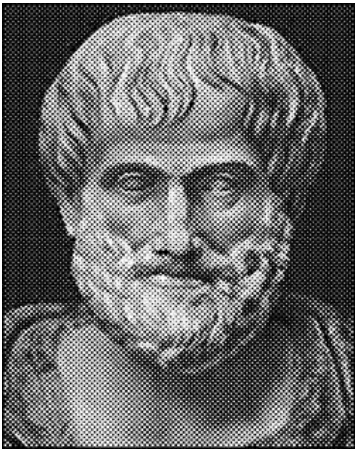
It is known that, a very large library was established in Alexandria, when the city was founded in the delta of the Nile in accordance with the order of Alexander the Great

[1] И. П. Магидович, В. И. Магидович. Очерки по истории географических открытий. I том. Москва, «Просвещение», 1982. стр. 129

and probably, it was filled with manuscripts brought from most cities of Egypt, Babylonia and Greece. That's why most well-known scientists of ancient times tried to go to Alexandria in order to increase their knowledge.



Platon (427-347 BC)



Aristotle (384-322 BC)

The Greek scientist, well-known astronomer, geographer and mathematician Eratosthenes Kerensky, who lived in Alexandria (end of III century and beginning of II century), had determined by means of "roughly made things" that, the length of the equator was equal to 252 thousand stades – about 39690 km (today's length is 40076 km) and the Earth radius was 6311 km (today's length is 6378 km). Besides it,

he had written that, 1 degree was equal to 700 stades. Several scientists write that, Eratosthenes had written this information in accordance with Pytheos's calculations. According to Pytheos's calculations, 1 degree of the meridian was equal to 105-112 km.

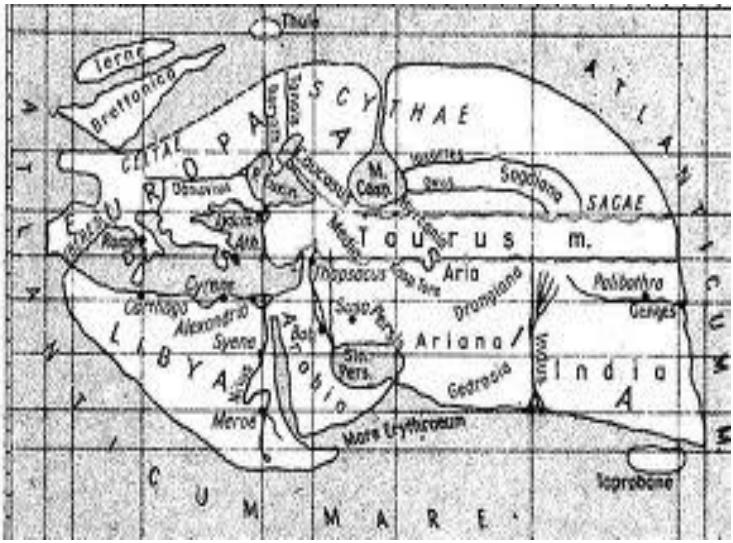
The Syrian geographer, historian and traveler Posidonius calculated length of the equator at the end of II century and beginning of I century. He thought that, his first result – 180 thousand stades was correct. This result surprised some geographers and travelers of XV-XVI centuries.

First scientists of ancient times tried to divide known land areas of the Earth into continents. According to historical sources, geographers of Miletus used words "Europe" and "Asia" for the first time when spoke about division into continents.

Young contemporary of Anaximander Hekatey Miletli (VI-V century BC) mentioned Libya (Africa) besides those continents. First two islands had almost been forgotten till the age of Herodotus.

Herodotus described Arabia, Syria, Small Asia, Mesopotamia, Iran Mountains and Northwestern India as Asia in his work. He declared that, the territory, which was located in the East, was unknown desert, Europe was situated in the north of Asia, Egypt and Libya were situated

in the west. Egypt was connected with Asia by means of the "narrow cape" (Isthmus of Suez and Sinai Peninsula).



The Earth's appearance according to **Herodotus**

Herodotus wasn't aware of existence of the word "Africa". This word was met for the first time in the ancient literature, remained parts of the poem ***"Annales"*** of Quintus Ennius at the end of III century. But this name concerned only main province of Carthage. Occupiers founded province by name Africa after Carthage was destroyed by

Romans (146 BC) and then the whole continent was called Africa.[1]

Scientists of ancient times made significant discoveries in astronomy by means of primitive methods. For the first time, Aristotle had explained his idea about the unity of the World Ocean. But the theory about the global World Ocean was founded by Eratosthenes. He wrote: "… If largeness of the Atlantic Ocean wasn't an obstacle, it could be possible to sail from Spain to India through the same parallel" (Strabo I, 4, §6). It was known in 200 BC that, Spain was situated on the same parallel with India. Posidonius had explained this theory exactly: "… It is known that, settled land is surrounded by the ocean. It isn't surrounded by any land area" (Strabo I, 3, §5). Strabo also agreed with this thought (I, 1, §8).

Global changes occurred in geographical structure of the Earth in ancient times, but those changes couldn't be analyzed theoretically. Scientists of that time accepted the theory, which noted that the Earth was round and there was global World Ocean.

Pompony Mela defended the idea about the World Ocean in the middle of I century and mentioned that, West and

[1] И. П. Магидович, В. И. Магидович. Очерки по истории географических открытий. I том. Москва, «Просвещение», 1982. стр. 126

East Oceans were connected with Britain and Skiff Oceans in the North and with Ethiopia, Red and Indian seas in the South.[1] We may look through the map made by Pompony Mela. He named part of the Indian Ocean and the territory between the Red Sea and rank of the Indian River as the Red Sea and the territory between the rank of the Indian River and south-eastern part of Asia as the Indian Sea.

The Indian Ocean, Ephiop and Red seas separate Europe, Asia and Africa with the hypothetic land surrounded by water and settled by people, who lived on the opposite side. Most scientists don't agree with this thought and there weren't ocean in the East and North of Asia and in the south of Ethiopia in Ptolemy's ***"Geography"*** after 100 years. Thus, in Ptolemy's world map, the territory of Asia extended towards the North and North-east, but Africa extended towards the south. The south-east of Asia and south-eastern part of Africa were connected with the hypothetic land located in the south. At the result of it, the Indian Ocean became large lake. Ptolemy was very talented scientist of Europe before Renaissance and his map was demonstrated in all cartography and geography circles. In that case it was impossible to go to India from Europe

[1] И. П. Магидович, В. И. Магидович. Очерки по истории географических открытий. I том. Москва, «Просвещение», 1982. стр. 131

through the south of Africa. It was possible to go to India through the sea by going round the Earth. But that way was very long for seamen.

The Earth's appearance according to Pomponius Mela

That's why land road began to be used for going from Europe to India at first. Travelers and merchants used to make maps even with primitive methods in order to appropriate the most convenient way going to the east of Asia. Any effort wasn't made in order to discover seaway to India even during development of navigation and improvement of ship constructions. Even when the Roman

Empire intensified its occupation policy towards the East, it didn't do anything for discovery of a seaway to India though it had powerful navy (led by Gnaeus Pompeius and other well-known Roman commanders). It means that, information about the Earth's structure was very little. Land road was still considered convenient for going to India.

Astronomy is one of the most ancient sciences of the world. The Greece scientist Aristotle had developed a new system about the Earth's structure. What did that system look like? He thought that, the Earth stood motionlessly at the center of the universe and planets revolved round the Earth. It had a special rule. Each planet had its sphere and it was pinned on its sphere. Each planet's sphere revolved round the Earth with certain speed. As planets were pinned on their spheres, they revolved round the Earth by means of those spheres. Aristotle explained that, as planets' spheres were transparent crystals, it was possible to see other planets, which were located behind each others. During the age of Aristotle and after it people thought that, there were 7 planets. They were Mercury, Venire, Mars, Jupiter, Moon, Sun and Saturn. For example: this thought existed during the age of Nasiraddin Tusi and Ulugbek (XIII-XV centuries) too. For the first time the Earth was considered a planet by Copernicus (1473-1543), but he thought that, the Moon and

the Sun weren't planets. There was the sphere of "constant stars" besides the sphere of planets in the system of Aristotle.

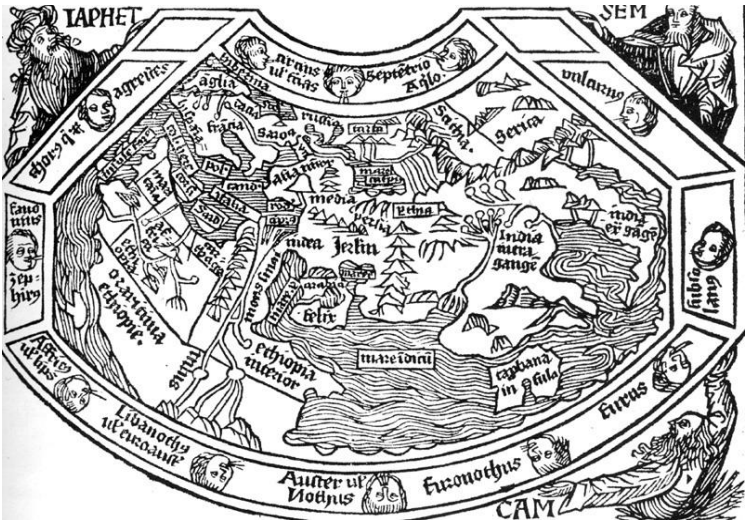
Two of ancient Greek astronomers differ for their activities – Hipparchus and Ptolemy.

Hipparchus, who lived in II century BC, was remarkable scientist of his time, but there is very little information about him. It is known that, he was born in Nicaea and Rhodes Island and had made some astronomical observations in Alexandria.

The Greek scientist had calculated measurements of the Moon very exactly. According to Hipparchus, radius of the Moon was equal to 0.27 Earth radiuses. It is approximately equal to today's radius of the Moon. Well-known astronomer of ancient times had written that, the distance between the Earth and Moon was equal to 59 Earth radiuses (real average measurement is equal to 60.3 Earth radiuses).

Hipparchus is the author of the first astronomical catalogue after Chinese astronomers. Coordinates of 1080 stars had been noted in the catalogue. There is no doubt that, he had used elements of trigonometry for this purpose. For the first time, Hipparchus separated stars for their brightness.

The distance between the Earth and Sun was considered equal to 1120 Earth radiuses from the age of Ptolemy till XVII century. This measurement is 20 times less than the real measurement.



Ptolemy's world map

The Greek scientist Claudius Ptolemy is the remarkable astronomer of ancient times. He lived in Alexandria in II century.

His main works are ***"Almagest"*** and ***"Geography".*** Besides it, he has several works about optics.

"Almagest" of Ptolemy was considered the most important work in the history of astronomy during about 1400 years. People who had read his work and Euclid's ***"Principles"*** were considered remarkable experts on astronomy and mathematics.

Ptolemy mentioned methods of determination of longitudes offered by Hipparchus of Nicea three hundred years ago in the general instruction of making maps. [1]

"Almagest" consists of 13 articles. The first and second articles are about the simplest astronomical events and the Earth, the third article is about movement of the Sun, the forth is about movement of the Moon, the fifth is about the astronomical instrument – astrolabe, the sixth is about lunar and solar eclipses. The seventh and eighth articles are star catalogues. These catalogues consist of the list of 1028 stars.

Other five articles of ***"Almagest"*** are about movement of planets. Ptolemy wrote in the second edition of ***"Almagest":*** "Generally, we can accept that, the sky is spherical and moves spherically. The Earth is spherical too and it is

[1] Д. Хауз. Гринвичское время и открытие долготы. Москва, «Мир», 1983. стр. 17-18

situated in the middle of the sky, it looks like a point without any motion in respect of stars". [1]

Claudius Ptolemy (90-160)

Ptolemy is well-known in the history of astronomy for his theory by name "Geocentric system".

Ptolemy had determined cycle of movement of every planet on its epicycle, measurements of those epicycles and

[1] Н. Веселовский, Ю. А. Белый. Николай Коперник. Москва, «Наука», 1974. стр. 198

cycle of movement on depherents. After it, movements of planets could be prognosticated beforehand, but of course with some mistakes.

Astronomers of the Eastern world

Observatories should be built for improvement of the astronomy. In accordance with the order of Abbasids' representative – caliph Mamun, grandiose observatory was built in Baghdad.

Professor S. Klasco Ryndzune mentioned: The book ***"Short course on Algebra and Almugabele calculation"*** was written at the most ancient university of the world by name "House of wises" (Baith Al-Hakim) founded in 830 by the caliph of Baghdad Abdullah Al-Mamun ibn-Harun ar-Rashid (786-833)... As ar-Rashid had organized a department for Indian, Turkish Professors and Greek Professors moved from Byzantine at Baghdad University, those Professors' Arab students could achieve significant successes in philosophy, medicine and other sciences and

translated the most important books and works of ancient Greek authors into Arabic.[1]

Muhammad Khwarizmi, Muhammad Kathir Al-Farghani from Fergana, Ahmad ben Abdullah Al-Marwazi were well-known astronomers.

***Muhammad ibn Musa Al-Khwarizmi* (780-850)**

[1] Журнал Ассоциации искусственного интеллекта. Новости искусственного интеллекта. С. Клатско-Рындзиун. Москва, 1993, стр. 136. Bu Almaniyada ingilis dilində yazılmış R. A. Əliyev, F. Əliyev, M. Babayev "Fuzzy proqress control knowledge engineerinq in petrochemical and Robotic manufacturing" adlı kitabdakı ön sözün pus dilindəki tərcümə-sidir. Ed. by S. Klaczko. Koln: Verlaq "TUV Rheinland". 1991. səh. 150

Al-Khwarizmi had played a significant role in development of astronomy and mathematics. He had written first book of algebra and founded this science. Scientific heritage of Al-Khwarizmi are learnt by European scientists and he is famous in Europe with names *"Algarizmus", "Alkhorezemos", "Alkarethmus", "Alkhvarithmus", "Algorithmus",* and *"Algorithm".*

Author of ***"Addition and deduction with an Indian method", "Short course on Algebra and Almugabele calculation", "Tables of astronomy", "Book of land descriptions"*** Abu Abdullah Muhammad ibn Musa Al-Khwarizmi Al-Majousi (780-850) had led calculation of degrees near Baghdad in 827. Length of one-degree meridian arch of the Earth was equal to 111815 meters according to results of those calculations. Today's result is 110938 meters (difference is 877). This result was very important for determination of the Earth's measurements. First degree calculation was carried out by the Greek scientist Eratosthenes in 250 BC in Egypt. But results got by Eudox weren't accepted by scientists seriously. Khwarizmi had become the leader of "Beytul hukema" (house of scientists), which was the academy of sciences of Baghdad, when he was 35 years old.

"Book of land descriptions" of Khwarizmi is considered the most valuable work in the history of geography. There were a lot of information about most countries, seas, rivers and mountains. Khwarizmi travelled along Volga and in Byzantine.

Some western historians or scientists used wrong information by presenting Al-Khwarizmi as an Arab scientist without using primitive methods. Professor S. Klasco Ryndzune mentioned that, he was one of the greatest scientists of the Turkish world. He wrote: "As the notion "algorithm" is used in modern mathematics, we understand that, this word has been formed of Latin transliteration of the name of well-known librarian and mathematician Abu Abdullah Muhammad ibn Musa Al-Khwarizmi Al-Majousi (780-850), who was born in Khiva". Turkish region Khiva was independent till 1873, before marches of the Russian Empire to Middle Asia.[1]

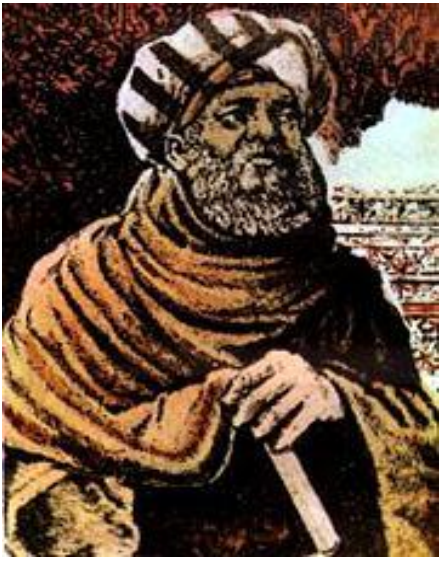
The European scientist was very just when spoke of Al-Khwarizmi.

Ahmad ben Abdullah Al-Marwazi was well-known with the name Habash Al-Hasib in the history of astronomy. He

[1] Журнал Ассоциации искусственного интеллекта. Новости искусственного интеллекта. С. Клатско-Рындзиун. Москва, 1993. стр. 136

had noted main achievements of the Indian astronomy in his book ***"Zic"*** written with the method of ***"Sindihind".***

Sabit Ben Guerra (821-901), who was one of the most remarkable mathematicians and astronomers of IX century,



Sabit Ben Guerra (821-901)

become popular as a skilful scientist after he moved to Baghdad. As the scientist knew Syrian and Greek besides Arabic, he had some scientific translations too. Sabit had a significant role in translation of ***"Principles"*** of Euclid and

"Almagest" of Ptolemy into Arabic and their distribution in the Eastern world. His translations were the most smooth and exact translations. He was the author of more than 150 works and translations.

Abul Abbas Tabrizi also was well-known astronomer and mathematician of IX century.

Well-known Arab scientist Battani, who lived in Syria (the second part of IX century – 929), had built an observatory in Rakka on his own account and in 878-918 he used to make astronomical observations there. He had determined values of some important astronomical quantities and got more exact results. The astronomy book of Battani had been translated into Latin by the German scientist Johann Muller (Regiomontanus) in XV century. The book's title was ***"Mohametis Albetini de Scienta stellarum Liber" (Muhammad Al-Battani's scientific book on stars)*** in Latin.

Battani (Abu Abdullah Muhammad ben Jabir ben Sinaya Al-Harrani Ali Sabi) was born in the family of the rich Arab nobleman and was called "Arab Ptolemy". ***"Zic Sabi"*** written by Battani on the basis of translations of Plato Tyvalsky, Maslama Ahmad Al-Majriti and Regiomontanus was known by European astronomers in the middle ages.

Abu Nasr Muhammad ibn Muhammad Al-Farabi (870-950) was one of the most well-known scientists of the middle ages. The scientist, who was born in Uzbekistan, Farab, had travelled a lot. He had written many works on philosophy, medicine, mathematics, astronomy and music. Well-known Arab scientist Ibn Hallikan wrote about him: "… Turkish scientist Al-Farabi is well-known philosopher and author of interesting works on logic, music and other sciences. He is the most genius Muslim philosopher".

Al-Farabi's commentary about ***"Almagest"*** of Ptolemy made him more popular. Al-Farabi is well-known in the world, but it is not serious to call him the most genius Muslim philosopher.

Well-known scientist Ebul Vefa Al-Buzcani (939-998) had worked on theoretical and practical problems of astronomy. He had written several valuable works on mathematics, algebra, geometry and astronomy. Ebul Vefa had worked on the theory of the Moon and discovered "variation" of its movement.

Muhammad ibn Muhammad ibn Yahya ibn Ismail ibn Al-Abbas Al-Buzcani had come to Baghdad in 960 and carried out investigations in the observatory located there. Most of his valuable works were lost.

Ebul Vefa had a very significant role in development of mathematics and astronomy.

Sheikh Muhammadali Babakuhi Bakuvi

Though Azerbaijan isn't very large country, it is always notable for its poets and thinkers. Because science, culture, art and literature were the focus of attention there in the early middle ages and skilful experts were prepared for development of these fields. Besides it, Azerbaijani scientists were interested in scientific processes of countries located near borders of Azerbaijan and continued their investigations in those countries too.

The academician Ziya Bunyadov mentioned that, some Azerbaijani scientists had taught different sciences and carried out investigations in Baghdad, Mosul, Alexandria, Eden, Cairo and other Arab countries in early middle ages. It means that, there were high-level education centers in most cities of Azerbaijan at that time.

Professor N. K. Keremov had mentioned that, Azerbaijani geographers and travelers had a significant role in collection of correct and exact information about nature,

population and economy of Caucasus and Middle Asia, Near and Far East, India and Northern Africa.[1]

N. K. Keremov was right. Because most remarkable personalities of Azerbaijan travelled to different countries and collected very interesting information since early middle ages. One of them was the poet, scientist, philosopher, traveler and cosmographer Sheikh Muhammadali Babakuhi Bakuvi (931/32-1051). The orientalist and researcher Y. E. Bertels had written his whole name as "Sheikh Muhammadali Abu Abdullah Muhammad ibn Abdullah ibn Ubaydullah ibn Ahmed Shirvani Babakuhi Bakuvi".

Sheikh Abdullah Ansari, Abdurrahman Jami and Aliajdar Saidzadeh thought that, Babakuhi had travelled to Iran, Middle Asia, Arabia and India. Professor Eybali Mehraliyev also had written about it: "Sh. M. Babakuhi had travelled to Iran, Middle Asia and India during more than 20 years. He had met local scientists, shared his opinions on development of some movements in the Muslim world and learned traditions of indigenous population during his travels…"[2]

[1] Керемов Н. К. Путешествие Гудси. Москва, «Мысль», 1977. стр.5

[2] E. Mehrəliyev. Babakuhi Bakuvi (Nişapuri, Şirazi) və Pirhüseyn Şirvani. Bakı, "Nafta-Press". 2002. səh. 37

Babakuhi was aware of existence of the World Ocean as scientists of ancient times. It may be understood after reading his poem too:

There is a very rich nature
In the endless and large sea
So sages know its value. [1]

Sh. M. Babakuhi used to describe the nature and travel routes in his ghazals. He had described shape of the Earth in one of his poems too:

Your love was a white cock,
The Earth resembled an egg,
Its yolk is the Sun,
The nature has put it in the centre. [2]

E. Mehraliyev explained the poem as following: "Scientific explanations of the poet have been made as love explanations. When the poet described the Earth as an egg, he explained main features of the universe's heliocentric system. Besides it, he has explained it as a natural law. His

[1] Перевод на Азербайджанский Э. Мехралиев.
[2] Перевод на Азербайджанский Э. Мехралиев.

scientific thoughts haven't lost their significances still. It was impossible to write such ideas in a different way at the time when Islam had begun to be spread newly. Babakuhi's explanation was made 30-40 years before Abu Raihan Al-Biruni from Khwarezm and was very resolute thought about heliocentric structure of the universe. Besides it, this explanation was made 500 years before the corresponding discovery of the Pole scientist Nicolaus Copernicus…

On the other hand, the poet has described the Earth as an egg, the Sun as an egg yolk and he has hinted at the creator of biological processes by emphasizing the word "cock". But Babakuhi's thoughts haven't been described openly".[1]

The word "world egg" is used for the Earth in Sufism cosmography.[2]

But to my mind, Babakuhi has described the universe in the above mentioned poem. He has called human love white cock. And the word "white cock" may be used for our Galaxy.

The scientist has described the world as the universe and the Sun as an egg yolk located inside it in the hemistich "The Earth resembled an egg". In the hemistich "The nature

[1] E. Mehrəliyev. Babakuhi Bakuvi (Nişapuri, Şirazi) və Pirhüseyn Şirvani. Bakı, "Nafta-Press". 2002. səh. 37

[2] Е. Я. Бертельс. Суфизм и Суфийская литература. Москва, 1965. стр. 283, 284

has put it in the centre" Babakuhi wanted to note that the Sun was a fixed planet. It means that, the Sun couldn't revolve round the Earth, but the Earth could revolve round the Sun. The scientist had passed ahead of Copernicus for 500 years with this poem. Probably, Babakuhi was the author of scientific treatises too. He knew astronomy as well as the most well-known scientists of the Near East. Probably, Babakuhi had improved his knowledge about the structure of the Earth and Sky owing to Ebul Vefa, Abdurrahman Al-Sufi, Abu Raihan Al-Biruni, Hamid Al-Khojandi and Abu Nasr ibn Iraq. There isn't any information about direct meeting of Babakuhi and mentioned scientists in known historical documents. But it is possible to assume that he had contacted with them. Orientalists have to carry out researches in state libraries and manuscript funds of Tehran, Shiraz and Hamadan in order to find historical documents. Babakuhi had read works of Hussein Al-Khwarizmi, Al-Farabi, Abu Ali ibn Sina, Al-Balkhi, Abu Raihan Al-Biruni, Naser Khosrow and other scientists when he was in Khwarezm. He had met some scientists there. It means that, Babakuhi had contacted with well-known scientists of the East.

Most works of the scientist is still remaining. It shouldn't be forgotten that, the scientist, who lived 120 years, had

visited Maragha, Hamadan, Khorasan, Baghdad, Isfahan, Rey and other cities and participated in scientific meetings held there. There is no doubt that, works of the scientist could be kept in libraries located in Maragha observatory founded by Rashidaddin and N. Tusi. Tusi's cosmographic thoughts couldn't influence on thoughts of the remarkable astronomer and mathematician.

Though there wasn't any observatory in Azerbaijan in X and XI centuries, astronomy and geography had developed highly. Babakuhi had described the Earth, Universe and Galaxy before N. Tusi in his poems.

He had mentioned that, the universe was surrounded by cosmic bodies and the Earth was part of it. The Sun was a fixed planet. Most parts of the Earth were covered with the World Ocean – great sea. It means that, Babakuhi was aware of existence of the heliocentric system.

It is necessary to note that, Greek scientists had a significant role in intensive development of astronomy by scientists of the East. Because well-known scientists of the East used to read works of Greek scientists before they started their activities. The influence of Greek scientific schools was very important in regions of the Near East in early middle ages. Most scientists accepted this fact.

… Though some authors approached to establishment of the Islamic union positively, science and philosophy of Greeks had spread in the Near East and Iran by means of political and economic relations of Byzantine after the first part of V century. Nestorian teachers taught Greek philosophy in Syria and Lebanon. As the Nestorian school was closed in 431 because of the church, those teachers moved to Iran and began to translate works of Greek scientists into Arabic.[1]

Even in 1149 Khaghani Shirvani was a friend of the Byzantine princess Comnenus.[2]

Main scientific works of well-known scientists

Cairo observatory of Egypt, Rey observatory of Iran and Mamun Academy of Central Asia were important scientific centers of the East.

[1] Исаченко А. А. Развитие географических идей. Москва, «Мысль», 1971. стр. 11

[2] Q. Kəndli-Herisçi. "Xaqani Şirvani". Bakı, 1988. səh. 517

The founder and scientific leader of the Cairo observatory was Ibn Yunus (died in 1009) in X century and the astronomical catalogue ***"Zij-i Al-Kabir"*** was made in that observatory under his leadership. N. Tusi had praised mentioned astronomical catalogue in his work ***"Zij-i Ilkhani".***

Well-known scientist of his time Abdurrahman ben Omar Abdul Hussein Al-Sufi (903-986) had established the Rey observatory. Observations carried out there, were efficient and a star catalogue had been made according to them. In 1874 that catalogue had been published in Petersburg by Shellerup with the title ***"Decreption des etoiles fixes" (List of fixed stars)***.

Al-Sufi is the author of many valuable works. Besides him, inventor of the sextant, well-known scientist Khojandi also had participated in establishment of the Rey observatory.

Mamun Academy was established by Khwarezm-Shah Mamun II in the second half of X century. Cultural and economic life of Khwarezm began to develop and large cities as Urganj and Kyat began to be founded at that time. Mentioned cities were popular for their cultural and scientific centers having rich libraries.

Remarkable scientists as Harachi and Hamdaki, who were teachers of Al-Biruni, Abu Ali ibn Sina, Abu Nasr Iraq, Khojandi, Abu Sahl Masihi, Abul Hasan Hammar and Al-Biruni worked in Mamun Academy.

Abu Raihan Muhammad ben Ahmad Al-Biruni (04.10.973-13.12.1048) got his education in Kyat with Abu Nasr Mansur ibn Ahmad ibn Iraq and started his first astronomical observations there. Al-Biruni left Kyat and went to Jurjan when he was 22 and wrote his well-known work ***"Al Athar, al Baqqia" ("Chronology of ancient nations").*** The book is about histories of culture, art and literature of some nations, their calendars, traditions, holidays etc.

The book brought great fame to Al-Biruni and he was invited to the Academy founded by Khwarezm-Shah Mamun II. He worked there for seven years. Mamun Academy carried out its activity till invasion of Khwarezm by Mahmud Ghaznavi in 1017.

I want to remember two paragraphs of ***"Muhammad Nasiraddin Tusi"*** written by H. Mammadbayli. Some scientists of Mamun Academy could move from Khwarezm after the invasion. But a group of scientists and Al-Biruni were arrested. He was accused of being against Islam. Al-Biruni was freed by means of palace members and became

the most popular scientist in the palace of Mahmud Ghaznavi. He named one of his astronomical works ***"Massoud Qanuni"*** in honor of Mahmud Ghaznavi's son. Mahmud Ghaznavi and his son used to benefit by knowledge of Al-Biruni.

Once ambassador of Turks came to the Sultan Mahmud Ghaznavi and said that, there was an interesting country in the North and it was always daylight there. Sultan didn't believe it and asked Abu Raihan's opinion. As Al-Biruni explained this fact very convincingly, Sultan believed him and gave many presents to the ambassador.

Mahmud Ghaznavi marched to the north of India and took Al-Biruni with himself. The scientist learned Sanskrit perfectly during a very short time and got acquainted with scientific achievements and traditions of Indian nations. Al-Biruni wrote scientific works in Sanskrit, translated different works from Arabic and Persian to Sanskrit and from Sanskrit to Arabic and Persian.

Mathematics and astronomy had developed enough in India before Al-Biruni moved there. Trigonometry also had been learned. The Indian astronomy book ***"Surya-Siddhartha"*** was translated into English in 1860. This book was written in IV century. Other work – ***"Siddhartha-Chiromani"*** was written in XII century by Bascar Acaria.

Abu Raihan Al-Biruni (973-1048)

Mentioned works had been investigated exactly by Reynaud, Albrecht Weber, Moritz Cantor and others. Later it became clear that, Indians had learned mathematics and astronomy owing to Greeks.

The time spent by the scientist in India was very efficient as Ptolemy's ***"Almagest"*** and Euclid's ***"Principles"*** translated by him into Sanskrit played a significant role in development of the science in India.

The book ***"India"*** written by Al-Biruni in 1030 is very valuable work and half of that book (forty of eighty chapters) is about astronomical knowledge of Indians. The book was named by Al-Biruni as ***"Book containing explanations of instructions accepted and rejected by the "Indian" sense".*** Well-known Russian orientalist Barthold had written that, mentioned work of the scientist hadn't any analogue in scientific literature of ancient and middle ages.

That book was translated into Arabic in London in 1887 and into English in the next year.

As Al-Biruni's scientific heritage is very rich, we can look through a small list of his valuable works:

1. Determination of the Earth's measurements at the result of observation of descent of the horizon seen from the top of the mountain.
2. Astronomy equipments and use of them.
3. Different ways of preparation of the astrolabe.
4. Projection of star specters.
5. Comets.
6. About investigation of sky events.
7. An effort to check movement of the Sun.
8. Notes on Euclid's works.
9. Notes on Ptolemy's astronomy.
10. About Khwarezm's works on astronomy.

11. About Arabs' theory on movement of the Earth.

Al-Biruni was one of main defenders of the heliocentric system in spite of uninterrupted persecutions of Muslim confessors because of his scientific activity. He struggled against people, who considered the geocentric system basis of the astronomy and thought that, the astronomy would be idle without that system.

Al-Biruni used to say: "The theory on fixedness of the Earth is one of bases of astronomy and this fact is one of dogmas of Indian astronomers. It makes the astronomy more difficult".

Al-Biruni mentioned that, the Earth's revolution didn't reduce importance of the astronomy. Actually, all kinds of astronomical events may be explained on the basis of this theory.

Well-known scientists tried to improve some scientific discoveries of Al-Biruni after several centuries. But some discoveries are still out of attention. The remarkable scientist Professor R. Husseinov wrote about Al-Biruni: "Al-Biruni – well-known scientist of Middle Asia, who was popular for his theory on the Earth's rotation in XI century, is the author of some astronomical tractates and there is a very interesting thought in these tractates: Earth's rotation

about its own axis don't contradict any provision of the astronomy".[1]

But Sheikh Muhammadali Babakuhi Bakuvi had tried to change the astronomy fundamentally by describing heliocentric structure of the universe before mentioned two scientists. His idea was advanced 500 years before the discovery of Nicolaus Copernicus.

This thought was mentioned by other eastern scientist Nasiraddin Tusi and is available in German sources too. But the corresponding scientific investigation wasn't completed because of unknown reasons.

It means that, before the Pole scientist Nicolaus Copernicus (1473-1543), eastern astronomers had advanced an idea about movement of the Earth. ***"About rotations of celestial spheres"*** was published in 1543 – when Nicolaus Copernicus died. Copernicus had explained his heliocentric system in this work. According to this system, there isn't fixed Earth in the center of the world, there is the Sun, which rotates about its own axis. The Earth rotates around the Sun and about its own axis as all other planets.

[1] Azərbaycan Respublikası "Təhsil" Cəmiyyəti 2002 il 28 iyunda dahi Azərbaycan alimi Nəsirəddin Tusinin 800 illik yubileyinə həsr olunmuş "Nəsirəddin Tusinin elmi xidmətləri və Nəsirəddin Tusi yazıçı-tədqiqatçı Ramiz Qasımov yaradıcılığında" mövzusunda keçirilən elmi-praktik konfransda professor Rəhim Hüseynovun məruzəsi.

Al-Biruni defended ideas of the heliocentric system in his works ***"India", "Different ways of preparation of astrolabe", "The key to astronomy", "Does the Earth rotate or not?***" and ***"About Arabs' theory on movement of the Earth".***

The scientist had prepared a wall quadrant with 7.5 m diameter in 995 in order to make detailed astronomical observations. One of quantities determined by means of that equipment was inclination of the ecliptics. He had twice made observations for determination of inclination of the ecliptics (in 995-996 and 1020) and got $23^0\,35'\,45''$ and $23^0 35'\,50''$ at the result of these observations.

H. Mammadbayli wrote: "Al-Biruni had offered new method for determination of the Sun apogee's longitude. He was the author of significant works on mathematical cartography and geography. The idea on the shape of the Earth wasn't advanced by Al-Biruni as some authors mention. Al-Biruni's main scientific service was preparation of the new method for determination of the Earth's measurements".[1]

The scientist explained this method as following:

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh.25-26

"I have offered a new method different from methods of Greek, Indian scientists and scientists of Mamun for determination of the Earth's meridian arch. I found a high mountain in India for this purpose. Then I found the horizon by means of the tool (astrolabe) on the top of the mountain, it was located along the east-west line. The angle was 34 degrees. The height of the mountain was equal to 652.05 elbows".

According to calculations of the scientist, the Earth radius was equal to 12851369 elbows, the Earth's length was 80780039 elbows and one-degree arch of the Earth was equal to 50.2 Arab miles.

Al-Biruni works on the following scientific work

Nallino and Shoy had determined that, an elbow was equal to 0.493 m and an Arab mile was 4000 x 0.493 m = 1972 m.

Al-Biruni had determined that, the length of one-degree meridian arch was 111.6 km (today's value is 111.1 km).

Experts mention that, Al-Biruni had prepared a new method, which corresponded technical level of his time, for calculation of the longitude and by the way improved mathematical geography. Though this method was theoretically correct, hadn't satisfactory results as had many observational errors.

Al-Biruni had offered a method for finding difference of longitudes and determined difference of longitudes of Shiraz, Gorgan, Gazna and Baghdad.

Al-Biruni had prepared table of longitudes and latitudes of several cities. It should be mentioned that, he had used the length of the meridian calculated before. The Tajik scientist H. U. Sadigov wrote about services of Al-Biruni: "Al-Biruni, who was one of remarkable astronomers of the East, is the author of very significant works".

We can't deny that, the astronomy is an ancient science. It was spread widely in the East in the early middle ages and Muslim astronomers had made great efforts in order to discover its details. According to above mentioned facts,

this science was developed in Azerbaijan in the age of Babakuhi Bakuvi. It was developed in the northern part of Azerbaijan – in Shirvan before other regions. Professor Eybali Mehraliyev's notes prove it.

According to works on the history of mathematics, Shirvan was the astronomical center and high-level investigations were carried out there as Shirvan had relations with Khwarezm since IX-X centuries…

The astronomer and poet Falaki Shirvani wrote about services of Vahidaddin Shirvani (1100-1159 – R. G.) and citizenship ideals of Kafiaddins. [1]

Abu Ali ibn Sina (980-1037) was invited to the Mamun Academy when it was established. His main works on the astronomy and mathematics are:

1. About characteristics of the equator.
2. Answers of ten questions of Al-Biruni.
3. Answers of sixteen questions of Al-Biruni.
4. About speeds of the Earth and Sky.
5. About celestial bodies and their movements.
6. About astronomy equipments made for observation in Isfahan.
7. About the sky, stars and meteorites.

[1] E. Mehrəliyev. Şirvan Elmlər Akademiyası. Bakı, "Çaşıoğlu", 2000. səh. 52-53

Abu Ali ibn Sina (980-1037)

Hamis ben Al Hazar Abu Mahmud Al Khojandi, who was the teacher of Al-Biruni, also worked in the Mamun Academy. He is the author of several scientific treatises and his treatise about application of the astrolabe is one of the most significant astronomical works.

Khojandi worked in the observatory of Rey located near Tehran. He had invented a sextant, which's diameter was equal to 80 elbows (40 m), and that tool was able to measure angles with exactness of $1''$. Khojandi had

determined inclination of the ecliptics as $23^0\ 32^/\ 21^{//}$ with exactness of $2^/\ 01^{//}$.

He wrote about those observations: "We made observations in Rey with the sextant, which I had invented in 384th year of the Islamic calendar and 363rd year of the Yezdicurd era. It consists of the circle arch, which's diameter is equal to 80 elbows. I have named it ***"Suds Fakhri"*** in honor of the ruler of Rey, Hamadan and Isfahan – Fakhriddovl.

We could get following results after successful observations and exact calculations. My sextant is able to measure inclination of the ecliptics with degrees, minutes and seconds unlike other tools, which measure corresponding quantity with degrees and minutes". It proves that, Khojandi was the first person, who could determine that, inclination of the ecliptics was a variable quantity. Indians had determined exact value of the inclination (240).

Khojandi wrote: "Ptolemy determined it as $23^0\ 51^/$, the author of the ***"Examination table"*** (Habashul Hasid) determined it as $23^0\ 35^/$, but I determined this quantity as $23^0\ 32^/\ 21^{//}$".

Difference between values determined by Indians and me is approximately equal to half degree. It can't be error of tools because all determined values varied insignificantly.

The teacher of Al-Biruni – one of advanced scientists of the Mamun Academy Abu Nasr ibn Iraq (died in 1035) lived in Khwarezm before the Mamun Academy was destroyed and continued his scientific activity in the palace of Mahmud Ghaznavi after it. He is the author of some significant works on astronomy and mathematics.

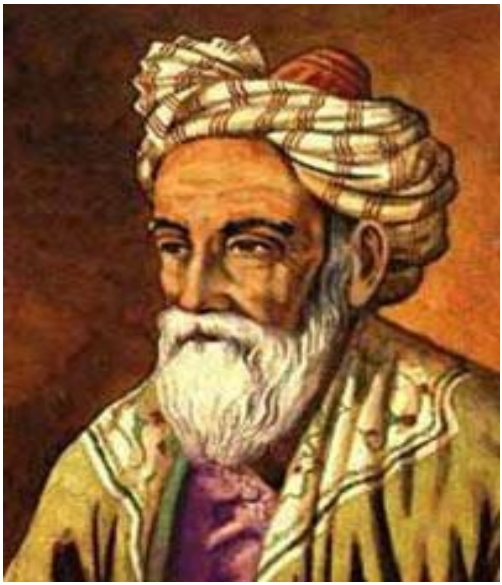
His most significant astronomical works are:

1. Preparation of astrolabe with artificial way.
2. About difficult parts of Euclid's XIII book.
3. Astronomical table of the shah.
4. Table of minutes.

The teacher of Abu Ali ibn Sina Abu Sahl Isa ben Masihi Gorgani also worked in the Mamun Academy. The scientist, who was the author of some scientific works on astronomy and medicine, died in desert when tried to hide from persecution of Mahmud Ghaznavi's troops.

Omar ibn Ibrahim Al-Hayyam Giyasaddin invited Abul Fath (1048-1123) to the palace of his friend – Nizamulmulk Jalaluddin Malik shah Saljugi in 1074. Malik shah chose Isfahan as the capital and established observatory there.

Omar Khayyam was the head astronomer, Abu Muzaffar Sfaran and Mamun ben Al-Najab Al-Vasiti were astronomers of the observatory as they planned reforms in astronomical calendar.



Omar Hayyam (1048-1123)

Western scientists began to know well-known poet Hayyam as a great scientist owing to the French scientist Vopke.

The astronomical catalogue ***"Zij-i Malik Shah"*** was prepared in Isfahan observatory under the leadership of Hayyam. A copy of that catalogue is kept in the national library of Paris (manuscript № 5669). Coordinates of 100 stars have been described in the catalogue.

Ramiz Daniz

The founder of Maragha observatory – Nasiraddin Tusi

Azerbaijani scientist, Muhammad ibn Muhammad ibn Hasan Nasiraddin Tusi (1201-1274), who was remarkable philosopher, astronomer, mathematician, historian, geographer, financer and lawyer of XIII century, founded an observatory in accordance with his own project in Maragha located at the center of Azerbaijan. His first teacher was his father, but then he got lessons of teachers of Bahmanyar's and Abu Ali ibn Sina's schools. Names of N. Tusi's teachers have been written in historical documents. The student of his first teacher – Sadraddin Sarkhas was Fakhraddin Damady. The teacher of Sarkhas was the student of Abul Abbas Lovkari – Afzaladdin Gilani and he had got lessons of the student of Abu Ali ibn Sina – remarkable Azerbaijani scientist Bahmanyar. The second teacher of Tusi was Gutbattin Misri and his third teacher was the inventor of the dancer clock and the author of the astronomical catalogue ***"Zij-i Akbar al Hakimi"*** – Yunis Misri. Tusi's comprehensive and profound knowledge made him famous in the world of science during a very short time.

N. Tusi's heritage is an encyclopedic source for the whole Near and Middle East and has a special role in

formation and development of Azerbaijani people's thoughts. We may evaluate his scientific-literary heritage as part of the spiritual wealth of the Renaissance period.[1]

The most characteristic feature of N. Tusi's activity is its encyclopedic specification. Nasiraddin Tusi was famous in the whole Eastern world as genius scientists Abu Ali ibn Sina, Abu Raihan Al-Biruni and Hamid Al-Khojandi.

Authors of the many-volumed encyclopedia ***"Cambridge history of Iran"*** (in English) had played a significant role in investigation of N. Tusi's heritage. Comprehensive scientific activity of the scientist and scientific achievements of Maragha observatory have been analyzed in articles of B. Bail (Manchester University), A. Bauza (Naples Institute of Orientalism) and other scientists.

Everybody was aware of N. Tusi's encyclopedic knowledge. That's why the leader of Kuhistan Nasiraddin Mohtasham invited him to his palace as the honorary guest and asked to translate ***"Tahzibul akhlaq" ("Purity of moral")*** of Abu Ali Miskvih, who was the scientist of the Mamun Academy, from Arabic into Persian. But N. Tusi

[1] Azərbaycan Beynəlxalq Universiteti. Nəsirəddin Tusinin 800 illik yubileyinə həsr edilmiş Respublika konfransının materialları. Bakı, 2001. Professor M.F. Bayramovun məruzəsi, səh. 264

dodged that responsibility and said that, he was able to write more valuable work in that theme.

N. Tusi kept his promise in 1235 and wrote ***"Akhlagi Nasiri"***, which became very popular in the East, and presented it to the ruler. Copies of the work spread in the Caucasus, Iran, Middle Asia, India and other countries in a very short time. Mongke khan and Hulegu khan also read one of copies.

N. Tusi went down in history as the moral theorist of eastern nations after he wrote ***"Akhlagi Nasiri".***

It should be noted that, if N. Tusi could achieve fame in the world owing to "***Zij-i Ilkhani"*** and Maragha observatory, he was famous among eastern nations after ***"Akhlagi Nasiri"*** was written. This work was significant for its content's public, economical, political, moral, philosophical and educational essence. So the work became popular as the textbook of moral in schools of the Middle and Near East during more than 700 years. Many copies of the work were spread among people. ***"Akhlagi Nasiri"*** is a summary of moral, philosophical and pedagogical thoughts existing in the Near and Middle East. According to researches, any other work as ***"Akhlagi Nasiri"*** hasn't been written in Persian during recent 700 years.

The scientist had proved himself as a skilful teacher and remarkable educator with this work. He had described talents of people, influence of the environment and conditions on people and emphasized role of the education in human life.[1]

"Akhlagi Nasiri" consists of three articles, 30 chapters, "Introduction and reason why the book is written" and "First notes and division of sciences".

"Akhlagi Nasiri", which is considered immortal work in the field of ethics and education, might be written by a very educated person. People all over the world may be proud of the author of such book.

The scientist was arrested and sent to the Alamut ("The eagle's nest") castle after the work was published. Though several reasons of the arrest were listed, the most real reason was as following: progressive ideas of ***"Akhlagi Nasiri"*** had infuriated Muslim confessors, so the scientist was arrested.

Tusi wrote: "Defeated people shouldn't be annihilated wholly because they are slaves already". [2]

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[1] Azərbaycan Beynəlxalq Universiteti. Nəsirəddin Tusinin 800 illik yubileyinə həsr edilmiş Respublika konfransının materialları. Bakı, 2001. Professor H.M. Əhmədovun məruzəsi, səh. 3

[2] Xacə Nəsirəddin Tusi. Rəhim Sultfnovun farscadan tərcüməsi. Əxlaqi-Nasiri. Bakı, "Lider nəşriyyat", 2005. səh.235

N. Tusi was in prison at the Alamut castle. Though the scientist's moral situation was unbearable during more than 20 years spent in prison, he could write several scientific works there: ***"Sherhul-Isharet", "Tahriru Al-Majisti" (Almagest), "Tahriru Uglidis"*** (first edition). He wrote the last book in 1248 and its last edition (consisted of 13 parts) was written later.

N. Tusi wrote following thoughts at the end of ***"Sherhul-Isharet"*** (Commentaries on the philosophical treatise of Abu Ali ibn Sina ***"Isharet***"), which was completed by him in 1242: "I have written most chapters of this book under very hard conditions. I was in a very difficult situation. I have written this book in front of the hell".[1]

N. Tusi's torment is understandable. He was deprived of important libraries, which he needed for his investigations. All works written by the scientist in the prison were controlled. But in spite of it, he could write his immortal works at the Alamut castle under very difficult conditions.

L. V. Stroeva gave interesting information about foundation of the state of Ismailis: "The rebellion of Ismailis caused establishment of ismailism, which was a branch of shiitism, in Iran. In the middle of VII century

[1] Nəsirəddin Tusi. "Şərhül İşarət". Bu ifadələri profeccor Ə. K. Zəkuyev tərcümə edibdir.

Shiites thought that, only Imam Ali and his relatives had the right to be political leader of the caliphate as Imam Ali was considered religious leader of Muslims".[1]

According to I. Goldsier, later thoughts about Imam's personality broke relationship between Shiites.[2]

Their relationship was broken in VIII century after the sixth Imam Jafar Al-Sadiq deprived his elder son Ismail of the title of Imam. As he died before his father, he couldn't be an Imam. After it, part of Shiites, which considered that, his son Muhammad ibn Ismail was Imam, began to be called as Ismailis. They carried out their activities illegally as tried to avoid Abbasis' persecutions. Imam Ubeydullah – the successor of Imam Ali and Fatima (prophet's daughter) founded the Fatimid Caliphate (909-1171) independently. Ismailism was declared official religion of the Fatimi Caliphate.[3]

In spite of all these, the state of Ismailis was considered the partner of the Abbasid Caliphate and became one of distinguished states of the region.

[1] Л. В. Строева. Государство Исмаилитов в Иране в XI-XIII вв. Москва, «Наука», 1978. стр. 32

[2] И. Гольдциер. Лекции об Исламе. СПб, 1912

[3] Л. В. Строева. Государство Исмаилитов в Иране в XI-XIII вв. Москва, «Наука», 1978. стр. 32

When Genghis khan's grandson – Hulegu khan approached borders of Azerbaijan with his army, spies sent by the khan explained him that, Nasiraddin Tusi was genius scientist and wise person. Hulegu khan had heard a lot about the Azerbaijani scientist before too. He encircled the Alamut castle as felt reverence for scientists and wise people.

His troops occupied the castle in 1256 and freed N. Tusi and other scientists, who were in prison there.

While N. Tusi was at the Alamut castle, his family and most relatives lived in Hamadan. Well-known Azerbaijani historian Rashidaddin Fazlullah (1247-1318), who was N. Tusi's contemporary, wrote that Hulegu khan respected the scientist very much: "Hulegu khan respected Nasiraddin, sons of Rashiddovl and Muvafiqaddovl as they were from Hamadan and were great doctors. He had given them means of conveyance for taking their families, relatives and followers to the palace".[1]

The scientist became adviser of the Mongolian ruler as soon as he was freed from the castle. He assumed the responsibility for holding a number of political events of Hulegu khan after he was freed. Khan had to occupy the

[1] Рашид-ад-дин. Сборник летописей. III том. Москва, 1946. стр. 31

capital of the Abbasid Caliphate – Baghdad in order to broaden borders of his new state. N. Tusi gave him necessary advices. Though Hulegu khan thought that, it was dangerous to attack Baghdad, which was considered holy city of the Muslim world, he became more decisive owing to N. Tusi's advices.

Hulegu khan, who had stopped his troops near Baghdad, sent offers on surrendering to Mustesim – the caliph of Baghdad. The caliph rejected and threatened him with the wrath of God.

One of advisers – Husamaddin advised the ruler to give up his attack to Baghdad and to attack Constantinople. But as N. Tusi's advice was different, he quarreled with Husamaddin.

Rashidaddin Fazlullah wrote in his work ***"Jami Al-Tawarikh":*** "Hulegu khan consulted with statesmen and advisers about mentioned attack. Everybody said his opinion.

Hulegu khan called the astrologer Husamaddin and asked:

– What are stars saying?

The astrologer answered fearlessly:

– Success isn't expected in attack to Baghdad and war against Abbasids because nobody has achieved anything by

attacking Abbasids and Baghdad yet. If you won't listen to me and go there, six kinds of unhappiness may happen: first – horses may die and illness may spread among troops, second – the sun won't rise, third – it won't rain, forth – cyclone will spread and an earthquake will destroy the world, fifth – plants won't grow, sixth – the great ruler will die in the same year…

Then Hulegu khan called Nasiraddin Tusi and asked his advice. Tusi answered that, none of listed cases would happen.

Hulegu khan asked:

– Then what will happen?

Nasiraddin Tusi answered:

– Hulegu khan will be the caliph".

According to Rashidaddin, N. Tusi was far from the prejudice and was able to analyze the situation correctly. He proved his thoughts with scientific grounds.

Though Arabs ruled countries located in the Near East and south of the Caucasus Mountains during hundreds of years, those regions began to weaken gradually. A great change occurred in the Arab Caliphate in 750. As the Amavid dynasty (661-750) couldn't rule the empire, the Abbasid dynasty (750-1258) seized power and ruled the caliphate till the middle of XIII century. The capital of the

caliphate – Baghdad was the greatest and richest city of the world. Besides it, it was the greatest cultural, art and science center of the Near East. All popular scientists carried out their activities in this city.

Hulegu khan founded his mighty state in Azerbaijan in 1260 after Baghdad was occupied (1258). Elkhans were rulers of the new state called Ilkhanids.

The policy of Nasiraddin Tusi

Mongols hadn't any religious belief when they attacked Afghanistan, Iran, Near East and north of the Caucasus. They believed in ghosts. European monarchs and especially the Pope wanted Mongols to accept Christianity. The Pope sent his ambassadors to residences of Mongol rulers for acceptation of the new religion. But Muslims won this "competition". Berke khan (1201-1266) accepted Islam when he was holding power (1257-1266) and nomad Mongols became Muslims after it. Most of Russia's lands were controlled by Berke khan and he had listed Russian nations for the first time.

Though Azerbaijan had already been occupied by Hulegu khan, Berke khan also wanted to occupy this country. V. Shklovsky wrote about it using Marco Polo's ***"Travel book"*** as a source: "Berke khan also wanted to occupy Azerbaijan after Hulegu khan".

There were very good pastures below the Kur River. Livestock spent winter in those pastures and was taken to mountains in summer. Azerbaijan was famous for its artisans, cloths, carpets and swords made there were spread all over the world.

But Azerbaijan had already been conquered by Hulegu khan and he highly estimated this land. He declared Tabriz its capital.

Rulers of the Golden Horde and Mongolia fought with each other for Azerbaijan during about 100 years.[1]

There was a battle between troops of Hulegu khan and Berke khan near the Darband castle. Berke khan lost the battle in 1259 and his troops hid behind the Terek River. After the battle, he looked at corpses and said sadly: "We could conquer the whole world if we were together".

Did N. Tusi accompany Hulegu khan at that battle? It is known that, the famous scientist accompanied the ruler of

[1] В. Шкловский. Земли разведчик. М., «Молодая гвардия», 1966

Mongolia at all battles. Hulegu khan took his advices during difficult operations.

Most historians, who investigate Islam, condemn N. Tusi's participation in annihilation of the Baghdad Caliphate together with Mongol invaders. The Baghdad Caliphate and Mongol invaders both were threat for the Near East and Azerbaijan then. But they weakened each other at the result of struggling.

It should be noted that, N. Tusi, who accompanied Hulegu khan during occupation of Baghdad, had a significant role in rescue of scientists, women and children, who were in the city. He could make Hulegu khan to change his policy and to stop mass slaughters after occupation of Baghdad.

According to historical sources, Hulegu khan, who had approached Baghdad, stopped near borders of the territory, where Saljuk Turks lived. He had two choices: he might attack Baghdad, which was the last shelter of the Arab Caliphate, or lands of Saljugis, which extended to Constantinople. Hulegu khan's decision had to prevent weakening of Ilkhanids. Of course, the ruler had to take advices of his viziers and advisors before making decision. N. Tusi's advice was important for him. But the scientist had powerful opponents.

Though N. Tusi's scientific activity is approved by all without any doubt, his thoughts on religion couldn't be accepted without arguments. He was blamed for being against Muslims, helping Mongols, participating in occupation of Baghdad, advising Hulegu khan to kill the caliph and being an infidel. Tusi's answer was laconic enough: "I am a Muslim, so everything said about me is nothing but lie".

Calling N. Tusi, who was considered "Teacher of the world", infidel is an immorality as he was sincere Muslim and knew Koran very well. He is the author of some brilliant aphorisms about religion:

"Only order of the God is significant".

"The religion is a rule and state is its column".

"Muslims are hands. They can be body if they unite".

Though historians of Islam blame N. Tusi for annihilation of the Baghdad Caliphate, it isn't difficult to understand that, their approach was wrong. I'll try to substantiate it.

According to historical sources, lands of Iran and Azerbaijan were devastated by Genghis khan in 1221. Mongols sent Hulegu khan and 70 thousand fighters to the West in order to be leader in Southern Caucasus. This decision was made after Mongke khan was declared great

khan of Mongols in the congress held in Qaragorum. Mongol troops annihilated all political and military forces they met during the occupation process in order to prevent sabotages and terrors.

Muhammad Shah's son – Jalaluddin came to the throne (1221-1231) after destruction of Khwarezm and went to Afghanistan and Iran in order to resist Mongol troops. The ruler of Ismailis' state Aladdin (1212-1255) came to the throne when he was 9 (1221). His policy was neutral. He achieved agreement with Jalaluddin, who was an enemy of Mongols. The historian Nasavi, who was the secretary of Jalaluddin, wrote: "For the first time, Ismailis met Jalaluddin in 624th year of the Islamic calendar and 1226-1227th years of the chronology of Christianity. Ismailis had made every effort for this meeting".

Though there was a conflict between Ismailis and Jalaluddin for several times, his vizier Sharaf Al-Mulk preferred peace when he was in Ganja and Beylagan. He kept good relationship with Ismailis. I. Patrushevsky wrote about it: "Sharaf Al-Mulk's activity was a tragedy for Jalaluddin's life and quickened his death".

Hulegu khan had got acquainted with the political situation existing in Iran and Near East before his march to

Iran. Jalaluddin, Aladdin, Mustesim and Saljuk Turks were enemies. So Hulegu khan used this convenient situation.

The Mongol commander Kit Buka Noyon marched from Qaragorum to the West with 12 thousand fighters in August of 1252. He passed the Amu Darya River in 651 (Islamic calendar – R. G.) (March of 1253) and started military operations in Kuhistan. Kit Buka Noyon surrounded the Girdkuh castle with five thousand cavalrymen and infantrymen after part of the province was occupied.[1]

Hulegu khan, who was the commander of the powerful army, crossed the frontier of Iran in 1253 and attacked the territory of Ismailis founded by Hashashins. Mongols, who had occupied Iran easily, met with the strong resistance of Hashashins. The leader of Kuhistan was considered the owner of tens of invincible castles – Alamut, Girdkuh, Lamasar etc. located in mountainous territories of his country. Hulegu khan knew that, Hashashins were supporters of the Baghdad Caliphate and powerful rival of Mongols. The leader of Mongols, who was known as a skilful politician and experienced commander, deviated from occupation of Ismailis' castles by direct attacks and

[1] И. П. Патрушевский. Вазир Шараф ал-Мульк. – Ближний и Средний Восток. Москва, 1962. стр. 39

surrounded most of them. Hulegu khan demanded Ismailis to surrender without any battle.[1]

But in spite of it, the first castle surrounded by Mongols in Kuhistan (Girdkuh) resisted for 20 years and was occupied during the age of Abaga khan (1265-1282).

Hulegu khan used Genghis khan's principle when conquered Ismailis – killed everybody who resisted and showed mercy to everybody who surrendered. But then the ruler changed his principle. He ordered his fighters to kill everybody without exception. Almost everybody was killed in the country in several years. Mongols killed Jalaluddin, Aladdin and Ruknaddin when occupied this region.

After long negotiations, Ismailis' last ruler Ruknaddin Khurshah ibn Aladdin ibn Jalaluddin (1255-1257) emptied about fifty castles including the Alamut castle for Mongols. Nasiraddin Tusi and other wise persons acted as mediators in this process.

The historian of middle ages Juvayni mentioned that, occupation of the Alamut castle hadn't been realized as Mongols expected. Ruknaddin destroyed about 40 castles according to Mongols' instructions, but defenders of the

[1] Рашид ад-дин. Сборник летописей. Перев. с персидского А. К. Арендса. Под редак. А. А. Ромаскевича, Е. Э. Бертельса и Ю. Якубовского. М.-Л., III том. 1946. стр 26

Alamut castle, who could repulse first attack of Mongols, didn't surrender even when Hulegu khan's troops approached the castle's walls. Mongols sent Ruknaddin to defenders to make them to surrender. But he couldn't achieve success. The castle's commandant Mugaddam was a very stubborn man and didn't want to surrender. Hulegu khan ordered the prince Bagata to surround the castle with his troops and went to Lamasar. Mongols attacked Alamut during three days under the leadership of the prince, but failed and were obliged to go back. Then defenders started negotiations on surrendering.

Lyudmila Stroeva wrote about occupation of the Alamut castle in ***"Ismailis in Iran in XI-XIII centuries".***

"Defenders of the Alamut castle sent Ruknaddin to Hulegu khan as a mediator for surrendering. So khan sent him to the castle. He allowed defenders to take whatever they can from the castle during three days. Hulegu khan allowed Ruknaddin to climb the tower of the castle. There was a rich food stock in the castle. Part of it had remained from the age of Hasan ibn Sabbah".

Juvayni advised Hulegu khan not to touch the library existing there. All historical works of the library were given to the historian. Juvayni ordered to keep astronomical equipments, Koran, valuable manuscripts and to burn all

works on Ismailis. But the historian could take some of such works.[1]

Hulegu khan and Doguz Hatun.
From the manuscript "At-Tavarih" (XIV century)

So, the Alamut castle – the center of Ismailis (till 1090-1256) was destroyed.

N. Tusi had written his well-known books when he was in prison at the Alamut castle by using valuable works

[1] Л. В. Строева. Государство Исмаилитов в Иране в XI-XIII вв. Москва, «Наука», 1978. стр. 243

existing at the library of the castle. Later the Azerbaijani scientist took most works, which were kept at the castle, to Maragha library together with Juvayni.

So, Ismailis was conquered as the partner of the Arab Caliphate. Hulegu khan had to destroy the Baghdad Caliphate or the territory of Saljuk Turks in order to maintain safety of Ilkhanids.

He used to take advices of his viziers and advisers before important marches as it has been mentioned above. N. Tusi was known as the messenger of peace and his advice was more important for Hulegu khan than advices of other noblemen. The Azerbaijani scientist had to defend Saljuk Turks as he was Turkish by origin. Besides it, he knew that, Turks, who lived in Anatolia, were considered defenders of Islam. Even Christian rules of Europe had organized seven major Crusades against Saljuk Turks in order to annihilate Islam according to the Pope's order. Besides it, Turks settled in Anatolia played a role of barrier and strong line of defense between the Christian world and Ilkhanids in the West. After Hulegu khan invaded Iran and Azerbaijan, Turkish cavalrymen and infantrymen began to enter Mongolian Armed Forces. But it wasn't easy for Mongols' khan to win Saljuk Turks. Hulegu khan knew that, Turks were courageous, faithful and devoted people and never

were up in arms against each other. All these factors rescued Saljuk Turks. Later Turkish troops of the Mongolian Armed Forces had a significant role in destruction of the Baghdad Caliphate.

N. Tusi started construction of Maragha observatory during that period. If Hulegu khan didn't trust the scientist's wisdom, wouldn't permit him to found the observatory.

Mongols had occupied Azerbaijan during the age of N. Tusi. All administrative and cultural places were under the control of Mongols. It means that, the Azerbaijani scientist and his works also were under their control. N. Tusi was a head vizier of Hulegu khan and Abaga khan owing to his wise advises. Besides it, he was respected by them for his scientific achievements.

Hulegu khan considered N. Tusi the most skilful politician of the country for his reasonable advises and outlook. So, the scientist's advises were more significant for Mongols' ruler than advises of other noblemen. Hulegu khan knew that, Tusi's offers on the authority and management were very important. He had analyzed ideas of Aristotle, Platoon, Al-Farabi and ibn Sina when worked on such issues as the global policy, territorial policy and policy of sociability. According to H. B. Bayramov and S. M. Bayramov, analyze of the ***"Policy"*** of Platoon proved that,

Tusi had encyclopedic outlook in the field of public-humanitarian thoughts. He explained his interesting ideas with titles "Policy of the country", "Policy of defense", "Policy of liberality", and "Policy of people" (chapters of ***"Akhlagi Nasiri"*** – R. G.). Tusi, who proposed several government principles, divided the policy on this field into two parts: voluntary (democratic – H. B.) and forcible (authoritarian – H. B.) policy.

Most scientists tried to learn several science branches at that time. Especially they paid attention to mathematics, astronomy and philosophy. N. Tusi also had learnt several science branches very well. The scientist had made very interesting discoveries, which bewildered everybody. He is the author of hundreds of scientific works on astronomy, mathematics, physics, geography, history, philosophy, medicine, ethics, logic, musicology, geology and other fields of the science. But astronomy and mathematics are especially significant in N. Tusi's activity. He is the author of more than twenty investigations carried out in this field. Scientific researches and investigations carried out by the scientist were very large-scale and passed ahead of all previous scientists' works. His works on mathematics were in Arabic, but investigations on astronomy were in Arabic

and Persian. N. Tusi could become famous in the Near East as his works were in several languages.

The most well-known works of the scientist are ***"Shaklul-qita" ("Treaties about the perfect four-side"), "Jame ul-hesab" ("Collection of Counts"), "Measure of Circle", "Tahriru Uglidis" ("Recension of Euclid's Elements")***.

"***Zij-i Ilkhani" ("Astronomical tables of Ilkhanids")***, which consists of four parts, made the scientist popular all over the world. N. Tusi completed most of his scientific works after the observatory was built. It proves that, the scientist hadn't wasted his time in vain when learned several branches. He used to say that, people shouldn't waste their times in vain. Tusi thought that, everybody had to dedicate his life to the development of life.

Scientific results got by N. Tusi have spread widely and several science branches have been improved owing to them. Hulegu khan was constantly informed about the scientist's works while he was working on them. As the Azerbaijani scientist was very famous at that time, Abaga khan appointed him head vizier when came to the throne after Hulegu khan's death (1265). N. Tusi distinguished himself for his reasonable advises. The ruler trusted him even in the hardest situations.

I want to emphasize two paragraphs of the chapter "Muhammad Nasiraddin Tusi" of the book ***"Remarkable personalities of Azerbaijan"*** written by Chingiz Gajar:

"Most modern researchers think that, Nasiraddin Tusi was only a mathematician. His works have played a significant role in development of geometry and trigonometry in the East and Europe. Euclid's ***"Tahriru Uglidis"*** published in Rome in 1594 in Arabic and Latin had an important role in spreading Tusi's ideas in Europe. ***"Treatise on complete quadrilateral"***, which consists of five books, is known for its significance in development of trigonometry in Europe. Trigonometry is analyzed as an independent science branch in this work. The treatise has been translated into English, Russian and French.

The method of finding root of all degrees and Binomial formula are the most known discoveries of Nasiraddin Tusi made in the field of algebra. Besides it, scientist's works on history, mineralogy, physics, music and astronomy are also noteworthy.

Among them are ***"History of Baghdad", "Treatise on reflection and refraction of the light", "Euclid's optics", "Treatise on investigation of the rainbow", "Book about precious stones", "Treatise on public finance", "Selection of lucky days"*** (astrology) and others.

Most works of Nasiraddin Tusi are still waiting their researchers. They may be met in museums and libraries of Baku, Paris, Florence, Cairo, Istanbul, Moscow, St. Petersburg and Kazan.[1]

A number of the scientist's works haven't been discovered yet and are kept in state and personal libraries and manuscripts funds of the world. Probably, some of scientific works written in Maragha observatory are kept in different administrative buildings of Tabriz, Tehran, Peking and Nanking as works of other authors. One day all of his works will be discovered and mankind will estimate his services as necessary.

N. Tusi's important scientific works were always kept in most countries' museums and libraries. But they haven't been presented to readers properly. Some scientists have analyzed his works, but they have kept the author's name secret. One of them was well-known Italian geographer Paolo Toscanelli. He had found ***"Zij-i Ilkhani",*** used it and tried to keep the source secret. Later I'll give detailed information about it. But now I want to summarize information about N. Tusi.

[1] Ç. Qacar. Qədim və orta əsrlər Azərbaycanın görkəmli şəxsiyyətləri. Bakı, "Nicat", 1997. səh. 124

N. Tusi used to think about development of astronomy in Azerbaijan and building of the observatory since his early years. He needed powerful, influential and rich sponsor for realization of his ideas. The scientist could find such sponsor after half-century. It was mighty Hulegu khan. N. Tusi got his permission and started works on the observatory as soon as Baghdad was occupied. He found place for the building, prepared astronomical equipments, brought valuable books for the library of the observatory from different cities and invited scientists from different countries of the world for carrying out investigations in the observatory for a period of less than a year. N. Tusi wrote about it in ***"Zij-i Ilkhani":*** "Hulegu khan demanded to invite scientists for carrying out astronomical observations: Muayyidaddin Ordy from Damascus, Fakhraddin Maraghai from Mosul, Fakhraddin Ikhlatini from Tiflis and Najmaddin Dabirani from Qazvin".

According to other sources, well-known scientists Gutbaddin Shirazi, Shamsaddin Shirvani, Jamaluddin iz-Zeydi Bukhari, Fao Mun-Chi and others also worked in Maragha observatory. They improved their knowledge by means of N. Tusi besides working in Maragha observatory. Every employee of the observatory could work independently as the most skilful and experienced scientist

after leaving the observatory, which resembled an education center, and returning their countries.

According to the remarkable politician and historian of Azerbaijan Rashidaddin, Jamaluddin also had to found an observatory in Peking. But he wasn't able to fulfil this task. He could complete the task after coming to Maragha together with the Chinese scientist Fao Mun-Chi, taking Tusi's advises and obtaining sketches of equipments, which were necessary for the observatory.

Chingiz Gajar wrote about it: "One of the most remarkable scientists of Azerbaijan Nasiraddin Tusi was appointed advisor of Hulegu khan. Nasiraddin's fame had reached Peking even before this event and he was invited to the capital of the empire for construction of the observatory, which was planned as a perfect education center. But Tusi had rejected that invitation and convinced Hulegu khan of the importance of construction of the observatory in the capital of Ilkhanids – Maragha".[1]

As Hulegu khan's activity is very interesting for most researchers, its investigation is worthy of note.

He was one of beloved grandsons of Genghis khan. The most favourite entertainments of Hulegu, who preferred

[1] Ç. Qacar. Qədim və orta əslər Azərbaycanın görkəmli şəxsiyyətləri. Bakı, "Nicat", 1997. səh. 129

nomad's life, were hunting and organization of grandiose banquets. He was interested in beautiful things. He had learned military science and used it successfully.

According to Rashidaddin, Hulegu khan loved science very much, respected scientists and benefited by their knowledge.

Hulegu khan was courageous, stern and cruel, besides it, liked toadies very much… He was kind-hearted for his friends and merciless for enemies and he was greedy for wealth.[1]

Hulegu khan was brother of the ruler of Chine – Khubilay khan. The influential and mighty ruler respected him very much. Tusi knew that, Khubilay khan wouldn't reject his brother and was sure that, Hulegu khan was able to get his brother's permission for construction of the observatory in Azerbaijan. It was necessary to invite experts from Chine to Azerbaijan before getting corresponding permission. Young scientist Fao Mun-Chi was invited to Azerbaijan according to the request of Hulegu khan.

N. Tusi played a role of professional diplomatist in this business. Though the ruler of the great empire (Yuan) – Khubilay khan wanted to found an observatory in Chine, it

[1] Л. В. Строева. Государство Исмаилитов в Иране в XI-XIII вв. Москва, «Наука», 1978. стр. 243

was built in Azerbaijan. A large sum of money was needed for construction of the observatory and its future was unknown. The science center built in the empire had to develop astronomy and Khubilay khan knew it. He wanted to build another observatory in Chine with 20 thousand dinars given by Hulegu khan after Maragha observatory was completed and to invite the most experienced experts from Azerbaijan for this purpose. Khubilay khan knew that, skilful experts would be prepared in Maragha observatory for development of astronomy, mathematics, geometry and geography. So, experts invited from Azerbaijan would carry out main part of works, which had to be carried out in the observatory of Chine. Surely, graduators of N. Tusi's school were able to work in any part of the world.

Hulegu khan conquered all territories of Azerbaijan and declared himself the ruler of this country in 1256. After it, he appointed the genius scientist N. Tusi his advisor.

N. Tusi was born on February 18, 1201 in the settlement Bahar of the city Hamadan. He used the pseudonym "Tusi" as had got his education in the village Tus of the province Khorasan. He got his primary education by means of his father and secondary education by means of well-known scientists of XIII century. The student of Sarkhas – the student of well-known Azerbaijani philosopher Bahmanyar,

who was the student of Abu Ali ibn Sina, also was Tusi's teacher.

They say that, Nasiraddin had a phenomenal memory, used to analyze everything he read and heard, to accept positive ideas and reject negative ones since his early years. He liked to make new riddles, theorems, devices and equipments. He was interested in difficult scientific problems…

Tusi was famous as a genius mathematician all over the world. His philosophical, public-political and juridical ideas are very interesting. Abaga khan (1265-1282) appointed N. Tusi his vizier after he came to the throne in 1265 after the death of Hulegu khan. The scientist, who was a vizier of Ilkhanids for 9 years – till the end of his life could put several ideas on the "state" and "society" forward.[1]

Tusi had read and analyzed plenty of books since his early years. He was always respected by influential personalities of Azerbaijan and his researches carried out in different fields had made him famous all over the world.

N. Tusi had learned several sciences since his childhood. The science, literature, art and culture had developed highly

[1] Azərbaycan Beynəlxalq Universiteti. Nəsirəddin Tusinin 800 illik yubileyinə həsr edilmiş Respublika konfransının materialları. Bakı, 2001. Professor İ. M. Zeynalovun məruzəsi, səh. 270-271

at that time. Tusi had learned several languages and several science branches in order to analyze works of well-known scientists of the ancient time and early middle ages.

Azerbaijan was famous for its remarkable personalities known in the Near East as Muhammad Babakuhi Bakuvi, Shahabuddin Abu Hafs Suhrawardi, Qatran Tabrizi, Ali Khatib Tabrizi, Afzaladdin Khagani Shirvani, Omar ibn Osman Kafiaddin Shirvani, Ajami Nakhchivani, Mahmud Zanjani, Sheikh Nizami Ganjavi, Mahsati Ganjavi etc. during the age of N. Tusi. Hulegu khan had also heard about these people as the science and culture were important for him. N. Tusi was the most comprehensively developed representative of Azerbaijan and could amaze everybody with his knowledge. Hulegu khan trusted him even in the hardest situations. Actually, the scientist's advises were very reasonable. Owing to one of his advises, the great empire was razed to the ground and global changes occurred in the history.

Any state wasn't founded after the Baghdad Caliphate disintegrated (1258), but its territory was appropriated by Ilkhanids. Ilkhanids' treasury of the science and culture was opened for scientists of other regions. N. Tusi had an irreplaceable role in this historical process.

The ruler, who wanted to govern the state in peace, ordered Tusi to write a book about the state structure and finance system. Some issues of that book are still topical.

Muhammad Nasiraddin Tusi wrote about unemployment of youth: "They found jobs for healthy and prompt people who were not occupied with agriculture, trade, juridical affairs etc. Taught them to use weapons and called them to the army. Taught some of them to write and read. So, everybody was drawn into the corresponding job".

…Tusi advised the ruler to pay enough wages to state servants and officials. He wrote: "Then state servants wouldn't appropriate state's property".[1]

Besides it, I want to mention that, Hulegu khan had established Ilkhanids, which included Iran, Azerbaijan, Georgia, Iraq, Small Asia till the Kizil Irmak river, Turkmenistan and Afghanistan. The Baghdad Caliphate, which was considered powerful and rich state of the region, had been destroyed completely. Saljuk Turks were busy with appropriation of lands of the Byzantine Empire. Hulegu khan, who had founded his residence in Azerbaijan,

[1] Azərbaycan Beynəlxalq Universiteti. Nəsirəddin Tusinin 800 illik yubileyinə həsr edilmiş Respublika konfransının materialları. Bakı, 2001. Professor M. N. Seyidovun məruzəsi, səh. 210

gave up the occupation policy and spent the rest of his life for governing his state.

Turkish fighters attacked Baghdad first of all. After them, Mongol fighters brought all streets of the largest city of the Near East under their control and plundered the most grandiose buildings. Baghdad became ruins. N. Tusi, who was accompanying Hulegu khan during that march, could prevent death of many scientists, old men, women and children. The scientist rescued thousands of innocent people and this event went down in history.

But some politicians described occupation of Baghdad as a brutal execution: "Hulegu went to the caliph of Baghdad – Abbasi Mustamid, but struggle lasted in Baghdad, bloody clashes occurred often etc.

His (Hulegu khan's – R. D.) commander Bagu occupied Baghdad in February of 1258. The slaughter lasted for 40 days: towers, gates were destroyed, besides it, magnificent buildings and scientific collections were burned… So, Abbasids' rule, which had lasted for 500 years, was ended".

It seems that, K. Marks wanted to exaggerate occupation of Baghdad. But the reality was different. Though Mongols made great destructions and slaughters in the city, later Hulegu khan could liquidate chaos in the city in accordance

with advises of N. Tusi and Juvaini and brought the situation under his control.

Some historians write that, occupation of Baghdad was related with N. Tusi's desire to take vengeance on his enemies. They say that, 20-years imprisonment of the scientist at the Alamut castle was fault of the caliph of Baghdad. It is said that, N. Tusi had sent an ode to the caliph of Baghdad when he was in Kuhistan. It was received by supporters of the caliph's vizier ibn Alqam. After reading the ode, vizier thought that N. Tusi was a dangerous opponent and ordered to arrest him.

Above mentioned version was invented by historians of Islam in order not to soil the name of the caliph of Baghdad – Mustesim. But in spite of all these, N. Tusi wasn't furious at Nasiraddin Mohtasham and ibn Alqam. Nevertheless, everybody knew that, the Azerbaijani scientist was respected by Hulegu khan for his wisdom.

It has been proved that, N. Tusi was humanist and merciful person. He never desired to revenge. Following historical event proves it:

The caliph's vizier ibn Hajib also was hiding when Mongols occupied Baghdad. N. Tusi had come to Baghdad in order to present his work on **"Ahli beyt"** to the caliph

when he was young. The vizier looked through the book and threw it in the River Dajla.[1]

N. Tusi's friends advised him to throw ibn Hajib in the river as he did it with the book. But, the scientist bore him no malice.

N. Tusi's character was the same when he was in prison and at the palace of Hulegu khan. It is already known that, he could rescue thousands of people during occupation of Baghdad and among them were a lot of remarkable persons. People, who had exposed to repressions for their political thoughts, mostly asked N. Tusi's help. And the scientist asked Hulegu khan's support in his turn.

According to the history, ambassadors going to Chine and Mongolia from European countries used "Silk way", which passed through several countries of Asia. Part of the "Silk way" passed through Azerbaijan. There is no doubt that, ambassadors could get acquainted with Azerbaijan's culture, literature, art, customs, science, policy and historical personalities when they were in this country.

So, they heard a lot about N. Tusi, who was famous in Azerbaijan and Near East in the middle of XIII century for his character and scientific achievements.

[1] A. Məmmədov. Hökm və hikmət. Bakı, "Qafqaz-LTD", 2002. səh.158

There is no doubt that, N. Tusi's fame had spread in Europe. Experts of astronomy, mathematics, geometry, geography and history were especially interested in his activity.

Most of his colleagues knew him as the philosopher and scientist. Representatives of the ancient Greek philosophy – Fales, Platoon, Aristotle and philosophers of the middle ages M. Al-Ghazali, Bahmanyar, Al-Farabi, Al-Biruni, ibn Sina had a significant role in formation of philosophical ideas and ethnic thoughts of the scientist. Arab historian and sociologist of the middle ages ibn Khaldun mentioned that, N. Tusi was ibn Sina's follower.

N. Tusi understood death of the matter as its replacement at the result of changes in its form and features as previous peripateticians.

"People could get an opportunity to get acquainted with Tusi's ideas owing to this philosophical work written in Azerbaijani ***("Akhlagi Nasiri"*** – R. D.). The scale, logical basis and structural analyze of ideas proved that it was humanist thinker's conception on humanity".

There is no doubt that, the author of above mentioned ideas knew several science branches. But unfortunately, his scientific heritage hasn't been investigated enough. So, some works of the scientist including his theory on the

meridian of America haven't been learned yet. He had written that, the prime meridian started on Haldat Islands.

Construction of the immense observatory in Maragha

It should be certainly mentioned that, any state leader didn't want to build an observatory in Azerbaijan then. But the largest observatory of the world was built here in accordance with Nasiraddin Tusi's personal initiative. He could get permission of the ruler for construction of the science center when he was in Baghdad. Nasiraddin Tusi convinced Hulegu khan of the importance of mentioned science center.

A lot of money was needed for construction of the observatory. At first this business didn't seem expedient. But N. Tusi could prove that, its result would be very useful.

Perhaps, the scientist could explain it to Hulegu khan in a very easy way. Thunder, lightning, wind, thunderstorm, heavy showers, streams, aridity, movements of celestial bodies and their collision with the Earth were interesting for

every ruler. They could win battles more easily if had information about all these factors.

The scientist didn't seek his own benefit only. He did his best for his colleagues' welfare too.

N. Tusi was very active in organization of publishing of books on science and economy. Lots of valuable stones brought from Baghdad and Alamut castle were kept in the treasury in Shahi Island located on the Lake Urmia. It was necessary to register those valuable stones, so the ruler asked N. Tusi to write a work about properties of valuable stones and the scientist wrote initial and brief version of ***"Javahirname"*** (Mineral Cures) during a short time. Whole part of the work is known by the name ***"Trangusnameyi Ilkhani".*** There are descriptions of 23 minerals, 2 bones and 3 grass kinds of economical and medical importance in ***"Javahirname",*** which has a significant role in the history of Azerbaijani art.

Hulegu khan had taken possession of great trophy when he occupied Baghdad. N. Tusi didn't waste the opportunity and could make the ruler to pay salaries to all scientists, who had participated in construction of the observatory and worked there. Those salaries were paid with money collected by means of taxes according to the initiative of the

scientist. N. Tusi made great efforts in order to improve welfare of all scientists in Azerbaijan.

N. Tusi could get permission of the ruler for construction of the observatory as the scientist had given useful advises for occupation of Baghdad. He knew that, Hulegu khan would take possession of Abbasids' great trophy after occupation of Baghdad.

The scientist could convince the ruler of the convenience of Maragha – one of ancient towns of Azerbaijan for construction of the observatory. As the town was located at a high position, it was easy to observe celestial bodies there.

N. Tusi had sent valuable books to Maragha when he was in Baghdad. He tried to find remarkable and well-known scientists.

Construction of Maragha observatory was started in 1259 on the slope of the hill located in the west of the town. Nasiraddin Tusi also participated in projection of the building and installation of astronomical equipments. Skilful architects were invited to Maragha for construction of the observatory. N. Tusi trusted Muayyidaddin Ordy, who was invited from Damascus, very much. N. Tusi installed five new and five old astronomical equipments in the observatory together with the remarkable astronomer and constructor M. Ordy. New equipments were prepared

by scientists. Besides it, globes of the Earth and Sky were also prepared in Maragha observatory for solution of some astronomical problems.

Let's speak about the architecture of the observatory:

16 main and subsidiary buildings were also built there. Seven of them were round. Main tower of the observatory was in front of buildings. The width of the round tower was 22 meters. Main cabinets of astronomers and mathematicians were in this tower. Tusi, Ordy, Fao Mun-Chi and Gutbaddin Shirazi spent all of their times there and observed stars and other celestial bodies. This observatory was considered one of the most important science centers. It hadn't analogue in any region of the East till the middle of XIII century. Foreign representatives, especially Mongol representatives of Chine and Middle Asia were amazed when they saw the observatory.

Equipments of the observatory were in the field with 350 meters length and 150 meters width located on the hill. Equipments used for observation of celestial bodies were installed in main buildings. There were religious schools, libraries, workshops of machine-building, metal-casting etc. including scientists' cabinets. A mosque was also built in the mentioned field. Maragha observatory would support activity of wise people all over the world according to N.

Tusi's project. He had told to Hulegu khan that, the observatory would be open for all foreign scientists as soon as its construction would be completed. Though there were wars and conflicts, astronomy, mathematics, geometry and geography had to be developed in all countries of the world. The scientist thought that, every ruler needed wise persons and development of the science instead of wars.

It is known that, there was another observatory in Azerbaijan before construction of Maragha observatory. E Mehraliyev wrote according historical documents: "He (Kafiaddin Omar – R. D.) established an observatory in the upper part of Shamakhi and invited Abdulkerim Shirvani, Falaki Shirvani and other astronomers there".[1]

He supported geocentric system in the science.

Maragha is located at $46^0\ 16^/$ geographic longitude and $37^0\ 23^/$ geographic latitude and it is one of the most splendid places of Azerbaijan. Especially foreigners liked this town. One of them was well-known traveler V. Shipchinsky. He wrote about Maragha: "It smelled blossomed wild olive-trees even several kilometers away from the town. Maragha is located at 35 kilometers away from the eastern coast of the Lake Urmia and on the height of 1613 meters from the

[1] E. Mehraliyev. Şirvanilər. Bakı, 1996. səh. 20-21

ocean's surface. It is a very old town: it was attacked by Saljugis in 1029 and was destroyed by them…"

There are marble deposits in Dashkasan located around Maragha and marbles brought from there were used in construction of the observatory. There are plenty of Narzan mineral water springs in southern and eastern bottoms of mountains located around the town. The weather is very pure owing to the Lake Rezayya located around Maragha. So, Maragha is convenient for astronomical observations. Nasiraddin Tusi had been in all regions of Azerbaijan in order to find convenient place for the observatory and at last chose Maragha.

Scientists were invited to Maragha from different countries and cities during the construction process. Everybody worked intensively. Besides local students, foreign students also studied there. Tusi tried to develop Maragha as cultural, art and scientific-educational centers as Athens, Rome, and Alexandria. There were enough necessary opportunities in the capital of Azerbaijan for it: first, Azerbaijan was becoming powerful state, second: his rulers were mighty leaders of their age. Nobody could dare to occupy such country. In a word, there were great

perspectives for development of all science branches in Azerbaijan.[1]

The observation was built in 12 years and began to be used in 1271. There were all necessary facilities for scientists' works in Maragha. There were a lot of equipments in the observatory. N. Tusi – the founder of the observation allowed to use those equipments in foreign countries too. The ruler of Azerbaijan Abaga khan was satisfied with works carried out in the observatory and tried to help experts, who worked there. The ruler's kindness and benevolence pleased everybody.

Both rulers of Ilkhanids Hulegu khan and Abaga khan had read ***"Akhlagi Nasiri"*** written by N. Tusi. That's why they accepted the scientist's advices and admonitions without doubt.

N. Tusi could establish medieval academy in the observatory. If Mongols didn't cause a scare in European countries, students of those countries would come to Azerbaijan in order to get education. Then Maragha observatory would be well-known in European countries too. The scientist had made great efforts for this purpose.

[1] R. Qasımov. Xristofor Kolumb, Nəsirəddin Tusi və Amerika qitəsinin həqiqi kəşfi. Bakı, "Çaşıoğlu", 2002. səh. 72

The observatory wasn't built in Maragha accidentally. Nasiraddin Tusi knew that, Azerbaijan was situated on the "Silk way", on the point of intersection of different trade ways and in the place of the strategic importance. The country was within Ilkhanids and far-sighted scientist assumed that it would be weakened by other states in 100-150 years. That's why he established the observatory in Maragha, but not in large cities as Tabriz, Isfahan and Baghdad, which were within Ilkhanids. He knew that Maragha was the capital of Azerbaijan, but it might escape from great destructions unlike other cities of the strategic importance during future bloody and destructive wars, so, the observatory could be saved for future generations. There weren't large fortifications, castles and towers in Maragha. Actually, later, capital of Azerbaijan was moved from Maragha to Tabriz.

The observatory established by N. Tusi had passed ahead of all well-known observatories of the East for its structure, scale and scientific investigations carried out there. It was considered academy of astronomy, geography and mathematics for scientists of the world.

It was important to establish astronomical research institute carrying out intensive and exact observations for

determination of most main astronomical quantities for solution of several problems.

One of such quantities was an annual precession dose. It is known that, the axis of rotation may change its direction at the result of impact of the gravitation of the Moon and Earth on the equatorial part of the Earth. Some changes occur on coordinates of stars at the result of the gravitation the Moon, Sun and planets. It was necessary to know elements of lunar and solar movements and eclipses in order to prognosticate lunar and solar eclipses and to prepare movement tables of the Moon and Sun.

Several valuable works were written about different science branches under the leadership of N. Tusi. Main elements of geocentric orbits of planets and their daily movements were described in ***"Zij-i Ilkhani". "Zij-i Ilkhani"*** was considered unique work in the field of astronomy for several centuries. Unfortunately, the work wasn't translated and spread in the world then. But some scientists, who were interested in the book, could read it with the help of translators.

Nasiraddin Tusi wrote in the introduction of ***"Zij-i Ilkhani":*** "Hipparchus's observations were considered most productive works before us. More than 1400 years have passed since that time. 285 years after Hipparchus,

observations of Ptolemy became popular. His observations were continued in Baghdad during the age of the caliph Mamun and more than 430 years have passed since that time. Observations of Hakami and ibn Al-Allama carried out 250 years ago were similar to our observations".

As it was mentioned above, some scientists write that, Paolo Toscanelli had used N. Tusi's table of geographic coordinates and his map when he made his well-known map in 1474. The Florentine cosmographer had noted on his map that, it was possible to go to India from Europe by crossing the Atlantic Ocean in the West. It proves that, progressive-minded people of that time believed that, the Earth was spherical and they noted this fact in their materials, maps and investigation works though there were a lot of people, who tried to impede them.

N. Tusi could prepare broad and pithy reports on stars. Those reports mainly consisted of coordinates of main stars. He had determined the prime meridian at 10^0 towards the west of the known meridian unlike Abu Raihan Al-Biruni and mentioned that there was a very large territory in that part of the Earth, which was unknown for the Old World. This conclusion has a very simple explanation. Usually geographers and cartographers of middle ages wrote that the

prime meridian passed through the beginning or the end of the continent, large island and peninsula.

As it has been proved that, P. Toscanelli had used the map and reports of the Azerbaijani scientist, I have come to the conclusion that, Christopher Columbus had also used ***"Zij-i Ilkhani"*** and N. Tusi's map, but he preferred to keep it secret.

Maragha observatory and its scientists

According to the remarkable Azerbaijani scientist Rashidaddin, more than 100 scientists and other employees worked in Maragha observatory. Most of them were N. Tusi's students. Later they became well-known scientists of their countries and got jobs in rulers' palaces. Even some of them tried to get their rulers' permissions for construction of similar observations in their countries. But as realization of such projects required plenty of money, they couldn't succeed. Names of some well-known and influential experts of Maragha observatory have been determined after investigation of several sources:

1. Muhammad Nasiraddin Tusi
2. Mahmud Gutbaddin Shirazi
3. Gregory Abul Faraj
4. Muayyidaddin Ordy
5. Najmaddin Dabirani
6. Fakhraddin Ikhlati
7. Fakhraddin Ahmad At-Tusi Al-Maraghai
8. Mahiaddin Maghribi
9. Sheikh Kamal
10. Damghanli Mahmud Najmaddin Usturlabi
11. Husamaddin Shami
12. Sadraddin Nasir Tusi
13. Najmaddin Katib
14. Fao Mun-Chi
15. Isa Mongol
16. Tagiaddin Ali Hashshashi
17. Nafisaddin ben Tolayib
18. Nasrani Safiaddin
19. Muhammad ben Muayyidaddin Ordy
20. Jamaluddin az Zaidi Bukhari
21. Mohiaddin Kamal
22. Abi Shukr Maghribi
23. Ibn Al-Fuvati
24. Nizamaddin Al-Naysaburi

25. Asiladdin Hasan at-Tusi
26. Karimaddin Abubakr ibn Mahmud Salmasi
27. Shamsaddin Shirvani
28. Mohiaddin As-Shirvani

Some scientists write that, scientists of Maragha and other Muslim countries used to copy works of ancient Greek scientists. Of course, it is impossible to agree with this thought. Scientists of the East had played a significant role in improvement of ancient scientific works when their copies were created. The Renaissance Culture was established in the East before Europe.

Some scientists describe Renaissance Culture as the product of Italy (XIV-XVI centuries) and Europe (XV-XVI and XVII centuries) and try to prove that the East was always behind the West for its culture.

According to scientists of the West, culture of Muslim countries doesn't correspond to all main features of the Renaissance Culture. But some orientalists of the West don't defend this thought. Well-known orientalist of Switzerland Adam Mets named his work devoted to investigation of the Islamic culture ***"Muslim Renaissance"*** and noted that the Islamic culture was older than the Western culture…

Model of Maragha observatory was made by the Academician M. J. Bulatov (1907-2004)

Application of the ancient culture developed during slavery years in Greece has spread widely in Italy too. The East had passed ahead of the West from this point of view, humanist philosophy and literature were developed in Chine, India and Iran in VIII-XII and in Azerbaijan in XII-XIII, innovations made by Nasiraddin Tusi in science – astronomy, mathematics, mineralogy spread all over the

world. The ancient culture has been applied in Azerbaijan Renaissance as Italian and European Renaissance. ***"Isgandarname"*** of Nizami Ganjavi and ***"Akhlagi Nasiri"*** of N. Tusi, especially its 30th chapter may be cited as examples. Nizami described Macedonian Isgandar, who had established Hellenistic stage of the ancient culture, historical personalities connected with him, first of all his teacher Arastoo (Aristotle – R. D.) and N. Tusi included ancient Greek philosopher Platoon's admonition to his student Aristotle and more than 40 instructive aphorisms written by him in ***"Akhlagi Nasiri".***[1]

According to historians, main duties of astronomers of the East lived in IX-XIV centuries was to present scientific works of ancient astronomers to the community.

The author of "The role of Maragha observatory in development of Islamic astronomy: ***Scientific revolution before Renaissance"***, scientist of Columbia University (USA) J. Saliba wrote that, such thought about astronomers of the East was considered right before 50th centuries of XX century. Because scientific works of representatives of "Maragha School" established in Maragha (Eastern

[1] Azərbaycan Beynəlxalq Universiteti. Nəsirəddin Tusinin 800 illik yubileyinə həsr edilmiş Respublika konfransının materialları. Bakı, 2001. Professor Y. A. Qaraməmmədlinin məruzəsi, səh. 267-268

Azerbaijan) in XIII century weren't known then. The scientist mentioned that, results of investigation of the activity of "Maragha School" prove that, presentation of scientific works of ancient astronomers wasn't only duty of astronomers of the East lived in IX-XIV centuries.

Besides it, in 1957 American scientist V. Roberts wrote that, the Earth model presented by astronomers of the East stimulated Copernicus's model.

Authors of many articles about "Maragha revolution" wrote that, scientific revolution was made by Copernicus owing to activities of scientists of Maragha. There is no doubt that, Copernicus had learned scientific heritage of Maragha observatory. It should be mentioned that, the scientist of Poland was considered "the most talented representative" of Maragha observatory.

N. Tusi is the author of many books and tractates about astronomy: ***"Zij-i Ilkhani", "Tahriru Al-Majisti", "The tractate about astrolabe", "Memories about astronomy", "Thirty chapters"*** etc.

The Academician F. Magsudov and Professor H. Mammadbayli wrote about ***"The tractate about astrolabe":*** "The astrolabe is mobile astronomical equipment. Observers can determine geographic coordinates of the place they stand on by means of this equipment. This book of Tusi had

spread widely. Another book of the scientist is ***"Thirty chapters".*** His theoretical work about movements of planets is named ***"Memories about astronomy"…***

Nasiraddin Tusi was guided by heliocentric theory of planets. The scientist's astronomical activities didn't lose their significances even after development of Copernicus's heliocentric system plan".[1]

Let's give some information about several scientists of Maragha observatory, which were famous for their astronomical researches:

Their scientific works had spread in Near East and South-Eastern Europe and admired experts of different fields in a very short time. So, several talented scientists of Maragha observatory were known abroad too. Every educational center can be proud of such result.

The head of Shamakhi Astrophysical Observatory – Academician Hajibay Sultanov mentioned that, Maragha observatory had stimulated development of physics and mathematics in Western Europe, Chine, Middle Asia and India.

Mahmud ben Masud Gutbaddin Shirazi (1236-1311) was born in Shiraz and spent his youth there. He was a student

[1] Ф. Максудов, Г. Дж. Мамедбейли. Мухаммед Насирэддин Туси. Баку, «Гянджилик», 1981. стр. 29-30

of Nasiraddin Tusi and learned astronomy and mathematics. Gutbaddin had worked in Maragha till 1282 and then was sent to Egypt as the ambassador of Mongols. He made a map of the Mediterranean Sea and lands located around it in Egypt. The scientist is an author of a very valuable work – ***"End of knowledge"*** written in Arabic about astronomy and geography achievements of his time. After it he wrote an encyclopedic book by name ***"Durratul taj" (Pearls of the crown)***.

Another scientist of Maragha observatory – a Jew, who had adopted Christianity, by name Johanna Gregory Abul Faraj Bar Hebraeus (1226-1286) was born in the eastern part of Anatoly Peninsula. Abul Faraj, who was a bishop in Malatya and head churchman in Aleppo, came to Maragha in 60^{th} years of XIII century and worked there under the leadership of Nasiraddin Tusi. He is the author of the valuable work, which includes brief information about bases of astronomy and geography and was written in Arabic. Abul Faraj became popular in Europe for his book ***"History of dynasties"*** or ***"Brief history of states"*** written in Arabic. This work describes lifestyle of multinational collective, which worked and lived in Maragha observatory.

The chief engineer and builder of Maragha observatory was Muayyidaddin Ordy. There isn't enough biographical

information about Ordy. Only two manuscripts of his treatise about ***"Astronomical equipments of Maragha observatory"*** written in Arabic have remained as historical documents. They are kept in national libraries of Paris and Tehran. The first manuscript was found by the teacher of the special school of eastern languages A. Jurden in Paris at the beginning of XIX century and was translated into French. The book was published in Paris in 1809 and 1810. It was translated into Germany in 1811. The book includes description of ten astronomical equipments prepared by Ordy under the leadership of Nasiraddin Tusi. At the result of analysis of information given in Ordy's tractate, researchers came to the conclusion that, equipments of Maragha observatory were more perfect than equipments of other observatories. It is known that, equipments invented by Ordy were used in most observatories of the world. Further made astronomical equipments also were improved by using Ordy's equipments.

Muhammad Ordy worked on preparation of astronomical equipments in the observatory and was the author of the most ancient star globe of the world (1279). Positions of stars were showed exactly on that globe.

A rich man had established a museum by name **"Picture Gallery"** in Dresden, Germany in XVI century and the

globe made of bronze, silver and gold were kept in that museum.

Sadraddin Ali Tusi was a leader of the observatory after his father's death. His brother Asiladdin is the author of one manuscript of ***"Zij-i Ilkhani"*** kept in the national library in Paris.

The sky globe of scientists of Maragha.
Museum of Dresden

Mahiaddin Maghribi was Spanish Arab. He came to Aleppo before construction of the observatory and worked in the field of astronomy there. When troops of Hulegu khan entered Aleppo, Mahiaddin used his privileges as an astronomer. Hulegu khan, who was aware of Nasiraddin Tusi's respect to astronomers, rescued Mahiaddin and sent him to Maragha.

Well-known scientist Fao Mun-Chi had come from Chine, Isa had come from Mongolia and Fakhraddin Ikhlati had come from Tiflis. Scientists of Maragha observatory were of different religions. Besides Muslim scientists, Christians, Nasranis and Buddhists also worked in the observatory and they were always welcomed there. There were Persians, Arabs, Jews, Uzbeks, Chinese, Turks, Mongols and others among scientists of Maragha observatory besides Azerbaijanis. It turns out that, Maragha observatory was multinational cultural center and there was a real emancipation there. This factor was one of the most advanced features of the observatory.

The astronomer by name Go Shu-Ching established an observatory in Khanbaliq (Peking) in 80th years of XIII century. According to ***"History of Juan dynasty"*** written in Chinese and notes of the Azerbaijani historian Rashidaddin, Mongke khan had asked Hulegu khan to send Nasiraddin

Tusi to Chine for construction of the observatory after he was freed at the result of occupation of Hashshashis' tower. But as the Azerbaijani scientist wanted to establish an observatory in Azerbaijan, he didn't go to Chine. So, the Chinese astronomer by name Fao Mun-Chi was sent to Maragha in order to organize construction of an observatory in Peking. Fao Mun-Chi went to Chine together with another astronomer by name Jamaluddin in 1265 after gathering enough experiences in Maragha observatory and reached Peking after two years.

Khubilay khan, who paid special attention to the science and culture, was the ruler of the great Juan Empire and hoped that Chinese experts would be able to build a building resembling Maragha observatory in Peking. In Peking observatory celestial bodies were observed with astronomical equipments brought from Maragha observatory (Rotary quadrant and Armillary device). Astronomical equipments invented under the leadership of N. Tusi were considered the most exact astronomical equipments for at least 200-year period. Those equipments are still kept in Chine (Peking observatory).

There were several observatories and science centers in the world before construction of Maragha observatory. ***"Tables of Faridaddin"*** made by Fakhraddin Shirvani at

"Darul-Uloom" and "Dar Al-Adab" academies in Shirvan was popular. Mamun Academy in Central Asia, Alexandria observatory in Egypt, Baghdad observatory in Iraq, Rey and Isfahan observatories in Iran served astronomy properly. Mentioned educational centers stopped their activities during next historical processes.

I want to mention one interesting problem. Ten devices and equipments were used in Maragha observatory for scientific experiments and observations. Five of those devices and equipments were known before the middle of XIII century, but other five were invented in Maragha observatory under the leadership of N. Tusi. Equipments and devices invented in Maragha observatory were used in Peking observatory of Chine, Ulugbek's observatory of Samarqand, Tycho Brahe's observatory of Denmark and Jaipur observatory of India established during next years and great works were carried out in order to improve those equipments. Let's give some information about mentioned observatories.

Ramiz Daniz

Application of *"Zij-i Ilkhani"* in other astronomical catalogues

The grandson of Timur Leng, who valued science, culture and art, – Ulugbek (22.03.1394 – 27.10.1449) established a grandiose astronomical observatory in Samarqand when he was the ruler of Samarqand. He invited well-known scientists as Giyasaddin Kashi, Gazi-Zadeh Rumi and Ali Kushchi to his observatory in order to develop astronomy and mathematics. Giyasaddin Kashi made the astronomical catalogue by name ***"Zij-i Khagan"*** in accordance with ***"Zij-i Ilkhani".***

Giyas ad-din, who had learned astronomical equipments of Maragha observatory, is the author of the tractate about astronomical equipments and interesting works as ***"The key to arithmetic", "About environment of a circle", "Chord and sinus"*** and others having a significant role in development of mathematics.

Gazi-Zadeh Rumi was Ulugbek's teacher and became leader of the scientific collective after the death of Giyas ad-Din. Ali Kushchi completed even all scientific works after the death of Rumi and made ***"Zij-i Ulugbek"*** and ***"Zij-i Gurgani"*** catalogues including information about main works of Ulugbek's observatory.

Ali Kushchi (1402-1474)

Ulugbek's observatory was well-known for its wall sextant, which's radius was 40.04 meters, and astronomical catalogue by name ***"Zij-i Ulugbek".*** The wall sextant consisted of a quarter-circle as its analogue in Maragha observatory. Its scale was between 0 and 90.

Half of the device was under the ground and other part of it was on the ground. Special building was built for the upper part of the wall sextant. It was three-storeyed building and its height was 21 meters. The device was placed on the

meridian plane. There was a cupola on the upper part of the building for observation of the Sun and planets.

One of Uzbek astronomers of XX century Jalalov compared ***"Zij-i Ulugbek"*** and ***"Zij-i Ilkhani"*** and found plenty of similarities between them. There was a single difference between observation programs described in ***"Zij-i Ilkhani"*** and ***"Zij-i Ulugbek":*** Coordinates of 1018 stars had been determined at the result of observations made in Ulugbek's observatory. According to results of investigation of those stars' coordinates by the American astronomer E. B. Knobel, longitudes of 900 stars and latitudes of 878 stars were redetermined in Ulugbek's observatory. It was considered high result in the field of astronomy. E. B. Knobel wrote: "The star catalogue made in accordance with his special observations has an exceptional importance".

Well-known French mathematician and astronomer Pierre Laplace, who had investigated Ulugbek's observatory, wrote: "He (Ulugbek – R. D.) made a star catalogue and astronomical tables in the capital of his country Samarqand and they were best tables made before Tycho Brahe's observatory".

The star catalogue ***"Zij-i Ulugbek"*** was considered detailed and necessary work for development of astronomy, improvement of astronomical observations, learning of

uncommon movements of celestial bodies and their structures. But Ulugbek's observatory had been working since the first half of XV century though Maragha observatory had been working since the second half of XIII century. Maragha observatory was 150 years older than Ulugbek's observatory. Such period is enough for achievement of important scientific results. Scientific experiments, astronomical observations and scientific results of Maragha observatory were superior of achievements of all observatories built before Tycho Brahe's observatory. We should admit that, astronomers of Samarqand had used results of works carried out in Maragha observatory in most of their activities. Well-known scientists of Azerbaijan H. Mammadbayli, Z. Khalilov and Farajov also approved this fact.

Let's note values of annual precessions in order to clear up this question:

Ptolemy – 36.0
Al-Battani – 54.4
Al-Sufi – 55.0
Nasiraddin – 51.4
Ulugbek – 51.4

Professor H. Mammadbayli wrote about it: "The table of geographic coordinates of 256 cities was made in Maragha

observatory and it was included in ***"Zij-i Ilkhani".*** Such table existed in ***"Zij-i Ulugbek"*** too. According to results of investigations, that table was copied from ***"Zij-i Ilkhani"*** to ***"Zij-i Ulugbek".*** Only coordinates of Samarqand were redetermined. There were sine and tangent charts in ***"Zij-i Ulugbek"*** too. But those charts were more exact that charts prepared in Maragha observatory.

Ulugbek (1394-1449)

Values of those functions were precise to the fourth digit. It should be mentioned that, scientific works carried out in

Maragha observatory had great influence on the activity of Samarqand observatory. But each observatory had its own scientific activity".[1]

Astronomers of Ulugbek's observatory used scientific works carried out by the remarkable Azerbaijani scientist N. Tusi as directives and Maragha observatory was a reference point for them.

In general, scientific-practical works carried out in Maragha observatory established by N. Tusi were stimulators for astronomical observations of all new observatories established in the middle ages and all scientific experiments were used there. That's why European astronomers knew structures of astronomical equipments invented in Maragha observatory. Several rotary quadrants (azimuthal quadrants) and one wall quadrant were found in Tycho Brahe's observatory established in Copenhagen. Its semicircle was improved and became "Universal" device used in modern astronomy. It proves that, Tycho Brahe had sent several scientists to Azerbaijan for investigation of the activity of Maragha observatory before construction of his observatory in Copenhagen. All equipments and devices invented and used in Maragha were

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh.148

interesting for all astronomers, mathematicians, cartographers and geographers of the world.

Though precisions of observations made in Maragha were ideal in comparison with European and Asian observatories, observations made by Tycho Brahe at the end of XVI century were more precise.

Jaipur observatory of India was considered well-known center of astronomical observations in its country and in the south of Asia. Two astronomical catalogues – ***"Zij-i Shah Jahan"*** and ***"Zij-i Muhammad Shah"*** were made in that observatory during the age of Shah Jahan (1628-1659) and Muhammad Shah (1719-1748). Investigation of mentioned catalogues by several scientists proved that, its observation program consisted of observation programs of Samarqand and Maragha observatories. Some of tables of those catalogues consisted of the copy of the table of ***"Zij-i Ilkhani".***

The author of ***"Zij-i Shah Jahan"*** – Indian astronomer Abu Mulla Farid Dehlvi and the author of ***"Zij-i Muhammad Shah"*** – great scientist of India Savoie Jay Sing had learned activity of N. Tusi and astronomical observations made in Maragha observatory when they prepared mentioned astronomical catalogues. It should be taken into account that, Savoie Jay Sing made his catalogue

in the middle of XVIII century and almost all astronomers of the world used N. Tusi's work as the source though 500 years had passed since ***"Zij-i Ilkhani"*** was made. All of astronomical equipments used in European observatories were being improved on those days. Optical equipments were being produced. Astronomers of Asian observatories preferred to use equipments produced in Europe for their astronomical observatories.

The remarkable statesman of India Javakharlal Nehru wrote about Savoie Jay Sing: "Savoie Jay Sing had learned development level of the astronomy in Europe before he started his observations, he understood that, scientists of the East had enough successes in this field and made non-optical astronomical equipments".

N. Tusi had another more valuable work on astronomy written before ***"Zij-i Ilkhani".*** He had named that work, which was completed in 1235, ***"Muiniyya" ("Muiniyya fi elm alhayya")*** in honor of the son of Ismailis' leader in Kuhistan Nasiraddin Mohtasham – Muinaddin Abu As-Shams. According to N. A. Abdulgasimova, N. Tusi had made a lot of changes in the cinematic model developed by Ptolemy in mentioned work in order to determine positions of planets beforehand. Thereafter those changes were continued by other Muslim scientists and Copernicus… N.

Tusi wrote ***"Hall"*** in Persian as the addition to ***"Muiniyya"*** after a while – during occupation of Mongols. Cairo and Tehran versions of both works are still kept. They played a role of stimulator in writing of ***"Zij-i Ilkhani"*** and were broadly analyzed by scientists.[1]

Nasiraddin Tusi works on "Zij-i Ilkhani"

As ***"Muiniyya"*** is about astronomy, it will be interesting to describe all of its four parts together with their chapters for readers:

[1] Azərbaycan Beynəlxalq Universiteti. Nəsirəddin Tusinin 800 illik yubileyinə həsr edilmiş Respublika konfransının materialları. Bakı, 2001. Professor N. Əbdülqasımovanın məruzəsi, səh. 375

I part consists of 2 chapters: I chapter includes introduction to astronomy and main geometric notions necessary for explanation of astronomy and II chapter is about several physics problems (especially two types of mechanical motion – rectilinear and circular motions).

II part consists of 14 chapters: they are about structure of celestial bodies.

III part consists of 12 chapters: they are about mathematical geography.

IV part consists of 6 chapters: they are about problems on measurements and distances of celestial bodies.

The geographical longitude of Mecca was $74^0 10'$ (it was $73^0 10'$ in ***"Zij-i Ilkhani")*** and its geographical latitude was $21^0 40'$ in ***"Muiniyya".*** N. Tusi wrote that settled part of the Earth consisted of "half of the territory between the equator and the North Pole".[1]

N. Tusi realized his dream and established a grandiose observatory in one of fascinating places of Azerbaijan – Maragha for development of astronomy and mathematics. Maragha was situated on the "Silk way", between the Near East and Middle Asia and on the threshold of Europe. It had

[1] Azərbaycan Beynəlxalq Universiteti. Nəsirəddin Tusinin 800 illik yubileyinə həsr edilmiş Respublika konfransının materialları. Bakı, 2001. Professor N. Əbdülqasımovanın məruzəsi, səh. 376-377

relations with Middle Asia, Near East, Small Asia, Balkan, Apennine, Crimean Peninsulas, Egypt, India and Chine and those relations were intensified. That's why N. Tusi could gather well-known scientists of different regions around himself.

The astronomy wasn't developed only in the south of Azerbaijan in XIII century.

…Close scientific and political relations between Rashid al-Din Vatvat (the historian of Khwarezm – R. D.), Khwarezm-Shah Tekush and Khagani (Afzaladdin Khagani Shirvani – R. D.), invitation of the genius poet Zulfugar Shirvani to the palace of Khwarezm-Shah Aladdin Muhammad at the beginning of XIII century when he was 20 years old etc. proved that, there were relations between Khwarezm and Shirvan in the field of astronomy.[1]

It turns out that, most well-known thinkers, poets and scientists, who had gone to the Middle Asia from Azerbaijan made great efforts in order to learn astronomy. The astronomy began to be developed in the north of Azerbaijan as other eastern countries. As well-known scientist Kafiaddin Omar knew astronomy, he stimulated interest of his sons and his nephew Afzaladdin Khagani for

[1] Q. Kəndli-Herisçi. Xaqani Şirvani (həyatı, dövrü, yaradıcılığı). Bakı, 1988. səh. 21

learning this field. There is no doubt that, as Khagani was the representative of influential and well-known kin, he was well-educated and interested in astronomy. Kafiaddin Omar taught astronomy to the genius Azerbaijani poet and thinker Khagani. The poet mentioned it in his poem ***"Praise of uncle":***

He taught me three branches of science,
Also astronomy and every notion…[1]

Unfortunately, Khagani didn't use his abilities and phenomenal brain for investigation of this field. He might be remarkable astronomer of the world.

Shamsaddin Shirvani was a student of astronomers of Shamakhi and experts of Maragha observatory benefited by his scientific experiences.

The most grandiose academy of sciences was located in Maragha

It was possible to prognosticate lunar and solar eclipses in accordance with tables prepared in Maragha observatory.

[1] Xaqani Şirvani. Seçilmiş əsərləri. Bakı, "Yazıçı", 1987. səh 87

Most of those tables were distributed among scientists and students, who worked in the observatory. Only people of certain level were aware of lunar and solar eclipses in Azerbaijan unlike other places of Asia and Europe and they used to discuss it among themselves. The astronomy and astrology were developed in Azerbaijan highly. Maragha observatory was one of the most advanced observatories of its time. The greatest science academy was in Maragha. The most ancient sky globe was made in Azerbaijan (Maragha observatory) and it is known by the world community. This invention hasn't any alternative. According to some historical sources, there were star and earth globes in Maragha observatory. As the scientific collective of Maragha observatory had invented star globe under the leadership of N. Tusi, the earth globe also might be invented in Maragha. N. Tusi knew that, the Earth was spherical and he might make an earth globe and divide the earth into two hemispheres. Besides it, he knew measurements of the Earth. But models made by him haven't remained till today. There are some articles about the inventor of the first earth globe. According to historical sources, the German geographer, cosmographer and traveler of Nurnberg Martin Behaim (1459-1507) made the first earth globe in 1492 after returning to Europe from expeditions made to coasts of

Africa. But N. A. Abdulgasimova wrote that, the first earth globe had been invented by the Azerbaijani scientist. She wrote: "According to manuscripts of scientists, who worked in Maragha observatory, Europeans were aware of existence of different scientific devices including earth and star globes. The first geographic globe was made in 1266 by the Azerbaijani scientist Karimaddin Abubakr ibn Mahmud Salmasi".[1]

I think that, professional scientists of Maragha observatory might make tens of such globes.

The globe invented by Muhammad Ordy was decorated with gold and silver and that model was saved as the valuable work of art. This was prescience of the scientist. Most experts could declare that the star globe wasn't made in Maragha observatory if it wasn't kept in the hall "Physics-mathematics" of the museum "Picture Gallery" in Dresden. Thus, first globes of the world having precise coordinate divisions were made in Azerbaijan. There isn't any information about realization of precise observations and existence of exact dancer clocks in Maragha observatory. But it is known that, N. Tusi's third teacher

[1] Azərbaycan Beynəlxalq Universiteti. Nəsirəddin Tusinin 800 illik yubileyinə həsr edilmiş Respublika konfransının materialları. Bakı, 2001. Professor N. Ə. Əbdülqasımovanın məruzəsi, səh. 22

Yunus Al-Misri was an inventor of a dancer clock in Azerbaijan and some of his students worked in Maragha observatory. N. Tusi created a rich library for scientists of Maragha observatory using authority of Hulegu khan. There were 400 thousand manuscripts at the library. Most of manuscripts had been written in Azerbaijan. Maragha library was considered one of the greatest libraries of the Near East and most of manuscripts, which were kept there, had their own histories. Authors of those works were genius and wise people.

A lot of cultural and art monuments, science centers of different cities were damaged at the result of attacks of Hulegu khan's troops. But N. Tusi prevented destruction of those monuments and works of art, brought valuable works to Azerbaijan and maintained their safety. So, mentioned library was created in Maragha and about 76 works of N. Tusi were kept there. Most of scientists, who worked in the observatory, used his works as the scientific source. Scientists of Chine, India, Arab countries, Mongolia and Europe carried out intensive scientific works in Maragha. Nobody doubts that N. Tusi was known as a genius and phenomenal person. He coped with works of several people on his own. The scientist could achieve more unique results if used all of his energy for scientific works instead of

public affairs. But N. Tusi used to spend most of his time for public affairs, construction of the observatory, delivery of valuable manuscripts there, drawing well-known scientists, talented students and pupils into research works in Maragha observatory, improving their welfares, establishment of education centers in most cities of Azerbaijan.

I have discovered that, N. Tusi's life and activity were similar to lives and activities of two historical figures. They are the philosopher Demetrius of Pharia, who lived in Athens in ancient times, and skilful politician, author of ***"Politics"*** Abu Ali Hasan ibn Haja Nizamulmulk, who lived in the early middle ages.

Demetrius went to Alexandria as soon as he was banished from Athens. He didn't know how the ruler of Egypt Ptolemy Sotera I would meet him…[1]

Ptolemy I, who was predecessor of Macedonian Isgandar in Egypt, was well-known as a commander and writer and was an author of the historical work by name ***"History of Isgandar"***. Demetrius offered him to establish grandiose cultural and art center and to name it Museion – "Temple of Muses". Invitation of scientists, delivery of manuscripts and increase of their copies were started after Museion was

[1] Р. Хаггард. Клеопатра. Баку, «Гянджлик», 1990. стр. 13

ready and Demetrius of Pharia was appointed leader of the academy. [1]

Nizamulmulk was born in 408th year of the Islamic calendar (1017-1018) in Noghan district of the Tus province and was killed with knife by one of representatives of Hasan Sabbah in Sahna settlement of Baghdad in 485th year of the Islamic calendar (1092).

Haja Nizamulmulk Hasan ibn Ali was a vizier of Saljuk sultans Alp Arslan (1063-1072) and Malik Shah (1072-1092) and he carried out important works for development of Saljugis' state, realization of construction works, increase of the state's economic power, development of the army, improvement of the science and culture. Almost the state was ruled by Nizamulmulk.[2]

Besides dealing with public affairs, the scientist worked on the foreign policy, rules of religion, supported establishment of special religious schools for preparation of statesmen and religious figures. Mentioned religious schools were known as "Nizamiyye" schools. The most well-known "Nizamiyye" school was Baghdad school, where statesmen, religious figures, astrologers, philosophers, lawyers and

[1] Н. А. Ионина, автор-составитель. Сто великих чудес света. Москва, «Вече», 2000. стр. 145

[2] BSE, ikinci nəşri, 29 cild, səh. 603

poets were prepared… Sadi Shirazi also was a graduator of that school.[1]

Azerbaijan also was within Saljugis' state when Nizamulmulk was a vizier. So, ***"Politics"*** is very important source for learning history of Azerbaijan concerning XI century. Besides it, this work was used in next centuries too. Muhammad Al-Ghazali also had used ***"Politics"*** in his ***"Nasihat-al-muluk"***…

"Politics" was first published by the French orientalist Sh. Shafer in 1892. Sh. Shafer published French translation of **"Politics"** a year later and biography of Nizamulmulk in 1897…[2]

N. Tusi established rich library and Maragha observatory as Demetrius and invited the most well-known scientists there. Besides it, he worked as vizier and advisor, played a significant role in public affairs, established religious school and supported scientists. So, activity of N. Tusi was similar to activities of above mentioned persons.

Maragha observatory was considered the greatest academy of sciences of the world as it was the first diversified science center of the East. It had passed ahead of

[1] Əbu Əli Həsən ibn Əli Xacə Nizamülmülk. Siyasətnamə. R. Sultanovun yazdığı müqəddimədən. Bakı, "Elm", 1989. səh. 3

[2] Əbu Əli Həsən ibn Əli Xacə Nizamülmülk. Siyasətnamə. N. Məmməd-zadənin əlavəsi. Bakı, "Elm", 1989. səh. 27

"Beytul hukema" of Baghdad, "Mamun Academy" of Urgenj and other science centers of the world for astronomical observations, scientific investigations and researches, invention of astronomical equipments, achievement of scientific results, education programs, number of scientists and students and written scientific works. Though the observatory was established for astronomical observations, history, geography, geometry, botany, philosophy, mineralogy, physics, chemistry, medicine, astrology, optics, literature, aesthetics and even musicology also were learned there besides astronomy and mathematics. Well-known experts were prepared in each field. It is known that, more than hundred scientists worked under the leadership of N. Tusi. After taking into consideration above mentioned facts we may say that, Maragha observatory was the greatest academy of sciences of the world.

The academician Magsud Aliyev wrote about Maragha observatory and its founder N. Tusi: "Nasiraddin Tusi established National Academy of Sciences in Maragha observatory in XIII century. The astronomy, different branches of astronomy – machine-building, observational equipments, mathematics, geography, mineralogy, law, physical geography, nature study, social sciences,

philosophy, musicology, geometry, trigonometry and spherical trigonometry were founded there. There wasn't any analogue of that Academy of Sciences. Such institutions began to be established in Europe only in XV and XVI centuries. [1]

Skilful experts could be prepared and valuable scientific results could be achieved in the Academy of Sciences of Maragha if Azerbaijan didn't participate in wars afterwards".

Greater academy of sciences was established near Shamakhi in XI century. It was named "Academy of Medical Sciences" and remarkable scientist – philosopher, mathematician, astronomer, anatomist, chemist and physician Omar ibn Osman Kafiaddin Shirvani was considered its founder. He was one of skilful experts of medicine, philosophy and pharmacology in the middle ages.

The Professor Eybali Mehraliyev wrote about it: "That scientist (Kafiaddin Omar –R.D.) gained respect of the ruler (Shirvanshah Fariburz I (1063-1096) –R.D.) and his activity included testing biologic-medical technologies (making

[1] Azərbaycan Respublikası "Təhsil" Cəmiyyəti 2002 il 28 iyunda dahi Azərbaycan alimi Nəsirəddin Tusinin 800 illik yubileyinə həsr olunmuş "Nəsirəddin Tusinin elmi xidmətləri və Nəsirəddin Tusi yazıçı-tədqiqatçı Ramiz Qasımov yaradıcılığında" mövzusunda keçirilən elmi-praktik konfransda akademik Maqsud Əliyevin çıxışı

medicine by means of plants, mould funguses and parts of animal bodies), preparation system of surgical methods, astronomy, mathematics, construction (water settings, civil and production settings), poetry and prose, law, philosophy, history, music (theory and rules of singing), painting, politics and military science…

The structure of Shirvan Academy of Sciences was as following in XI-XII centuries: presidium – president department – legal sciences – house of science. As there was close relation between military figures and scientists, we may come to the conclusion that, military science also was an element of the academy's structure".[1]

Shirvan Academy of Sciences of XI century was described in the article about development of the science in the East, which was in the historical encyclopedia published in 1953 in Paris. [2]

It has been proved that, science centers of Azerbaijan had developed highly, fame of most scientists, who worked in those centers, had spread all over the world and they were invited to different cities.

[1] E. Mehrəliyev. Şirvan Elmlər Akademiyası. Bakı, "Çaşıoğlu", 2000. səh 69-70

[2] "L. Histoire de la Seinse", Paris la volume II, 1953. la paqe 52

Preparation of genius scientists is realized on the basis of the scientific base formed in accordance with their predecessors' thoughts. So, N. Tusi's encyclopedic activity is a continuation of previous science centers established in the East and Azerbaijan.

Yagut Al-Hamavi wrote about the scientific environment developed by Azerbaijani scientists in IX-XII centuries, scientists of Barda, who lived in IX-X centuries, and scientists of Shamakhi, Darband, Ganja, Tabriz and Khoy, who lived in X-XII centuries.

Kafiaddin Omar, who is considered founder of Shirvan Academy of Sciences and pharmacology in Azerbaijan, systemized knowledge about pharmacology in his work ***"Tibb-i-Nabavi"*** and described methods of making medicine by means of plants, animals and minerals there. His son Osman ibn Omar Vahiaddin Shirvani and Falaki Shirvani worked on mathematics, physics and astronomy, Abdulkerim Shirvani and his grandson Fazil Faridaddin Abul Hasan Shirvani made astronomical equipments and carried out astronomical investigations.

Abu Al-Fazl Hubaysh ibn Ibrahim Tiflisi – the physician, astronomer and mathematician, who lived in XII century, is the author of 9 works about medicine and pharmacology, ***"Bayan an-Nujum" (Description of stars), "Madhal ila***

ilm an-Nujum" (Introduction to the science of stars) and tens of other works…

Shamsaddin Shirvani (1210-1280) had come to the science center established by Tusi from Shirvan astronomical center. Besides carrying out scientific researches, he had invented astronomical equipments (astrolabe). The Azerbaijani engineer Karimaddin Abubakr ibn Mahmud Salmasi, who worked in the science center of N. Tusi, could make the earth globe by means of dough made of paper and drew climate zones on it.[1]

The Professor N. Abdulgasimova wrote in accordance with historical sources that, Karimaddin Salmasi made the first geographic globe of the world (1266). Though this news was sensational, it was a truth, as invention of such globes wasn't difficult for experts of Maragha observatory. As there were a lot of skilful scientists of geometry, mathematics, geography and astronomy in the observatory and Nasiraddin Tusi, who was considered founder of the spherical trigonometry, was their leader, preparation of sky, earth and climate globes in Maragha wasn't a problem.

[1] "L. Histoire de la Seinse", Paris la volume II, 1953. la paqe 52

Ramiz Daniz

Development of astronomy by Nasiraddin Tusi

Tusi wrote valuable works about different science branches in Turkish, Persian and Arabic. Some researchers write that, he was a poet. Of course, it's believable. The author of ***"Akhlagi Nasiri",*** which is considered masterpiece in the field of ethics and esthetics, could write poems very easily. Besides it, Tusi was interested in poetry and music too.

Once his students asked him: "Master, they say that, you're a poet?" and he answered: "No, I'm not a poet, I just write poems. Every astrologer may be inspired by twinkling stars and write a poem". Activity of the talented scientist was interesting for everybody. [1]

The collective of Maragha observatory made very precise devices for realization of astronomical observations. Precise clocks were very important for such observations. Dancer clocks were made in Maragha, but those devices haven't remained till the present time. May be, one day earth globes and dancer clocks made in Maragha observatory will be found in museums of some countries. ***"Astronomical tables***

[1] A. Məmmədov. Hökm və hikmət.Bakı, "Qafqaz-Ltd", 2002. səh. 159

of Ilkhanids" ("Zij-i Ilkhani") was prepared in accordance with astronomical observations. The last of those tables was made 10 years after Tusi's death in 1284. Such tables were made 400 years later in Europe.

The Professor, Doctor of physics and mathematics Rehim Husseinov wrote about ***"Zij-i Ilkhani":*** "The most valuable work of N. Tusi and Maragha observatory is ***"Astronomical tables of Ilkhanids" ("Zij-i Ilkhani"*** – R. D.). Mentioned work consists of four books. Bases of Chinese, Uyghur, Jew and Arabic calendars and ways of passing from one calendar to another are explained in the first book, the second book includes descriptions of the Sun and planets, ecliptic length of the Sun disc center on Maragha meridian in afternoons of certain days, exact values of average daily movements of planets, determination of time has been described in the third book and fourth book includes different information about astronomy. The difference between values of geocentric longitudes of planets written in ***"Zij-i Ilkhani"*** and modern values is equal to one thousandth of the second. Tusi could determine geocentric latitudes of planets with a precision of second. He could also determine more exact value for annual precession".[1]

[1] R. Ə. Hüseynov. Astronomiya. Ali məktəblər üçün dərslik. Bakı, "Maarif", 1997. səh. 10

"Maragha observatory established by Nasiraddin Tusi in 1259 was very popular in the East in the middle ages. It was the best equipped observatory of the world. There were sun and water watches, sky globes, armillary spheres, quadrants, devices for determination of horizontal coordinates of celestial bodies, device for determination of the Sun's height on the meridian in Maragha observatory". [1]

Probably, Columbus used tables made by N. Tusi when he discovered New World. The most skilful and experienced scientists were invited to Maragha observatory in order to get necessary information about structures of the Earth and Sky.

As I mentioned above, sky globe was made in Maragha. One of sky globes made by the son of Muayyidaddin Ordy – Muhammad (1279) is kept in the hall "Physics-mathematics" of the museum "Picture Gallery" in Dresden. It is considered the most ancient sky globe of the world.

Tusi's third son Sadraddin Ali Tusi became the leader of Maragha observatory after the scientist's death (1274). The son of Muayyidaddin Ordy – Muhammad also worked in the observatory then. He was one of well-known experts, who made astronomical equipments, as his father. The year

[1] В. Н. Пипуныров. История часов с древнейших времен до наших дней. Издательство «Наука», Москва, 1982, стр. 91

of preparation of his globe was determined according to positions of stars described on it – 1279. Some scientists of Europe investigated that unique globe. The globe made of bronze and decorated with gold and silver is considered one of decorative artworks of XIII century.

When we speak of Muayyidaddin Ordy, we remember activity of Nasiraddin Tusi and vice versa. And when we speak of Maragha observatory, we remember both of mentioned scientists.

It is known that, Muayyidaddin Ordy played a significant role in construction and furnishing of the observatory. According to some scientists (Professor A. Salamzadeh and others), besides being a founder of the observatory and leader of astronomical investigations carried out there, N. Tusi was one of its authors.

Ordy respected Tusi for his personality, skills and generosity as all other scientists, who worked in Maragha observatory. He explained his thoughts about Tusi in his treatise about ***"Astronomical equipments of Maragha observatory".*** Ordy wrote in the introduction: "Let's describe our devices created in the observatory located on the hill in the west of Maragha. They have been created in 660. All these works have been carried out under the leadership of the great scientist – our wise leader. He has all

praiseworthy characters. He knows even all science branches. He gathers all scientists in the observatory, protects them and tries to improve their welfares. We are glad to work under his leadership as he takes care of everybody… He is polite and affable even when he gets angry.

I'm talking about Nasiraddin Muhammad ibn Muhammad at-Tusi. God bless him. I had heard a lot about him. Information I had heard about him was very surprising for me. After getting acquainted with him, I understood that Tusi deserved all praises. I understood it when worked together with him. He didn't deny his valuable advises when we were far from our motherlands, friends and families. He was a substitute for all of them. Being together with him is enough for us. God bless him!"[1]

These opinions weren't written by historians and researchers of XIX century. They were written by the scientist, who had come to Azerbaijan from Syria and worked in Maragha observatory together with N. Tusi. All foreign scientists praised their leader. Colleagues called him "teacher of the world".

[1] Müəyyidəddin Ordinin "Marağa rəsədxanasının cihazları" kitabının müqəddəməsindən.

There isn't enough biographic information about Ordy. Only two manuscripts of his treatise about ***"Astronomical equipments of Maragha observatory"*** written in Arabic have remained as historical documents. They are kept in national libraries of Paris and Tehran. The first manuscript was found by the teacher of the special school of eastern languages A. Jurden in Paris at the beginning of XIX century and was translated into French. The book was published in Paris in 1809 and 1810. It was translated into Germany in 1811 as was interesting for astronomers. The book includes description of ten astronomical equipments prepared by Ordi under the leadership of Nasiraddin Tusi. At the result of analysis of information given in Ordy's tractate, researchers came to the conclusion that, equipments of Maragha observatory were more perfect than equipments of other observatories. It is known that, equipments invented by Ordy were used in most observatories of the world.

As it was mentioned above, there were ten great astronomical equipments in Maragha observatory. Five of them were invented there and other five were old.

1. Great wall quadrant
2. Armillary sphere
3. Device for measurement of propensity of ecliptics

4. Device for determination of equality moments

5. Device for determination of eclipse phases, for observation of lunar and solar eclipses.

These devices were used in other observatories before construction of Maragha observatory.

1. Device for determination of horizontal coordinates of celestial bodies

2. Device for determination of the Sun's height on the meridian

3. Earth globe

4. Star or Sky globe

5. Rotary quadrant

These devices were invented in Maragha observatory. The greatest device was the wall quadrant with 6,5 meters diameter. The greatest wall quadrant (diameter – 7,5 meters) was invented in Urgenj before invention of this one.

H. Mammadbayli described that device in his work. Its side-view looked like a wall. But that wall's base and one of sides consisted of a straight line, other two sides were replaced by 90-degree arch. A firm wood was bolted on the brick wall on that arch. A copper board was placed between them. There was a measuring board showing arch measurements on the copper board. The smallest division

was equal to a moment. There was the second important part on the wall quadrant besides the measuring board. It replaced pipes of the diopter. The diopter was a simple pipe. It was empty, there was a wire in one of its ends and other end was cracked. The observer should put the celestial body, crack of the diopter and its wire on one line in order to determine direction towards that celestial body. The pipe should be rotated in order to achieve this. Diopter could measure height while moving the wall quadrant along the measuring board.

As the wall quadrant was placed on the meridian plane, it could observe celestial bodies only at culmination moments (passage of celestial bodies through meridian is called culmination). So, height coordinates were determined.[1]

The second great device used in Maragha observatory was an armillary sphere. It was very old and was used even by astronomers of Alexandria.

The armillary sphere consisted of five circumferences – 1) ecliptics, 2) equality colure, 3) latitudes circumference, 4) sky meridian, 5) tropics. Ecliptics, sky meridian and tropics were divided into arch measurements. Ecliptic and horizontal coordinates of stars and planets were determined

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh. 67-68

by means of the armillary sphere. The rotary quadrant was invented by scientists of Maragha at the result of it. That device consisted of two circles, which had scales and perpendicular axes, one of which rotated perpendicularly to the horizontal plane and other rotated on that plane. Vertical circle was equipped with diopters in order to determine directions towards stars.

Professional astronomers also learned Tusi's scientific heritage. Though the scientist lived 750-760 years ago, his scientific achievements are still interesting for modern astronomers.

The Professor Rehim Husseinov wrote about him: "Scientific results achieved by Tusi in the field of astronomy are very significant. First of all, he is the founder of the spherical trigonometry, which is very important for the modern astronomy. Application sphere of the spherical trigonometry is very broad.

The most valuable work of N. Tusi and Maragha observatory is ***"Astronomical tables of Ilkhanids".*** Mentioned work consists of four books and includes information about calendars existing in the world, ways of passing from one calendar to another, movements of the Sun and planets, real afternoon time for each day in Maragha observatory, position of the Sun disc center on the ecliptic,

exact values of average daily movements of planets, determination of time, positions of planets in respect of the ecliptics and value of the annual precession".[1]

N. Tusi played a significant role in Ilkhanids' life as an intellectual, scientist, diplomatist and generous man during ages of Hulegu khan and Abaga khan. He was welcomed in all regions of the empire and never denied his advices and help to other people. He paid special attention to development of the science and establishment of education centers. Tusi thought that, the science should be people's supporter. He knew that, it was important to know everything as necessary. Besides being educated, Nasiraddin Tusi was very patient and well-behaved person.

Once a man sent him a letter full of abuses and called him "a dog". Tusi answered him very politely: "You're wrong, I can't be a dog. Dogs have four legs and long nails. But I am a human being. My body isn't hairy as dogs. My nails are wide. I talk and laugh. So, I differ from dogs".[2]

Tusi came to Baghdad from Maragha at the beginning of 1274. He fulfilled his duties as a vizier and took care of scientists and religious schools. The scientist went on a

[1] "Bilgi" dərgisinin "fizika, riyaziyyat, yer elmləri" seriyası. Nəsirəddin Tusinin astronomiya elmində xidmətləri. MEA-nın müxbir üzvü Rəhim Hüseynov. Bakı, 2002. səh. 4 №2

[2] A. Məmmədov. Hökm və hikmət.Bakı, "Qafqaz-Ltd", 2002. səh. 159

pilgrimage to the grave of the seventh imam Musei Kazim together with his son Asiladdin though he was very tired.

He said following sentences to his son before his death: "I can die in peace as I spent my life for people's welfare and science… The life, which wasn't spent for good deeds, is the life spent in vain".

The scientist, who had devoted his life, knowledge and skills to the mankind and science, died on June 25, 127 in Baghdad. Nasiraddin Tusi was buried in the Jame Mosque, which is situated at 10 km away from the capital of Abbasids – Baghdad. He was buried in the tomb of the seventh imam Musei Kazim (Peace to him).

They say that, almost all of the population of Baghdad participated at the scientist's funeral. People couldn't believe that, Tusi had left them. The scientist, who had devoted his life to the mankind, was a hope for most people.

There were following words on the grave of the genius Azerbaijani scientist Nasiraddin Tusi: "Supporter of people and religion. Such man was never born".

Indeed Nasiraddin Tusi deserved all of these praises.

Ramiz Daniz

Scientific results achieved by Nasiraddin Tusi

N. Tusi's masterpiece about geometry – ***"Tahriru Uglidis"*** was written twice. The first book written in 1248 consists of 15 articles and its manuscript was published in 1880 in Tehran with the method of lithography. Both of books spread in the world in a very short time. The second edition of the book, which had a special role in development of geometry, was very popular in Europe and especially in England at the end of XIII century. It was published in Arabic in Rome in 1594 and in London in 1657 after being translated into Latin.

It is difficult to believe that, the work could become popular in Europe in Arabic during a very short time. I think that, it was translated into Latin in 1657 and learned by experts of geometry and mathematics. ***"Tahriru Uglidis"*** was written in Arabic and its version, which is kept in Rome, is in this language. Regiomontanus, who was a famous mathematician and astronomer, went to Rome in 1461 and translated seven articles of Ptolemy's ***"Almagest"*** into Latin. He was in some libraries of Italy in 1461-1468, got copies of ancient manuscripts and returned to Vienna. Regiomontanus was known as a translator of scientific works rather than a scientist.

It is already known that, Regiomontanus had learned Arabic, worked on translation of scientific works of eastern astronomers and could translate ***"Tahriru Uglidis"*** before 1657.

According to historical sources, one of favorite teachers of Isaac Newton (1642-1726), well-known English mathematician of XVII century John Vallis (1616-1703) read lectures at the University of Oxford in accordance with ***"Tahriru Uglidis"*** and played a significant role in popularization of N. Tusi in England. J. Vallis, who leaded Euclid department at the University of Oxford, taught the theory of parallel lines offered by N. Tusi there.

According to H. Mammadbayli, besides describing the theory of parallel lines, relations and numbers and main issues of mathematics as axiometric geometry, Nasiraddin Tusi explained some new theorems, proved them and generalized some of those theories in ***"Tahriru Uglidis".*** He proved some theorems in different ways. The scientist included new notions in mathematics and tried to explain existing ones… Tusi proved the Pythagorean Theorem in 36 ways in the first edition of ***"Tahriru Uglidis"*** and in 12 ways in the second edition. The first book mainly consisted of theorems on the theory of parallel lines. The theory of parallel lines had a very important role in invention of non-

Euclidian geometry. Nasiraddin Tusi did his best for development of this theory.[1]

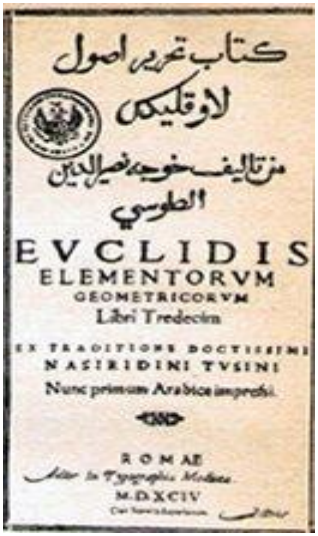
"Beginning", which had brought fame to Euclid, was published for many times during two thousand years as the initial course of geometry. It was taught in schools and universities before XX century. The work, which was interesting for all scientists, was copied in ancient times and spread in the world. Afterwards, ***"Beginning"*** was copied on the pergament from papyrus and on the paper from pergament.

The work was published for 2500 times – 6-7 times in a year during 400 years. The original copy of ***"Beginning"*** hasn't remained. But it was manifolded by copiers. Eastern scientists played an important role in this process. The work was translated into Arabic by Al-Hajjaj ibn Yusuf during ages of Harun Ar-Rashid and his brother Mamun for the first and second times. The next translation was made by Sabit Ben Guerra. ***"Beginning"*** was learned by Arabs in early middle ages and then attracted attention of European scientists. The work was translated into several languages. First editions were published in 1533. It was translated into

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh. 78

English in 1570 by the merchant of London by name Bellingway.[1]

Euclid (? – 275-270 BC.)



"Tahriru Uglidis" published in Europe

"Bases" or ***"Beginning"*** of Euclid written about geometry and arithmetic consisted of 13 articles before, but afterwards, two articles were included in it. The work was translated into Arabic for several times before XIII century. N. Tusi trusted only two of those translations – they were

[1] Д. К. Самин. Сто великих ученых. Москва, «Вече», 2002. стр. 19

made by Sabit Ben Guerra and Al-Hajjaj. But his ***"Tahriru Uglidis"*** was superior of all geometry books written before and was known as the best work on geometry in XIII-XVIII. The scientist wrote in the introduction of the work: "I decided to analyze Euclid's work written about geometry and arithmetic after finishing my works on analyze of ***"Almagest".*** I tried to analyze it exactly. So, I made some additional explanations. Some of those explanations were chosen from books of mentioned experts and others were my own conclusions".

Nasiraddin Tusi refuted V postulate and the theory of parallel lines offered in ***"Beginning".*** He wrote that, parallel lines intersected on the sphere, though they didn't intersect on the plane.

This problem was important for invention of the general cosmology and well-known scientists as Cauchy, Gauss, Bolyami and Lobachevski worked on it after some centuries. Lobachevski could manage this problem with the help of the Azerbaijani scientist Mirza Kazimbey. Mirza Kazimbey translated Tusi's works on mathematics from Persian into Russian in accordance with the request of the Russian scientist. So, Lobachevski could write his well-known work on non-Euclidean geometry.

The Professor Zahid Khalilov wrote that, the work ("***Tahriru Uglidis"*** – author), which was kept as a manuscript during more than 300 years, was published in Arabic in 1594 in Rome.

The English mathematician John Vallis and Italian mathematician Sakker also read this work. Proof of V postulate of Euclid by Nasiraddin Tusi played an important role in invention of non-Euclidean geometry.

The Professor V. F. Kagan described Nasiraddin Tusi's achievements in this field in his work ***"Bases of geometry***": "The Italian scientist Sakker, German scientist Lambert and French scientist Leganr accepted Nasiraddin's idea proving that, sum of interior angles of a triangle equals two straight angles as a postulate and developed the theory of parallels".[1]

The Professor B. A. Rozenfeld wrote: "Nasiraddin Tusi refused to prove the postulate of parallelism by means of two axioms and postulates and used only one simple postulate and it was an important step for Lobachevski's proof". N. Tusi's scientific achievements in the field of the theory of parallel lines were interesting for scientists of the middle ages and modern time. His work became popular in Europe after a very short time.

[1] В. Ф. Каган. Основание геометрии. М.-Л., 1949. стр. 119

Professors Rozenfeld and Yushkevich published N. Tusi's article about the theory of parallel lines and his work ***"Treatise removing all doubts about parallel lines"*** in Russian in 1960.

That work was found by the Iranian scientist Tagi Erani and published in Tehran in 1936. According to scientists of Uzbekistan Academy of Sciences, one of the oldest copies of the manuscript kept in the library of the Institute of Oriental Studies of Uzbekistan Academy of Sciences was prepared by one of students of N. Tusi – Nizamaddin Al-Naysaburi.

Those scientists wrote about mentioned work: "The treatise of Nasiraddin Tusi is very interesting, it explains the theory of parallel lines explained in "Tehran copy", criticizes theories of parallel lines of Al-Khaysam and Khayyam (they have been learned by historians of mathematics), describes works of the mathematician of IX century Al-Jouhari, whose work by name ***"Improved book of bases"*** haven't been found yet". Al-Jouhari, Al-Khaysam, Khayyam and Nasiraddin Tusi had a great role in invention of new geometry by Lobachevski in the first half of XIX century.

Well-known scientists of the middle ages Abul Fazl Tabriz from Azerbaijan, Khazin Shani from Egypt, Ibn Al-

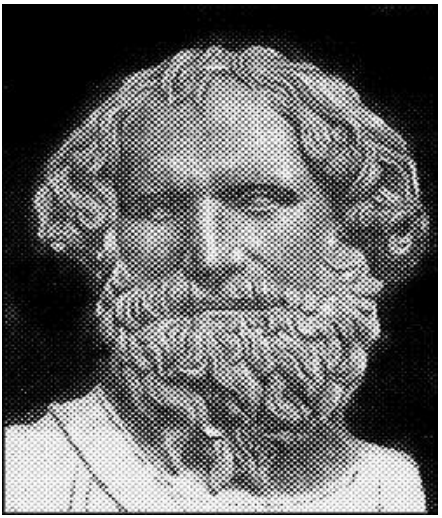
Khaysam and Omar Khayyam had carried out a lot of works on the theory of parallel lines. Eastern scientists were interested in well-known V postulate of Euclid.

Though N. Tusi lived 770 years ago, scientists of XX century investigate his immortal works with great interest. The scientist's commentaries about ***"About the sphere and cylinder"*** and ***"Measurement of the circle"*** of Archimedes have special places in the history of mathematics. The Kazakh scientist Audanbek Kubesov investigated those two works of N. Tusi perfectly and wrote dissertation about it.

N. Tusi wrote in the introduction of ***"About the sphere and cylinder":*** "I tried to understand some issues mentioned in ***"About the sphere and cylinder"*** of Archimedes (287-212 BC). It was necessary for main problems of geometry. At last I found a copy corrected by Sabit Ben Guerra. Part of the work was translated into Arabic inexactly. Besides it, there were some mistakes made by the copier in the book. I tried to correct the work and described some of its issues at the end of the second book.

I completed some conceptions of Archimedes by considering his well-known ideas. I found an old notebook. There were Yevtoki's commentaries about this book, which were translated into Arabic by Ishaq ibn Hussein. Besides it, there was a text translated by Ishaq and it covered I and XIV

captures. The text of Yevtoki's commentary was similar to that text. So, I decided to write a systematic book and to explain mentioned text. I proved postulates in accordance with principles of geometry, wrote necessary explanations, described Yevtoki's commentaries and explained existing difficulties".[1]



Archimedes (287-212 BC)

The Azerbaijani scientist wrote four ideas in the first book of that work and proved them. Kubesov wrote about

[1] Nəsirəddin Tusi. "Kürə və silindr haqqında" əlyazmanın Paris nüsxəsi. səh. 90-90a və Heydərabad nəşrinin 3-cü səhifəsi

those ideas: "Proofs of four axioms of Archimedes about comparison of straight lines and curves were especially interesting in commentaries of Nasiraddin Tusi written about the Greek scientist's work – ***"About the sphere and cylinder".***

The Greek scientist Yevtoki (VI century BC) also mentioned that Archimedes's axioms had been proved. But Nasiraddin could achieve more results. He invented method of infinitely small quantities (infinitesimal method) in order to prove mentioned axioms. Nasiraddin Tusi formed new postulates instead of those axioms, where lines were small segments and their ends were maximally close points. This approach resembled approach of differential and integral calculations of ancient atomists and scientists of Western Europe.

N. Tusi invented his own algorithm resembling modern limit methods according to postulates of Archimedes in order to prove mentioned axioms".

N. Tusi described his own method for cubic equations in the book. Kubesov wrote following question: "Were Renaissance mathematicians aware of Nasiraddin's commentaries about Archimedes's works or not?" He mentioned that, Nasiraddin's ideas could be met in most scientists' works. Those approaches had an important role in

invention of new mathematics in XVI-XVII, as its principles were based on notions of application, changing quantities, functional dependence and broad number concept added by N. Tusi including infinitesimal method (infinitely small quantities).

It turns out that, N. Tusi played a significant role in development of mathematics and geometry and European scientists might use scientific works of the Azerbaijani scientist. There is no doubt that, N. Tusi's works were popular in the middle ages and European scientists used them as a scientific source. So, I want to mention quotations of some scientists, who were popular in Europe for their scientific achievements.

H. Mammadbayli, who investigated scientific activity of N. Tusi, wrote thoughts of several popular scientists in his work by name ***"Muhammad Nasiraddin Tusi".*** I'll use several paragraphs of that work.

It is known that, astronomers, geodesists, crystallographers and cartographers used spherical trigonometry very often.

The word "Trigonometry" was first used in books of the German theologian and mathematician Pitiscus (1505). Nasiraddin Tusi is the founder of spherical mechanics which he used in his works. That discovery was discovered by

scientists of Western Europe 400 years later. The Dane scientist Ticho Brage (1546-1601) made tables of coordinates for more than 700 stars according to Tusi's calculations. Johannes Kepler founded spherical mechanics in accordance with Brage's scientific works. Isaac Newton discovered fundamental laws of mechanics after using their works. Tusi's works about mathematics were published in Renaissance centers of Europe – Italy, England and France for many times.

Watches were inseparable part of astronomical equipments used by Tycho Brahe. He had invented and tested four types of watches in 1577-1581 and came to the conclusion that, watches are unfit for solution of most astronomical problems.[1]

H. Mammadbayli wrote: "Trigonometry was an achievement of eastern scientists before additions of Euler were made. Azerbaijan had a great role in this achievement. N. Tusi and Giyasaddin Kashi played an important role in invention of trigonometry. N. Tusi wrote the first perfect work on trigonometry and modified trigonometry as an independent discipline. This work was published with different names. It was ***"Kitabi-fi-shaklul-qita" (The book***

[1] Д. Хауз. Гринвичское время и открытие долготы. Москва, «Мир», 1983. стр. 29

about the perfect four-side) in Arabic, ***"Traktat o polnom chetirekhstoronnike"*** in Russian, ***"Das Bush uber das transversalen fiqur"*** in German and ***"Fraite quadrilatere" in French".*** [1]

This book also was written twice – in Arabic and Persian as ***"Tahriru Uglidis".*** Its Arabic version was found in 1260 in Maragha. N. Tusi wrote in the introduction of this version: "I had a book, which consisted of theories by name ***"Shaklul qita".*** I had made some additions to existing theorems and proofs there. The book was in Persian. Some of my friends asked me to translate it into Arabic. So, I took their request into consideration and translated the book into Arabic. Besides it, I published the book without several surplus and unnecessary chapters".

The work was written in Arabic as it was necessary to prepare skilful experts in Maragha observatory and to spread scientific works written there in the Near East, Egypt, Apennine and Pyrenees peninsulas. N. Tusi's main purpose was to spread all scientific results achieved in Azerbaijan in the world.

Leading scientists of Maragha observatory used spherical trigonometry for determination of coordinates of celestial

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh. 92-93

bodies. Copies of ***"Shaklul-qita"*** were distributed among specialists in Maragha. That's why several old copies of the book are kept in most libraries of Western Europe. But those manuscripts haven't been learned enough as Arabic and Persian weren't popular languages in European countries. So, manuscripts kept in different places were found and investigated very slowly. Researchers could find a lot of documents when they looked for manuscripts in administrative buildings of Istanbul. An old copy of ***"Shaklul qita"*** found in the capital of the Ottoman Empire in 1891 was among them and mentioned work was published in French and Arabic in accordance with that manuscript. After publication of that book, which was about trigonometry, a heated argument arose between historians of mathematics in Western Europe as Regiomontanus was considered founder of trigonometry according to German historians of mathematics.

After N. Tusi's ***"Shaklul qita"*** written in French and Arabic was found by historians of mathematics, debates were restarted about the founder of trigonometry. The German scientist Henry Zutter, who had a great role in investigation of the history of astronomy and mathematics in the East, began to deny Regiomontanus's role in this field after reading above mentioned book. He wrote: "Plane and

spherical trigonometry was invented when military occupations of Tatar rulers were stopped temporarily. What would European scientists of XV century do if they were aware of this result? May be some of them knew something about it?" These questions weren't put in vain. Zutter thought that, some scientists knew the truth, but preferred to keep silence for unknown reasons.[1]

Scientists, who defended Regiomontanus's scientific works before, understood that, he began to lose his monopoly in mathematics and tried to stabilize situation in different ways.

The German scientist Anton von Braunmuhl, who is considered influential specialist in the history of trigonometry, published his work by name ***"Nasiraddin Tusi and Regiomontanus".*** According to most specialists, this work had a special place among works written about the history of trigonometry. Though the author tried to be unbiased in the work, he couldn't continue in this way. The result of mentioned work couldn't satisfy honest historians of mathematics. Braunmuhl came to the following conclusion: Nasiraddin and Regiomontanus both were influential scientists in the field of trigonometry.

[1] Ф. Кечори. История элементарной математики. Одесса, 1917. стр. 147

Regiomontanus wasn't aware of works carried out by Nasiraddin and so, he may be considered inventor of trigonometry.

H. Mammadbayli agreed with the French historian of mathematics Motuklo and wrote: "***"Shaklul qita"*** of Nasiraddin Tusi, table of trigonometric functions made in Maragha observatory and remake of that table by astronomers of Ulugbek's observatory prove that, innovations made by Regiomontanus and other mathematicians in XV century in Europe were less than innovations made by eastern scientists before".[1]

Of course, it is impossible to agree with this fact. As it was mentioned above, the table of trigonometric functions made in Maragha observatory under the leadership of Tusi was an important innovation. We should note that, scientists, who lived in Azerbaijan in XIII century, had carried out very important works in the field of trigonometry.

Though trigonometry was developed owing to scientists of Europe and Ulugbek's observatory, they weren't as professional as scientists, who worked in Maragha observatory. Azerbaijani scientists knew several branches of

[1] Ф. Г. Максудов, Г. Дж. Мамедбейли. Мухаммед Насирэддин Туси. Баку, «Гянджлик», 1981. стр. 54

the science and were authors of a lot of innovations and inventions.

Braunmuhl wrote: "Regiomontanus was considered author of this problem and its solution method. Though all these issues were explained in Nasiraddin's works either, we can't deny Regiomontanus's services in this field as there wasn't any relation between works of these two persons".[1]

According to Braunmuhl, Ptolemy knew some theorems about spherical trigonometry and he helped Regiomontanus. Nevertheless scientists have found out that, none of spherical trigonometric functions were known by Ptolemy or any other ancient Greek scientist.

So, scientists of the West refused to discover the real truth. They even wrote false considerations in order to overstate Regiomontanus's "scientific achievements".

The Soviet scientist V. P. Sheremetyevsky, who didn't make efforts in order to investigate the history of mathematics, tried to prove that, trigonometric functions were invented by Regiomontanus. His false conclusions can't be taken into account. V. P. Sheremetyevsky wrote: "The first achievement got in Europe in the field of

[1] H. C. Məmmədbəyli, M. Haşımzadə. "Şəklül qita"nın riyaziyyat tarixində əhəmiyyəti. Az.SSR. EA. Xəbərləri, 1951. №8

mathematics was trigonometry. It is clear as trigonometry is considered main part of astronomy and astronomy began to develop in XIV century on the basis of astrology…

Regiomontanus invented new trigonometric function which is known as tangent since XVII century".

Other European scientist F. K. Kechori wrote: "Bradwardine and other English scientists are considered authors of first works about trigonometry. Their writings about trigonometry were taken from Arabic sources. The Professor of the University of Oxford John Maudith wrote about tangent and Bradwardine wrote about cotangent and tangent in 1340".

There were different new functions. Indians used to apply sinus, sinus versus and cosinus, Arabs applied tangent and English applied cotangent.[1]

Sheremetyevsky, Kechori and other scientists wrote their preconceived opinions without carrying out necessary investigations in this field. They associated trigonometry with European scientists baselessly. Nevertheless eastern scientists had carried out important works in this field and passed ahead of European scientists for hundreds of years.

[1] Ф. Кечори. История элементарной математики. Одесса, 1917. стр. 147

The Professor H. Mammadbayli declared decisively that, above mentioned fact wasn't right. He wrote: "Abul Wafa Buzjani defined tangent, cotangent, secans and cosecans in X century. He named tangent shadow, cotangent completive of the shadow, secans and cosecans diameter of corresponding arches. Nasiraddin mentioned this fact in his work very clearly".[1] Nasiraddin wrote: "It (tangent theorem – H. C. Mammadbayli) was first offered by Abul Wafa Buzjani".

It proves that, European scientists overstated Regiomontanus's scientific activity purposely and described him as the founder of trigonometry. I can't understand Braunmuhl's purpose. He wrote that, Regiomontanus had invented trigonometry without reading works of Nasiraddin Tusi as he didn't know Arabic. But investigations prove that this thought was baseless. We'll see explanation of this conclusion below. I want to note that, European and eastern scientists couldn't write any work about trigonometry in XIV-XV centuries without reading works of scientists, who worked in the Near East and were well-known for their achievements got in the field of astronomy and

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh. 111

mathematics. Besides it, Regiomontanus lived only till his 40.

Misappropriation of Nasiraddin Tusi's invention by Regiomontanus

European scientists often used works of Muslim scientists in order to learn most branches of the science. N. Tusi's scientific heritage also was discussed by scientists of the West.

Astronomy and mathematics were developed highly in eastern countries and especially in Azerbaijan owing to N. Tusi's talent and works of most scientists were translated into Latin and Greek as they were interesting for European scientists. But some venturesome scientists translated works of eastern scientists and published them as their own works. Unfortunately, such events had happened for several times.

Valuable cultural monuments and manuscripts were taken from the capital of the Byzantine Empire to the Apennine Peninsula when Sultan Mehmet approached Constantinople. As mostly Venetian seamen participated in this process, most of manuscripts were taken to Venice.

Besides it, I want to mention that, there were historical documents, which proved that, there were relations between scientific centers of Constantinople and scientific centers of other cities including Maragha observatory.

It has been proved that, scientists of the Byzantine Empire had investigated library of Maragha observatory. Besides it, several scientists came to Maragha and Tabriz from the Byzantine in XIV century and translated scientific works kept there from Arabic and Persian into Greek and Latin.

I want to give some information about the German translator and scientist Regiomontanus (Johannes Muller) (1436-1476), who was considered great specialist of astronomy and mathematics in Europe.

He got his primary education in Leipzig and entered the University of Vienna, which was popular during that period, as was interested in astronomy and mathematics. At that time, astronomy was studied according to the tractate ***"Sphaera mundi" ("The sphere of the world")*** written by the Englishman John Hollywood or Halifax (died in 1256), who once worked in the University of Paris and was known with the surname Sakrobosko. That tractate, which was taught in five weeks (four hours each week), consisted of elementary explanations of obvious results of daily rotation

of the celestial sphere and was very popular during several centuries. After being published, the work became the first published manual of astronomy (1472), which was republished for 65 times during next two hundred years! Students learned to determine planets' positions at different moments in accordance with the Alfonsine tables and commentaries of the Italian by name Gerardo Sabionet – ***"Theoretica planetarum" ("The theory on planets"),*** got elementary knowledge about algebra and elements of the theory of perspective.

It was necessary to know astronomy at the level of the tractate of Sakrobosko and geometry at the level of Euclid's ***"Beginning"*** for getting first bachelor degree after the preliminary faculty. Applicants for this degree should be able to determine positions of celestial bodies at a given moment, know five books of ***"Beginning",*** theory of perspective and learn another tractate else, which should be chosen by the applicant. So, astronomical and mathematical preparation of students of the University of Vienna was higher than preparation of students of other universities.

There Regiomontanus got acquainted with the young teacher by name Georg von Peuerbach (1423-1461), who lectured about astronomy and they became close friends. Peuerbach had spent several years (in 1448-1450 according

to one source and in 1448-1450 according to another one) in Germany, France and Italy. He had got acquainted with well-known scientists Nicolay Kuzansky and Giovanni Biankini when he was in Italy. Peuerbach went down in the history as an astronomer, mathematician and teacher of Regiomontanus.

Regiomontanus (Johannes Müller von Königsberg).
(Geb. 6. Juni 1436, geſt. 6. Juli 1476.)

The teacher taught Regiomontanus Greek as he was interested in astronomy and mathematics and wanted him to translate required works from Greek into Latin. Regiomontanus went to Rome and translated seven articles

of Ptolemy's ***"Almagest"*** there after Peuerbach died in 1461.

He went to Venetia in 1463, analyzed and copied old manuscripts kept there. Besides it, he took copies of old manuscripts kept in most libraries of Italy to Vienna in 1461-1468. [1]

Vienna was mathematical center of Central Europe besides being residence of the emperor of Holy Rome Empire of the German Nation in the middle of XV century. Though the University of Vienna was the first university in German countries, it wasn't the oldest university of Europe and is about 250 years "younger" than the University of Bologna established in 1119, 17 years "younger" than the University of Paris (1348) and a year "younger" than Krakovski's University (1364). But that High School became one of the greatest educational institutions of Europe in hundred years – yearly student admission was about five hundred in 1450-1461 and about three thousand people studied at the university (one tenth of the population of Vienna, which was one of the greatest cities of Europe). The University of Vienna was becoming an important center of humanism. The Italian humanist and diplomatist Enea Silvio Piccolomini, who represented Vatican in the palace

[1] А. Берри. «Краткая история астрономии». 1946. стр. 84

of Vienna, and the Pope Pius II (since 1458) played an important role in this process.

The first person, who taught main disciplines on astronomy and mathematics (mathematics and astronomy were taught together), was Johannes von Gmunden (1480-1485 – 1442). Gmunden lectured about philosophy (according to Aristotle) after graduating from the University of Vienna and getting master degree, but specialized in mathematics by reading Euclid's geometry, theory on movements of planets described in Ptolemy's ***"Almagest",*** work of Gerardo Sabionet, theory on 60^{th} roots (published in 1515 with the name ***"Tractatus de minutiis physicis" ("The tractate on physical 60^{th} roots"))*** after 1412. Besides it, he taught students to use astronomical equipments (especially astrolabe). Gmunden was considered first professional teacher of mathematical disciplines in German countries.

Regiomontanus asked the Hungarian king Matthias Corvinus to allow to construct observatory and printing-house in Vienna and achieved his goal after a very short time. He went to Nuremberg in 1471, founded observatory and printing-house there. It is known that, the young scientist had used drafts and styles of eastern architects during construction of the observatory.

Regiomontanus went to Rome in accordance with the invitation of the Pope Sixtus IV in 1475 in order to organize works on the calendar and died there a year later. They say that, he was killed or died of cholera.

Astronomers used equipments of Arabs and ancient Greeks – astrolabes, parallel pivots, quadrants and Jakob's staff, including different sun, star and moon clocks during the age of Regiomontanus.

Regiomontanus was interested in astronomical equipments at the beginning of his activity. He wrote the work on the complex astronomical device, which imitated movements of celestial bodies and was invented in 1327 by Richard of Wallingford, in 1455. Regiomontanus's work about mentioned device hasn't remained till the present day. His work ***"About geometrical quadrant" ("Quadratum geometricum")*** was written in 1457. Mentioned device was applied for determination of the Earth's measurements in XI century and it was described for the first time by the French scientist Jan Liner in 1322.

Almost during the same period, Regiomontanus wrote ***"Instrumenten amussis" ("Precise equipment")*** considered for determination of heights of the Sun and stars. Besides it, Regiomontanus worked on improvement of road clocks.

After the death of Regiomontanus, his student from Nurnberg – B. Walter installed armillary sphere and used it for observations in 1488-1504. Copernicus made observations by means of that device in 1512-1541. Different improved armillary spheres were made and used in Tycho Brahe's observatory. [1]

Though Regiomontanus's life was too short, he could translate ***"Spherics"*** of Menelaus, ***"Spheres"*** of Theodosia and other works into Latin. I want to mention one interesting fact too. ***"Spherics"*** of Menelaus, who was from Alexandria, hasn't remained till the present day. Abu Nasr Iraqi translated that work into Arabic in the early middle ages. Perhaps, Regiomontanus had seen translation of the work (Arabic version). But he was popular in the field of mathematics and astronomy owing to ***"Joannis Reqio Montanus. De triaquius pianis et srhericis lidev v. unae curtabulus sinuum",*** which was about plane and spherical trigonometry.

Regiomontanus completed this work in 1464, when worked on translation of a lot of manuscripts in Italy, but it was published 69 years later – in 1533. Besides it, he completed the work in Italy when copied manuscripts.

[1] Белый Ю. А. Тихо Браге. М. «Наука», 1982. стр. 229

Regiomontanus went to Padua in April of 1464 and got acquainted with G. Biankini there. He lectured at the University of Padua on the history of mathematics and Alfraganus's (Al-Farghani) activity.

The Spanish-Arab mathematician Jabir ibn Aflakh, who worked in Seville in the middle of XII century, (his name was Heber Geber in Latin texts) also had a role in development of trigonometry. He could solve the problem on spherical triangle with given cathetus and corresponding angle (Heber's rule) for the first time in Europe. Results of works carried out by scientists of Muslim countries and their predecessors in the field of trigonometry were generalized in ***"Uncovering secrets of intersecting figures"*** or ***"Treatise on complete quadrilateral"*** of the scientist and encyclopaedist N. Tusi written in 1260. The treatise of N. Tusi is considered the first work, which analyzes trigonometry as an independent branch of science, in the history of mathematics.

European scientists of the middle ages got acquainted with materials of trigonometry after translation of works of eastern scientists of ancient times and middle ages from Arabic into Latin. Adelard Bat translated astronomical tables of Al-Khwarizmi adapted by Al-Majriti in 1126 and created basis for acquainting European scientists with basics

of trigonometry. Besides it, John of Seville translated astronomical tractate of the well-known astronomer Ahmet Al-Farghani from Fergana (IX century) known as ***"Book about elementary science on stars"*** in XII century. Regiomontanus was aware of both of mentioned translations. Besides it, probably, he had translation of Al-Battani's tractate ***"About movement of stars"*** which was made by Platoon from Tivoli in the middle of XII century and translation of N. Tusi's ***"Treatise on complete quadrilateral".*** As it was mentioned above, Regiomontanus had a Greek version of Ptolemy's ***"Almagest"*** and he had learned ancient Greek language in order to translate it into Latin. Probably, Regiomontanus used translations of Jabir ibn Aflakh and Arab astronomer and mathematician az-Zarkali (1030-1090), who was known in Europe as Arzakhel, either.

It should be taken into consideration that, only few copies of above mentioned translations were available. Scientists of the Central Europe didn't know anything about existence of translation of Al-Khwarizmi's tables made by Adelard, though it was one of rare sources, by means of which Regiomontanus could learn tangent. Besides it, I think, Regiomontanus couldn't use tables of tangents of all degrees between 0° and 45° made by the astronomer and

mathematician Giovanni Campano da Novara (1260-1280) though he had translation of Euclid's ***"Beginning"*** which was later published. These tables and tables of Regiomontanus's colleague, who had studied at the University of Vienna, – Peuerbach and his Italian colleague Giovanni Biankini were exceptions, other European predecessors of Regiomontanus couldn't make any innovation in the field of trigonometry.

It was done in 1462-1464. It was started in Rome and was completed in Padua. Regiomontanus wrote in his letter to Biankini that, the work about triangle was going to be completed.

According to H. Mammadbayli, Regiomontanus had used N. Tusi's ***"Shaklul qita"*** written in Arabic when he prepared manuscript of ***"De trianqulus".*** It means that, the scientist knew Arabic. Though most scientists of the West write that, Regiomontanus didn't know Arabic, it doesn't correspond to reality.

According to the encyclopedia ***"World astronomy",*** Al-Farghani's "Basis of astronomy" – ***"Alfraqanj rudimen ta astronomioe"*** was published in Latin in Nurnberg in 1537. The manuscript of that work was found by Melanxton among manuscripts of Regiomontanus. Though Al-Farghani was an Uzbek scientist, his book was in Arabic, but not in

Greek. How could he translate the book, which was written in Arabic, if he didn't know this language?

Al-Battani's ***"Mohametis Albeteni de Scienta Stellarum"*** was published in the same year in Nurnberg together with Regiomontanus's additions. The only copy of that book was kept in the Vatican library. So, the Academician F. Magsudov and Professor H. Mammadbayli wrote that, Regiomontanus knew Arabic and had read Nasiraddin Tusi's works on trigonometry. N. Tusi was well-known in Europe then. All these facts prove that, Regiomontanus knew Arabic.

There were Arabists, who worked with astronomers, in Rome, Florence and Venice as most scientific works of eastern scientists were written in Arabic and spread in Eastern Europe. Perhaps, Regiomontanus had learned Arabic with the help of those specialists.

"De trianqulus" was published 57 years after the death of Regiomontanus. It was published by Johann Schoener and his son Andre Schoener. Saleh Zeki mentioned that, as the book published in 1533 was edited by Schoeners, it differed from previous versions. Johann Schoener worked as the professor of the University of Nuremberg then.

The French historian of mathematics Montuklo wrote that, Schoeners had edited Regiomontanus's work on

trigonometry and he mentioned that, such perfect work couldn't be written by the author of XV century. He thought that Schoeners had modified the work.

Regiomontanus's heirs couldn't preserve his manuscripts after the scientist's death. At last they were acquired by the leader of the Lutheran Church Melanxton in Nurnberg. He asked Schoeners to edit Regiomontanus's ***"De trianqulus".*** Let's look through following fact in order to know Melanxton:

Georg Lausen came from Nuremberg to Frombork to Copernicus in 1539, took manuscripts of the scientist's ***"Rotation of celestial spheres"*** and returned to Nuremberg after three years in order to publish the work. He was dismissed from his position in the Wittenberg University in accordance with the order of Melanxton. He began to work in the Leipzig University. Andrea Ossiander was entrusted with publication of the book. Ossiander added a fake introduction to Copernicus's book and there was a serious contrast between the book and that introduction.

As Ossiander hadn't mentioned the introduction's author, it was known as Copernicus's work for a long time. Why Copernicus denounced his own work? The introduction ended with: "Astronomical hypothesizes can't be exact. Astronomy doesn't require it. Only idiots can consider these

hypothesizes exact. Good luck, readers!" It means that, the author considered his own thoughts nonsense. He couldn't evaluate his 36-years labor like this.

Nikolaus Copernicus (1473-1543)

At last in XIX century Pole astronomers proved that, mentioned introduction wasn't written by Copernicus, it was written by Ossiander in accordance with Melanxton's order.[1]

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh. 92-93

As Melanxton was a churchman, he approached important astronomical discoveries from the religious point of view. That's why Georg Lausen was dismissed from his position in the Wittenberg University in accordance with the order of Melanxton after he took Copernicus's book to Nuremberg and published it there. As several works of Copernicus, who had a significant role in development of astronomy, were considered illegal, most scientists of that time, especially Christian scientists tried to publish his works with fake introductions.

The difference between the original of Regiomontanus's ***"De trianqulus"*** and its copy published by Melanxton hasn't been discovered. According to all these facts, it hasn't been proved that, Regiomontanus was the author of mentioned work.

N. Copernicus wrote about the Earth's shape in ***"Commentaries about Aristotle's "About the sky***"" written in 1459: "The Earth is spherical. The spherical form is convenient for movement and especially for circular movement".[1]

N. Tusi's ***"Shaklul qita"*** and table of trigonometric functions made in Maragha observatory prove that,

[1] Н. Веселовский, Ю. А. Белый. Николай Коперник. М.: 1974. «Наука», стр. 65

achievements of Regiomontanus and other European mathematicians were less than achievements of eastern scientists in XV century.

Muhammad Al-Battani

Now we can write decisively that, Regiomontanus had learned Arabic when he was in Italy and translated Al-Battani's ***"Mohametis Albeteni de Scienta Stellarum" (scientific work of Muhammad Al-Battani about stars)*** into Latin. Besides it, he used N. Tusi's ***"Shaklul qita"*** when he wrote his ***"De trianqulus".*** The French historian of mathematics Montuklo also wrote that, European scientists couldn't write any rich scientific work in XV century. It

proves that, Tusi could pass ahead of western scientists in this field for hundreds of years and some of his works were stolen from libraries of Byzantine and Apennine Peninsula. Saleh Zeki wrote that, Regiomontanus had used scientific works of well-known eastern scientists.

As it was mentioned above, the ancient Persian version of ***"Shaklul qita"*** was found in Istanbul in 1891. It is known that, one of manuscripts of that work is kept in the Berlin State Library and two of them are kept in Oxford and Paris.

I want to mention that, scientists of the Near East wrote scientific works in Arabic in early middle ages, but ethical works were written in Persian. N. Tusi's ***"Shaklul qita"*** was written in Persian and Arabic. But its Arabic version hasn't been found yet. May be it is kept in one of libraries of Germany or Austria.

There is no doubt that, ***"Zij-i Ilkhani"*** was translated by western scientists from Arabic into Latin as a very important astronomical source and was analyzed by specialists of astronomy and mathematics. So, mentioned work of N. Tusi might be kept in the library of the well-known astronomer Paolo Toscanelli located in Florence and part of it might be translated into Latin during a very short

time. Regiomontanus had an opportunity to get acquainted with Toscanelli and Tusi's works when he was in Italy.

The scientist known for scientific works

"Collection of calculations" of the scientist, who was popular for his scientific works, was translated into Greek in Constantinople and then was taken to Italy. It is impossible to deny importance of his scientific achievements. H. Mammadbayli wrote: "Tusi wrote in the introduction of ***"Treatise on complete quadrilateral"*** that, continuous quantities could be understood only by means of discrete quantities. After 362 years, well-known scientist of geometry Cavaleri wrote in his letter to Galileo: "I think that, the principle of quantities is common for both continuous and discrete quantities"".[1]

Let's see the example proving that, Tusi's mathematical and astronomical works had spread in Europe: "There was following theorem in the 67th part of the well-known Pole scientist N. Copernicus's ***"Rotation of celestial spheres":*** A

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh. 135-136

small circle moves inside another one and touches it. That circle's radius is equal to half of the first circle's radius. The second circle's radius will outline the first circle's diameter during the movement. That theorem was first proved by Nasiraddin Tusi and explained in ***"Memories about astronomy"".***[1]

It proves that, N. Tusi's ***"Memories about astronomy"*** and ***"Treatise on complete quadrilateral"*** were translated into Latin and were important sources for scientists. Most of his works about geometry, astronomy and trigonometry were translated into Latin by scientists of Western Europe in XIV century and published in XVI-XVII centuries. According to the German scientist Henry Zutter, though churchmen were against development of relations with the East in the middle ages, they organized translation of "infidel Muslim" scientists' scientific works into Latin with great pleasure. Most eastern scientists' works on astronomy, mathematics, medicine and philosophy were translated from Arabic into Latin.

The Soviet astronomer, academician M. F. Subbotin, who was considered great expert in the field of spherical mechanics, wrote about Tusi's astronomical works:

[1] Ф. Г. Максудов, Г. Дж. Мамедбейли. Мухаммед Насирэддин Туси. Баку, «Гянджлик», 1981. стр.28

"Nasiraddin Tusi knew that, main essence of astronomy doesn't consist of the "world system" only. It included collection of observation materials and determination of events. That's why he founded an observatory and organized long-term systematic observations on the Sun, Moon and planets. On the other hand, the scientist made ***"Zij-i Ilkhani"*** with the help of scientists, which were invited to the observatory. Those tables were his main achievements. Nasiraddin realized the program, which would be realized by Ticho Brage after 300 years, when he made mentioned tables in accordance with special observations and analyze of Ptolemy's mathematical theory. It proves that, Nasiraddin was aware of the science's demands. Nasiraddin Tusi could cope with all difficult works owing to his great energy and talent as an organizer".[1]

Works written by N. Tusi were considered important source for all scientists.

Almost all well-known scientists of middle ages used N. Tusi's scientific works and made important discoveries owing to those works.

[1] М. Ф. Субботин. Работы Мухаммеда Насирэддина по теории движения Солнца и планет. «Известия» АН Азерб. ССР. № 5, 1951. стр. 57

According to investigations, though N. Tusi's ***"Book of collection of calculations with a board and land"*** written in 1265 hadn't been learned by historians of mathematics very well, it was used by eastern scientists of the middle ages. Hasan Nishapuri's ***"The Sun of arithmetic"*** written at the beginning of XIV century and Giyasaddin Kashi's ***"The key to arithmetic"*** written at the beginning of XV century based on ***"Collection of calculations".***

As Giyasaddin's work had been analyzed by European researchers, everybody thought that, the method of finding root of all degrees was described in Giyasaddin Kashi's ***"The key to arithmetic".***

Soviet historians of mathematics did a lot of things in this field after the middle of XX century. Translation of XI chapter of N. Tusi's ***"Collection of calculations"*** was published in XV edition of ***"Researches on the history of mathematics"*** in 1963 in Moscow. After it, it became clear that, methods of finding root were described in Tusi's above mentioned work 160 years before Giyasaddin Kashi.

All these facts prove that, Tusi's scientific works were very significant and his achievements weren't refreshed by other scientists at least during 100 years. I want to mention that, Tusi's most works, which aren't known by people, are kept in ancient libraries of Tehran, Tabriz, Istanbul,

Baghdad, Damascus and Near East without being analyzed and specialists have to work on them. The scientist is the first author of most discoveries in the field of mathematics. But foreign scientists often use his discoveries.

As it was mentioned above, most scientific works of N. Tusi haven't been learned by European researchers enough and so, some actual works of the scientist have been published by plagiarists as their own works.

Tusi's comprehensive scientific activity amazed people of all time. The Syrian historian Abul Faraj Bar Hebraeus worked in Maragha observatory in XIII century. He wrote about the observatory in his ***"General history":*** "I got an opportunity to work in Maragha library, which was full of books written in Syrian, Arabic and Persian. The library wasn't smaller than the library of Alexandria of Egypt and was the greatest library of the world for number of scientific works kept there".

It proves that, Maragha library had a great role in development of the science and culture. Bar Hebraeus could get acquainted with very significant historical materials there. The Syrian historian wrote about Tusi in his ***"General history":*** "The Turkish philosopher, well-known scientist, mathematician Nasiraddin Tusi was introduced to me (in 1264). He had invented equipments (astronomical) for

observations and created bigger (in comparison with Ptolemy's circles) copper circles. He had visited Alexandria in order to observe and record planets' movements. Scientists of different countries gathered around him in Maragha.

He got salaries and grants of scientists and students for them. He had a lot of works – translation of ***"Logic",*** researches on theology and natural sciences… Besides it, he is the author of ***"Ethics"*** (***"Akhlagi Nasiri"*** – R. D.) written in Persian. He collected thoughts of Platoon and Aristotle about applied philosophy there. He had got acquainted with works of ancient philosophers either and didn't deny them".

Such popular scientist couldn't not to attract attention of scientists, philosophers, thinkers and intellectuals of the West. N. Tusi was popular all over the world and his scientific heritage was discussed everywhere from Chine to Europe. There were enough information about him in large libraries of Europe and Near East in the middle ages.

The value of the annual precession of the Earth's rotation axis was determined as $51^{//}4$ in Maragha observatory under the leadership of N. Tusi (modern value is $51^{//}2$). There are a lot of mathematical, astronomical and geographical tables in ***"Zij-i Ilkhani".*** The most important tables are tables of sinuses and tangents in sexagesimal numeral system and

tables of geographic coordinates of 256 cities, which were known in XIII century.

Several astronomical catalogues consisting of geographic coordinates were made in the East before XIII century. But ***"Zij-i Ilkhani",*** which was written in Maragha, was very different for exactness of measurements. Geographic coordinates of Peking and Cordova, which were situated in the East and West of the Old World, were fixed almost precisely in mentioned catalogue and distance between East and West of the Old World was calculated at the result of it. The length of the equator was almost equal to the modern value. So, the width of the Atlantic Ocean was more than the width of the Old World. It meant that, there should be a large land area in the middle of the Atlantic Ocean. Coordinates of its eastern and western coasts had to be determined. According to ***"Zij-i Ilkhani",*** Tusi and science collective of Maragha observatory could cope with this job successfully.

Ramiz Daniz

Preparation for discovery of America

Though America was discovered by Christopher Columbus, scientists, who worked in Maragha observatory, were aware of existence of mentioned continent even in XIII century, because it was theoretically discovered by Nasiraddin Tusi.

Though this fact is denied by most scientists, it should be admitted that, ***"Zij-i Ilkhani",*** which was written in Maragha observatory under the leadership of Nasiraddin Tusi, had a great role in discovery of America. The most ancient manuscript of mentioned work was found after long researches. Besides it, manuscripts of 1308, 1403, 1600, 1652 and 1711 were also found and presented to specialists. It is known that, geographic latitudes started from the equator. In the middle ages, all scientists wondered where the prime meridian started. Tusi wrote in the introduction of ***"Zij-i Ilkhani":*** "Geographic longitude started in Algeria Haldat and Algeria Haldat is situated at 10^0 towards the west from the coast of the West Sea". Haldat Islands were named "Islands of Good Luck" in geographical works. But according to some scientists, those islands were Canaries.

№	Names of cities	According to Tusi	According to Greenwich	Difference of degrees	
1.	Cordova	$38^0\,26'$	$04^0\,47'$	$33^0\,39'$	
2.	Alexandria	$61^0\,54'$	$30^0\,03'$	$31^0\,51'$	
3.	Cairo	$63^0\,20'$	$30^0\,03'$	$33^0\,17'$	
4.	Aden	$76^0\,00'$	$44^0\,30'$	$31^0\,30'$	
5.	Medina	$75^0\,00'$	$39^0\,54'$	$35^0\,26'$	
6.	Mecca	$77^0\,10'$	$39^0\,50'$	$37^0\,20'$	
7.	Jerusalem	$66^0\,30'$	$35^0\,14'$	$31^0\,16'$	
8.	Damascus	$70^0\,00'$	$36^0\,18'$	$33^0\,42'$	
9.	Mosul	$77^0\,10'$	$43^0\,00'$	$34^0\,00'$	
10.	Khoy	$79^0\,40'$	$44^0\,58'$	$34^0\,42'$	
11.	Urmia	$79^0\,45'$	$45^0\,05'$	$34^0\,40'$	
12.	Nakhchivan	$81^0\,15'$	$45^0\,25'$	$35^0\,50'$	
13.	Maragha	$82^0\,00'$	$46^0\,10'$	$35^0\,50'$	
14.	Tabriz	$82^0\,00'$	$46^0\,17'$	$35^0\,43'$	
15.	Tiflis	$83^0\,00'$	$44^0\,49'$	$38^0\,11'$	
16.	Baku	$84^0\,30'$	$49^0\,52'$	$34^0\,38'$	
17.	Shamakhi	$84^0\,30'$	$48^0\,39'$	$35^0\,51'$	
18.	Derbent	$85^0\,00'$	$48^0\,17'$	$36^0\,43'$	
19.	Baghdad	$80^0\,00'$	$44^0\,24'$	$35^0\,56'$	
20.	Abadan	$84^0\,30'$	$52^0\,30'$	$32^0\,00'$	
21.	Shiraz	$88^0\,00'$	$52^0\,34'$	$32^0\,00'$	

22.	Kazvin	$85^0\,00'$	$50^0\,00'$	$35^0\,00'$	
23.	Nishapur	$92^0\,00'$	$58^0\,51'$	$33^0\,09'$	
24.	Samarqand	$99^0\,16'$	$66^0\,59'$	$32^0\,17'$	
25.	Bukhara	$96^0\,30'$	$64^0\,25/$	$32^0\,05'$	
26.	Khujand	$100^035'$	$69^0\,38'$	$30^0\,57'$	
27.	Sana	$77^0\,00'$	$44^0\,30'$	$32^0\,30'$	
28.	Urganch	$94^0\,30'$	$60^0\,45'$	$33^0\,45'$	
	Average Difference			$34^0\ 30'$	

H. Mammadbayli, who published part of the table in his work ***"Muhammad Nasiraddin Tusi",*** wrote: "According to the table, the prime meridian determined in Maragha observatory is situated at $34\text{-}35^0$ west of today's Greenwich Meridian. Where does this meridian pass? Let's see geographic map in order to answer to this question. The meridian, which is situated at $34\text{-}35^0$ west of today's Greenwich Meridian, passes through San Roka Cape located on the eastern coast of South America. What does this mean? It is known that, discovery of America was started on October 12, 1492. But mentioned table was made in Maragha observatory in 1270 s. How could it happen? May be Columbus was aware of existence of America before it

was discovered or Tusi's table was wrong? Thus, investigation of the table of Maragha observatory is very interesting.

№	Название Города	По Туси	По Бируни	По Птолемею
1.	Аден	$76^0\,00'$	$70^0\,00'$	----------
2.	Мекка	$77^0\,10'$	$67^0\,00'$	$67^0\,00'$
3.	Медина	$75^0\,20'$	$67^0\,30'$	$65^0\,20'$
4.	Sana	$77^0\,00'$	$67^0\,20'$	$63^0\,30'$
5.	Bukhara	$96^0\,30'$	$87^0\,50'$	$87^0\,20'$
6.	Urganch	$94^0\,30'$	$84^0\,01'$	----------
7.	Samarqand	$99^0\,00'$	$89^0\,00'$	$89^0\,30'$
8.	Khujand	$100^0 35'$	$90^0\,35'$	----------

Several tables made before Nasiraddin Tusi should be investigated. If geographic longitudes of same cities fixed in tables of different authors are compared, it will turn out that, Nasiraddin Tusi's table is different.

Comparison of tables proves that, Nasiraddin had determined the prime meridian at 10^0 towards the west. But

he confirmed that, some of previous authors had determined the prime meridian before".[1]

I should note that, P. Toscanelli had already seen N. Tusi's ***"Zij-i Ilkhani"*** when he made his map in 1474. Perhaps, the Italian scientist had used Azerbaijani scientist's mentioned work.

But astronomers and geographers of XV century wondered why N. Tusi determined the prime meridian at 10^0 towards the west of Haldat Islands – the eastern coast of the Atlantic Ocean, though other scientists as Al-Biruni and Al-Khojandi determined the prime meridian at 25^0 towards the west of the Greenwich Meridian. Surely, it couldn't happen by accident. How could he know where the remote eastern part of South America was located? If N. Tusi's purpose was to get different result, he could determine the prime meridian at 44^0 towards the west of the Greenwich Meridian. Such result would be more expedient for scientists of the observatory. Thus, in that case, 90-degree meridian could pass through Maragha. It proves that, Tusi was sure that he was right. Ch. Columbus, who went to transatlantic travel, knew whose help he needed. He wrote: "Ptolemy and other scientists wrote that, the Earth was

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh. 154-156

spherical. They mentioned that, its center was on the Aran Islands. According to them, that area was located below the equator, between Arabian and Persian Gulfs and the Earth's boundaries passed San Vicente Cape in Portugal and Kangara and Seres in the East".[1]

Columbus wrote that, the Aran Islands were on 90-degree meridian in the Eastern Hemisphere. Mentioned island is situated below the equator, between Arabian and Persian Gulfs. It may be Sheisel Islands only. The longitude of those islands was 53^0 with regard to the Greenwich Meridian. Completion of this measurement is 34^0. Ch. Columbus's and N. Tusi's results are almost same. It means that, the well-known traveler had got acquainted with the astronomical table made in Maragha.

Mentioned table consisted of coordinates of 256 cities. These cities included Cordoba of Spain and Peking of Chine.

[1] Христофор Колумб. «Путешествие», 1952. стр. 391

Ramiz Daniz

The map made in Maragha in Europe

The member of the Academy of Sciences of Uzbekistan T. N. Niyazov analyzed longitudes of Samarqand, Bukhara, Herat, Osh and Khojand and determined the prime meridian at 32^0 towards the west of the Greenwich Meridian. It means that, ***"Zij-i Ilkhani"*** had been made professionally.

As it is known, Ch. Columbus had used Canaries as a passage when he started his travel. But he could use Green Cape Islands, Azores and Madeira Island instead of Canaries.

Scientists of the middle ages wondered where Haldat Islands and Islands of Good Luck were situated. Some scientists wrote that, mentioned islands were situated at 35^0 towards the west of the Greenwich Meridian.

The English scientist G. R. Kaye wrote in his work ***"Astronomy of India"*** that, Islands of Good Luck were situated at 35^0 towards the west of the Greenwich Meridian.[1]

Why did he think like this? Most of scientists of the ancient time and middle ages thought that, Islands of Good Luck were situated at 35^0 towards the west of the Atlantic Ocean. Their location was near the border of the Old World. It means that, Kaye described mentioned islands at 35^0

[1] Г. Р. Кае. «Индийская астрономия». 1924. стр. 52

towards the west of the Greenwich Meridian. As it is known, there aren't such islands at 35^0 towards the west of the Atlantic Ocean.

Al-Biruni wrote: "Some scientists calculated the beginning longitude from Islands of Good Luck and others started calculation from the coast of the West Sea. The difference between these two places is 10^0". The Arab geographer Ali ibn Said Al-Maghribi Al-Andaluzi (1214-1274), who lived in Spain during the age of N. Tusi, wrote about Haldat Islands: "The Earth is spherical. It is surrounded by water on all sides.

The dwelling part of the Earth – Algeria extended from Haldat to Isles of Scilly for 180^0. Algeria Haldat was in the West. But Isles of Scilly were in the East".

Ali Al-Andaluzi didn't write openly that, the Earth was surrounded by water on all sides and didn't mention which places were its dwelling areas. He didn't describe concrete place of Algeria Haldat, but as it was in the West, some scientists thought that, it was Canaries, Madeira Island or Azores. I'll disprove it below. The concrete place of Isles of Scilly also may be determined. As meridians weren't divided precisely in those years, eastern parts of Asia, end of the Indonesian archipelago – Moluccas, Sulu archipelago and New Guinea were considered the East. Ali Al-Andaluzi

tried to fix the beginning and end of the Eastern Hemisphere in XIII century.

Of course, scientists of Maragha observatory also thought about location of Algeria Haldat. The Syrian scientist Gregory Abul Faraj, who worked together with N. Tusi, wrote: "According to Greek scientists, the dwelling part of the Earth starts on the west and it is called Islands of Good Luck or Haldat Islands".

Well-known Azerbaijani geographer and historian of XIII century Mahmud Ghaznavi thought that, Islands of Good Luck or Haldat Islands were situated on the western coast of the Atlantic Ocean. Another scientist of the observatory, Mahmud ben Masud Gutbaddin Shirazi wrote about mentioned islands: "According to Ptolemy and other scientists, the beginning longitude started from six islands, which were called Algeria Good Luck and Algeria Haldat and they were situated on the West Sea called "ocean". Those islands were dwelling areas in the ancient time. They were in front of Ethiopian. But now they have been covered by water".

Thus, two of scientists, who worked in Maragha observatory, Gregory Abul Faraj and Gutbaddin Shirazi wrote that, Algeria Good Luck and Algeria Haldat consisted of six islands and they were situated on the West Sea – on

the prime meridian. Which islands did they consider? We'll analyze it later.

Now, let's see opinions of several scientists. The Arab scientist Harrani (XIV century) wrote: "Western lands start from the West Sea. Nobody has ever been on the other side of that sea and don't know what is located there. There are plenty of settled islands there. Two of them are called Haldat. Two of them are the largest ones".

These words of Harrani surprised H. Mammadbayli and he wrote: "… Harrani's opinion is so interesting… Two of these islands – Cuba and Haiti are larger than other ones. It can be seen in the schedule of relative measurements. So, Harrani considered that, Islands of Cuba and Haiti were Algeria Haldat".[1]

Most scientists thought like this. But it can't be considered a sensation. Scientists thought that, Anthill islands located on the border of western lands and two large islands located there – Cuba and Haiti were Algeria Haldat. According to them, Anthill islands consisted of many islands and two of them were larger than other ones. I'm obliged to disprove it. Islands mentioned by Harrani can't be Anthill islands. Scientists of the middle ages described

[1] H. C. Məmmədbəyli. Mühəmməd Nəsirəddin Tusi. Bakı, "Gənclik", 1980. səh. 160-161

Anthill islands on the eastern coast of Asia, near Japan. As America hadn't been discovered then, nobody could describe Anthill islands in the east of that continent. But some scientists and geographers described Anthill islands on the western coast of the West Sea. Nevertheless, it doesn't mean that, Harrani meant today's Anthill islands.

Ancient scientists wrote that, Anthelia Islands were situated in the east of Asia. Really, maps, where Anthelia Islands were described, had spread broadly in Europe.

The Italian cartographer Francisco Pisano made a map in 1367 and described Anthelia Islands there. That map is kept in the Parma Public Library of Italy at present. Another map made by unknown author in 1424 is kept in the library located in Weimar, Germany. Its author was the German scientist Humboldt. The French cartographer Battista Beccaria also made a map in 1435. Anthelia Islands were described there under the name Stonechat. The Italian cartographer Andrea Biankini described Anthelia Islands in the centre of the Atlantic Ocean on his map made in 1436.

Why did scientists named those islands Anthelia? Eratosthenes wrote that, it was possible to reach India by sailing towards the west from Spain without changing the parallel. So, scientists thought that, there was only the West Sea (Atlantic Ocean) between eastern coasts of Asia and

Europe including western coasts of Africa. Everybody imagined the Earth like this before the discovery of America. Africa was called Libya in the ancient time. So, islands located on the western coast of the West Sea were called Anti-Libya. Gradually this name became Anthelia.

Besides astronomy and mathematics, geography also was investigated in Maragha. For example, coordinates of 256 cities of the Old World were determined there. So, a map of the Earth could be made in this city. It is known that, the most ancient sky globe of the world had been made by scientists of Maragha observatory. I mean, it wasn't difficult for those scientists to make a map of the Earth. Besides it, manuscripts of scientists of the observatory prove that, Karimaddin Abubakr ibn Mahmud Salmasi had made the first geographic globe in 1266. But unfortunately, it hasn't remained till the present time.

I think, the map of the Earth made in Maragha was copied and some of its copies were taken to Europe. It means that, N. Tusi did his best in order to prevent loss of inventions made in Maragha observatory.

I think, N. Tusi, Gutbaddin Shirazi, Muayyidaddin Ordy and Fao Mun-Chi had copies of mentioned map as they had great roles in realization of works of the observatory. So, it is convincing that, the map had several copies.

For example, the remarkable scientist of Maragha observatory Gutbaddin Shirazi worked in the observatory till 1282 and then he was sent to Egypt as the ambassador of Mongols. He might take the copy of above mentioned map to Egypt as he was interested in cartography. The scientist had made the map of the Mediterranean Sea and lands located near it when he worked in Egypt. Later Egypt was arrested by the Ottoman Empire and probably, the map was taken as a strategically important material.

Christopher Columbus and the discovery of global importance

Christopher Columbus was born in 1451 in Porta dell'Olivella – near the eastern part of Genoa, Italy, in the family of the weaver. He loved the sea and first travelled from Genoa to Khios in 1474-1475. Ch. Columbus met an accident on coasts of Portugal when he travelled from Khios to Flandreau in 1476 and was obliged to go to Lisbon. Columbus went to England, Ireland and Spain in the following year and returned to Portugal. So, the future admiral could visit important places located in the north-

western part of Europe. He could become a professional seaman.

Christopher Columbus (1451-1506)

Christopher Columbus married Felipa Moniz Perestrello in 1479 in Madeira Island or Portugal and began to live in Madeira Island. He started to learn practical navigation in Porto Santo Island. The traveler enlarged his knowledge in expeditions to Guinea realized in 1482 or 1483 after travelling to Azores.

Great geographical discoveries have successfully been used in ship building, navigation and improvement of geographical knowledge. Portuguese and Spaniards learned to make improved vessels, which could sail against the wind. Use of compass and development of cartography allowed sailing on an open ocean. As the Earth was considered spherical, people hoped that they would find eastern countries by sailing towards the west. [1]

Only one way existed for going to India and Chine. It was the "Silk way", which extended to Damascus, Tabriz and Peking. Abu Al-Hasan Ali Al-Masudi, Abu Hamid Al-Harnati from Granada, Giovanni da Pian del Carpine, Benedict from Poland, Andre Langumo, Guillaume de Rubrouck, Nicollo, Maffeo and Marco Polo, Ruy Gonzales de Clavijo and Niccolo de Conti, who were sent to the travel in accordance with orders of the Pope and European rulers, entered Asia from Small Asia and Levant. Merchants met great difficulties as taxes were too high. People preferred to go round Africa in order to go to mentioned countries over the sea.

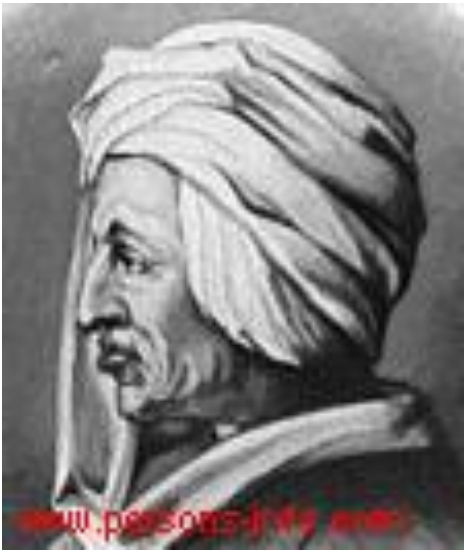
[1] М. Л. Абрамсон, А. А. Кириллова, Н. Ф. Колесницкий и др.; Под ред. Н. Ф. Колесницкого. История средних веков: 2-е изд. испр. и доп. Москва, «Просвещение», 1986. стр. 391

Columbus prepared his project for travelling to India through the western way when he was in Portugal and presented it to the king of Portugal Juan II in 1484. His idea was very simple and consisted of true and false parts. First (true): the earth is round. Second (false): the largest part of the Earth is land – Europe, Africa and Asia. So, the distance between the western coast of Europe and eastern coast of Asia is small: it is possible to reach India, Chine and Japan in the shortest time by passing the Atlantic Ocean through the west. But, seamen had to sail about 10000 km (to Japan) between Europe and Asia.[1] It was very difficult without having any stopping-place.

The Italian scientist, cosmographer and astronomer Paolo dal Pozzo Toscanelli (1397 Florentine – 1482), who lived in XV century, and humanist Pietro Martire also thought like this. Genius scientists as Aristotle, Eudoxus of Cnidus, Posidoni, Eratosthenes, Pifey, Pliny the Elder, Pompony Mela, Strabo and Plutarch also thought that, such travel was possible. The idea of Common Ocean was accepted by the church in the middle ages. Such theory was affirmed by the Islamic world including well-known Muslim scientists – Ali Al-Masudi, Muhammad Al-Khwarizmi, Battani, Abu

[1] И. П. Магидович, В. И. Магидович. Очерки по истории географических открытий. II том. Москва, «Просвещение», 1982. стр.14

Raihan Al-Biruni, Mahmud Al-Khojandi, Idrisi and Nasiraddin Tusi.



Paolo dal Pozzo Toscanelli (1397-1482)

The king and his noblemen understood that, Genoese scientists were enough wise. Juan II sent Columbus to **"Mathematical Union",** which was organized under the leadership of the archbishop of Ceuta Diego Ortiz de Villegas. Other members of that organization were Jewish scientists. Rodrigo, who had improved astrolabe and sextant, and expert of the navigation astronomy Hose

Vitsingo were among those scientists.[1] Mentioned persons thought that, measures and distances hadn't been fixed correctly in Columbus's project. Though those scientists also didn't know exact sizes of the Earth, they were sure that, calculations of Columbus were wrong. So, they advised king to reject him.

Columbus tried to prove that, though it was difficult to reach eastern coasts of Asia through the western way, it was possible. Portuguese couldn't achieve any positive result in research of unknown lands by using Columbus's project. It had a reason.

Al-Biruni, who was well-known scientist of Europe, had determined the prime meridian at 25^0 towards the west of the Greenwich Meridian and Portuguese seamen looked for Anthelia Islands and Islands of Good Luck there. Thus, expeditions organized under the leadership of **"Mathematical Union"** in Portugal hadn't to move away from the prime meridian. So, expeditions, which tried to discover Anthelia Islands and Islands of Good Luck, couldn't reach America. Though the prime meridian was kept secret by Portuguese, Columbus had understood that, they applied the prime meridian determined by Al-Biruni.

[1] Ч. Верлинден. Покорители Америки. Ростов-на-Дону, «Феникс», 1997. стр. 21

So, it was impossible to discover the continent located in the west of the Atlantic Ocean. The expedition of Portuguese organized in 1487 under the leadership of Van Olmen, which carried out researches in the west of the ocean, didn't worry Columbus. Anthelia Islands and Islands of Good Luck weren't on the prime meridian determined by Al-Biruni. Columbus planned to apply the prime meridian determined by N. Tusi. He was sure that, mentioned meridian would take him to unknown lands.

Columbus got acquainted with Herzog von Medinaceli don Luis de la Cerda with the help of Antonio Marchena when he was in Spain. Herzog approved the Genoese seaman's project and informed the queen Isabella about it, besides it, he said that, if the queen rejected Columbus, he would organize an expedition on his own account. The queen invited Columbus to Alcazar Palace in Cordoba on May 1, 1486 in order to get acquainted with him and presented his project to the special commission for discussion after interesting dialogue.

The commission gathered first in Cordoba and then in Salamanca, which was considered town of universities. The commission, which was organized under the leadership of Isabella's godfather Hernando Talavera and consisted of

monarchs and noblemen, made negative decision after 4 years.

Columbus didn't lose his courage and read a lot of scientific books in order to prepare for the expedition. He mainly read books on geography and cosmography. Especially, he read Marco Polo's books and made a lot of notes about them. He was sure that, his considerations were correct. Besides it, he had Pliny's "Natural history" in an Italian translation published in 1489, works of Plutarch and Ptolemy. He made notes on several books as Pierre de Ailli's ***"Imaqo Mundi" ("World Map"***) and Enea Silvia Piccolomini's (is known as the Pope Pius II) ***"Historia rerum ubique Mundi"*** besides Marco Polo's book written in Latin, which is still kept in the Columbia Library of Seville. There are about 2125 notes made by him.[1]

Pierre de Ailli wrote a tractate on general geography in 1410. He supported ideas of Marinus of Tyre, who thought that, Asia extended towards the east and there was only a narrow ocean between Asia and Europe. The French cosmographer even wrote that, it was possible to pass that ocean in several days when the weather was fine. The Genoese seaman underlined this sentence and made detailed

[1] Ч. Верлинден. Покорители Америки. Ростов-на-Дону, «Феникс», 1997. стр. 32

note about it. He made notes about the sentence, where the author of ***"Imaqo Mundi"*** wrote that, Spain isn't very far from India and the east starts near the west. Chapters about India and Asia are full of notes.

He underlined one of paragraphs in Enea Silvia Piccolomini's ***"Historia rerum",*** where the author wrote that, Asia extended towards the latitude of Spain. He noted on other paragraph, where the author described Chinese as peaceful creatures, that, Chine is situated near India, on the other side of Spain and Ireland.

J. Baker wrote that, Columbus's cosmographical ideas were founded in the middle ages. He used the book of Pierre de Ailli – ***"Tractatus de imagine mundi" (Tractate about the description of the Earth***), which included thoughts of Roger Bacon described in ***"Opus Magus"*** at the end of XIII century. So, Columbus hadn't any new ideas. [1]

Columbus had read ***"Almagest"*** of Ptolemy in Regiomontanus's translation and ***"Measurement of the Earth's circle"*** written in 9 chapters by Dicuilus, who was the author of two tractates about geography and astronomy (814-816) in order to learn geography and astronomy. Dicuilus's work was the first work written about geography

[1] Дж. Бейкер. История географических открытий и исследований. Пер. с англ.М., «Иностранной литература», 1950. IV глава.

in the French Empire. Main materials used for the work were taken from works of ancient scientists including Pliny.

The king Juan II entrusted the Frenchman by name Ferdinand van Olmen known in Portugal as Fernando de Ulmo with research of lands located on the other side of the Atlantic Ocean, after **"Mathematical Union"** rejected Columbus. Van Olmen started his travel with two caravels in spring of 1487.[1] In 1462, the former king of Portugal Alfonse V sent the seaman by name Vogado in that direction as the head of the expedition for discovery of unknown islands located in the west of the Atlantic Ocean, but the expedition couldn't get any result. Van Olmen couldn't return from the expedition.

Columbus's project was presented to the commission again in 1491, but he was rejected again. So, the Genoese seaman decided to go to France and Herzog Luis de Santangel, who was the financial counselor of Ferdinand from Aragon, convinced everybody that, Spain would repent for allowing Columbus to go.[2]

The king's herald came up with the seaman at 6 km away from Granada and made him to return back. Columbus's

[1] Ч. Верлинден. Покорители Америки. Ростов-на-Дону, «Феникс», 1997. стр. 23

[2] Ф. Дж. Купер. Мерседес из Кастилии или путешествие в Катай. Одесса, «Маяк», 1985. стр. 91

marine *("Santa Maria", "Pinta"* and *"Ninia")* left the port of Palos on August 3, 1492, discovered the island of Guanahini (today's Watling) located within Bahamas on October 12 and proved existence of the fourth continent of the world. Admiral reached Lisbon on March 4, 1493. Afterwards, Columbus travelled to coasts of the New World for three times – in 1493-1496, 1498-1500 and 1502-1504 and deliberately declared that, had discovered East Asia in order to mislead monarchs. But I emphasized in my works, especially in ***"Christopher Columbus, Nasiraddin Tusi and discovery of America"*** that, the well-known seaman knew where he was going and when he would reach the land.

Besides it, there is another "skeptic" conception too (since the middle of XVI century). According to this conception, Columbus knew that there was a land area in the west of the Atlantic Ocean before he started his travel on August 3, 1492. A. Vinio of America, Romulo Carbia of Argentine, M. Endre of France and R. Ballester Escalas of Spain supported this conception in XX century. [1]

I want to mention some details in order to analyze mentioned discovery. There are some literatures about purposes of Columbus's expedition. According to some of

[1] В. Л. Афанасьев. Текст воспроизведен по изданию: Бартоломе де Лас Касас. История Индии. Ленинград, «Наука», 1968. стр. 18

them, Columbus planned to reach Asia in 1492. It is necessary, to look through the agreement signed by the seaman and two kings in order to check this consideration. He could get titles and privileges, which he wanted, only after the discovery. Asia or any part of that continent wasn't described in the agreement.

Christopher Columbus started his first transatlantic travel

Portuguese seamen got right of organizing expeditions towards the south and east of Canaries and seamen of Castilia could organize expeditions towards the west and

north when the Pope divided the Earth between Castilia and Portugal in 1479. So, monarchs of Castilia couldn't mention any part of Asia in the agreement concluded with Columbus. Almost entire continent was given to Portugal. But the agreement might be only about Asia as according to ideas existing in ancient times and early middle ages, only Asia could be situated in the west of Europe, on the other side of the Atlantic Ocean.[1]

According to official chronics, after the first travel, Columbus declared that, he had discovered India in the west of Europe and brought several Hindus from there.

The Italian humanist Pietro Martire (Poignant Peter), who lived in Barcelona and were close to the kingdom palace, corresponded with his fellow-countrymen. He had written in the letter written on November 1, 1493: "One person by name Colon (Columbus) says that, he could reach India, the place of antipodes of the west. He discovered many islands located on the other side of the East Ocean near India as cosmographers thought… I don't want to write anything about it, nevertheless size of the Earth made me to think otherwise".

[1] Ф. Дж. Купер. Мерседес из Кастилии или путешествие в Катай. Одесса, «Маяк», 1985. стр. 237

That is, before the travel of Christopher Columbus, Pietro Martire thought otherwise about calculations of Paolo Toscanelli.

Christopher Columbus approached Guanahani Island

I think that, Ch. Columbus couldn't agree with thoughts of the Florentine cosmographer. First of all, well-known sea

traveler couldn't agree with length of the Earth's outline. It means that, Asia isn't situated in the Atlantic Ocean at 10000-12000 km away from Canaries in the west as Paolo Toscanelli thought. Columbus had determined that, land area located in the west of the Atlantic Ocean was at 4500-5000 km away from Europe. It means that, the mentioned land was other land, which was unknown for the Old World.

I think, he agreed with ideas of the Azerbaijani scientist after getting acquainted with N. Tusi's ***"Zij-i Ilkhani"*** and his map and was sure that, the land area located in the west of the Atlantic Ocean was at 5000-5500 km away from Europe. That distance could be overcome in 30-35 days.

Toscanelli was a defender and leader of the public library founded by the humanist Niccolo Niccolini. He defended ideas mentioning that, the Earth is spherical and planned to go to India through the western way. The astronomer had edited ***"Table of Alfonso"*** (XIII century). Though Toscanelli had read scientific works of most scientists, he had lessened measurements of the Earth for unknown results.

Experts can't justify Toscanelli for such rude mistake. He had made elementary mistakes when made his map in 1474. But he had opportunities for preventing those mistakes. The Greek scientist Eratosthenes lived in Alexandria. According

to his calculations, the length of the Earth's outline was 43625 km and its radius was 6943 km.[1] There is no doubt that, Columbus knew this fact. As he was interested in astronomy, he had taken into account calculations of Eratosthenes, Poseidon, Al-Khwarizmi, Al-Biruni, Tusi and Toscanelli before starting his travel.

Eratosthenes (276-194 BC)

Usually cupolas of temples were used as part of sun watches. The most popular example is the cupola of Santa

[1] R. Qasımov. Konkistadorların Mərkəzi Çili sahillərində faciəli ölümü. Bakı, "Çaşıoğlu", 1999. səh 247

Maria del Fiore located in Florentine. P. Toscanelli installed his popular gnomon in the temple in 1474 and could determine afternoon moment by means of it with exactness of half a second.

He attached a bronze plate with a hole in the middle of it on the window located on 90 m and made a ruler on the floor in the left of the main church. Rays of the Sun passed through the hole of the disk and reached the floor in two months – between the end of May and end of June. The device had remained until the end of XIX century and then was destroyed by restorers by mistake.

At the result of inexactness of measurements, Toscanelli lessened measurements of the Earth and determined that, the distance between Spain and India was 6 thousand miles – this measurement was two times less than the real measurement.

The French physician Jan Ferrell (1497-1558), who was interested in astronomy, wrote that, the length of the Earth's outline was 39816 km and its radius was 6337 km.[1] It means that, Toscanelli had made a mistake. According to his calculations, the length of the Earth's outline was 29000 km. So, Columbus didn't accept report of the Florentine

[1] О. Коротцев. Глобус, как измеряли землю. Ленинград, «Д.Л», 1980. стр. 312

scientist and took into account measurements determined by the Greek scientist Eratosthenes and geographic coordinates determined by N. Tusi.

Description of the world according to Eratosthenes

Of course, my hypothesis is serious enough. As N. Tusi's map was kept in the library of Florentine, ***"Zij-i Ilkhani"*** also might be kept there. How could Columbus find that work then?

Destiny of the map of Maragha

Jamaluddin iz-Zeydi Bukhari went to Chine together with the Chinese scientist Fao Mun-Chi in 1265, when Maragha observatory was being built. Fao Mun-Chi, who shared scientific investigations carried out in Azerbaijan with his colleagues, could become very popular in Nanking and in the Emperor's Palace in a very short time.

The emperor of Chine Khubilay (1256-1295), who paid special attention to all branches of the science, got acquainted with works of the young scientist and created good opportunities for him. The emperor's father Mongke khan had ordered Hulegu khan to occupy the Alamut castle of Hashashins as he wanted to invite Tusi to Chine in order to establish an observatory there. Hulegu khan occupied the castle, but the Azerbaijani scientist deviated from going to Chine. Afterwards Khubilay khan decided to establish an observatory in the capital of the empire Khanbaliq and sent Fao Mun-Chi to Maragha for achieving practise in this field.

After long preparations, construction of the observation was started in Khanbaliq in 80^{th} years of XIII century under the leadership of the well-known Chinese astronomer Qo Shu-Ching with participation of Fao Mun-Chi. Almost all equipments used in this observatory were invented by

experts of Maragha observatory. Armillary sphere, Rotary quadrant and sky globe are among them.

This fact has been noted in historical sources as well. According to historical sources of Chine, Jamaluddin iz-Zeydi Bukhari had brought small models and draughts of devices invented in Maragha observatory to Chine. The professional astronomer Jamaluddin worked on preparation of the Chinese calendar and the calendar of Jan Van was accepted in Chine in accordance with his offer. Geographic coordinates of 27 settlements of Chine also were fixed in ***"Zij-i Ilkhani".*** Astronomers of Maragha had important roles in development of trigonometry and astronomy in Chine.

Most works of Fao Mun-Chi were kept in large libraries as exponents after his death. The well-known Italian traveler Marco Polo, who had visited Chine in 1272, had worked as the ambassador of Khubilay khan in accordance with the offer of the Italian Aysen. Marco Polo could see the map brought from Azerbaijan in Nanking.[1] He knew that, it was brought by Fao Mun-Chi. There is no doubt that, the Venetian traveler knew Fao Mun-Chi and learned something about scientific works carried out in Maragha.

[1] R. Qasımov. Xristofor Kolumb, Nəsirəddin Tusi və Amerika qitəsinin həqiqi kəşfi. Bakı, "Çaşıoğlu", 2002. səh 124

Marco Polo bought mentioned map and took it to his motherland. The relation between Azerbaijan and Chine became more regular after formation of Ilkhanids by Hulegu khan. The friendship between two countries was improved. Chinese astronomers used the prime meridian fixed in ***"Zij-i Ilkhani"***. They considered mentioned work the most precise astronomical catalogue and the most skilful scientific workers of the world worked in Maragha observatory.

I came to the conclusion that, mentioned map could be kept in the public library founded by the Italian humanist Niccolo Niccolini in Florentine. The map, which was considered property of Polos, could be presented to the library in order to be preserved.

Marco Polo presented a copy of his book to the Frenchman Tibo de Sepua, who was the ambassador in Venice, in 1307 – 8 years after leaving Genoa prison. The French ambassador returned to his motherland after completing his work in Venice. So, mentioned work began to be copied and spread in France and ***"Travel book"*** began to be discussed again. But afterwards it turned out that, the book was full of mistakes. In spite of it, materials of Marco Polo's book were used by other authors either. For example, there were some citations from that book in the novel of Bodue.

After a while the traveler's book was found by geographers. Traveler's biography was written by the Venetian geographer Ramuzino 200 years after his death. He translated Marco Polo's work from French into Italian and included it in the second volume of ***"Travels by land and sea***".

The map considered for start of cross marches was included in ***"Book of Christians"*** written by Marino Sanudo the Elder in 1320. That map included descriptions of Europe, Syria, Small Asia and Arabia. Probably, the author had used Marco Polo's map. Besides it, the Venetian traveler had described territories of Georgia, Darband and Chine on the map rightly.

Victor Shklovsky wrote in his historical narrative ***"Land explorer"***: "There was Marco Polo's ***"Travel book"*** in the vessel when Christopher Columbus left Spain during his first travel and that book substituted for the compass and map".[1]

It is obvious that, Columbus was interested in the Venetian traveler's book. Probably, he had got acquainted with all materials brought from Chine by Polo. Columbus

[1] В. Шкловский. Земли разведчик. Москва, «Молодая гвардия», 1966. стр. 194

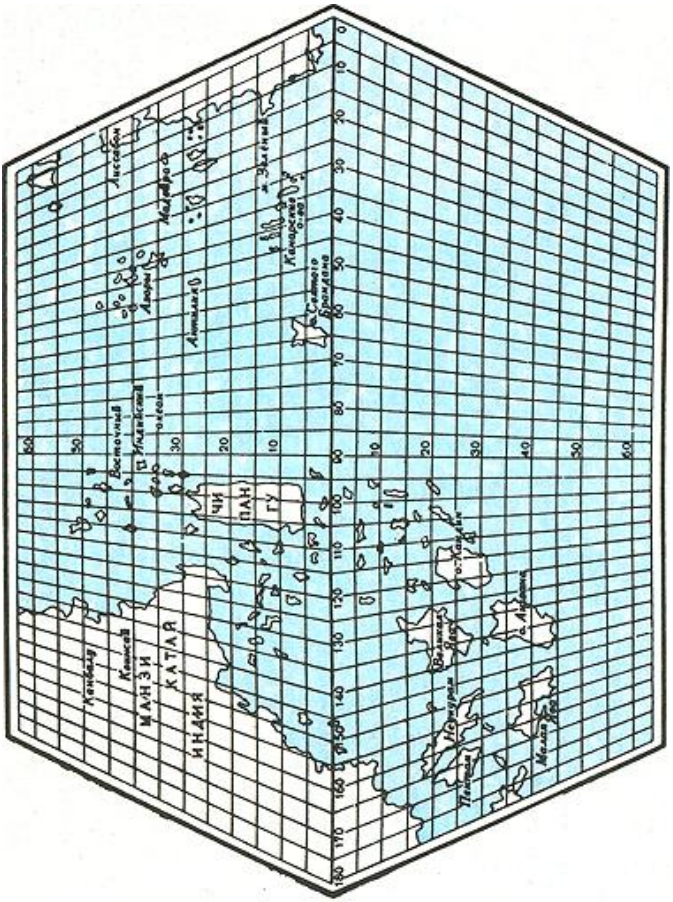
accidentally found Tusi's map when looked through materials brought by the Venetian traveler.

Unlike V. Shklovsky, my hypothesis is as following: There was the map of America besides other materials in the vessel when Columbus started his travel towards the New World and that book substituted for the compass. Columbus's work became easier as the prime meridian of the Old World passed through the remote eastern part of the unknown land. Mentioned map could be prepared under the leadership of N. Tusi. The location of the continent located on the other side of the Atlantic Ocean was approximately described on the map.

Toscanelli couldn't agree with most ideas of N. Tusi. Though huge land area was described at 5000 km towards the west of Europe on the map of the Azerbaijani scientist, Toscanelli thought that, it was in the east of Asia and at 10000-12000 km towards the west of coasts of the Old World. Probably, Toscanelli imagined the land located in the west of the Atlantic Ocean as part of Asia when looked through calculations of N. Tusi.

That's why he didn't agree with reports prepared in Maragha observatory and mentioned that, as the Earth was spherical, if there was a land area on the ocean on the way to the west, it should be part of Asia. Toscanelli wrote as

most scientists of XV century that, there couldn't be another continent in the Earth besides existing three continents.



The map made by Toscanelli in 1474 (reconstruction)

The Florentine cosmographer thought that, if the fourth continent existed, it could be discovered before. So, only the eastern part of Asia could be situated in the west of Europe, on the Atlantic Ocean. Besides it, the Florentine cosmographer wrote that, huge land area could be reached after about 10000-12000 km.[1]

Columbus took all these facts and reports made in Maragha into account and decided that, mentioned land area could be reached after 5000-5500 km. But Columbus didn't write that, the land area located on the ocean was unknown in the Old World. Thus, he falsely defended Toscanelli's idea, which mentioned that, the land located in the west of the Atlantic Ocean was part of Asia.

Columbus read a lot books when he was in Italy, Portugal and Spain. Columbus started his travel towards coasts of the New World by taking into consideration calculations of Eratosthenes and Earth's structure determined by N. Tusi.

I suppose that, outlines of America had been determined beforehand in Maragha. Scientists of the observatory had found out that, storms, cyclones and tsunamis weren't caused by winds, they were caused mostly by the Moon circulation. This discovery was very important for travelers.

[1] R. Qasımov. Xristofor Kolumb, Nəsirəddin Tusi və Amerika qitəsinin həqiqi kəşfi. Bakı, "Çaşıoğlu", 2002. səh. 130-131

As it is known, Columbus lived in Portugal and its colonies temporarily and was interested in navigation. His brother Bartolommeo was a cartographer wherever he lived. The most educated merchants learned that profession as it had become popular in the Apennine Peninsula.

Cartography and map trade were considered profitable occupations in European countries then. Bartolommeo Columbus used to buy and sell modern and ancient maps. Probably, he had found copies of maps made during the age of Macedonian Isgandar.

Knowing navigation and coastlines was very important for seamen sailing across the Mediterranean Sea. There was strong competition between Catalan and Italian experts in the field of cartography. Bartolommeo got acquainted with cartographers, geographers, archivists and library directors in several cities of Italy when looked for maps. He got acquainted with Toscanelli in Florentine. As it was mentioned above, the well-known scientist leaded N. Niccolini's library besides carrying out other works. Of course, there were a lot of materials about geography and astronomy.

In general, Toscanelli was known as well-known expert of geography and everybody tried to be his friend. Besides Christopher Columbus, Bartolommeo Columbus also visited

the library leaded by Toscanelli when he was in Florentine and analyzed necessary materials kept there. He could be indifferent to strange maps kept in the library as exponents. Bartolommeo was especially interested in the map, which described outlines of the land located in the west of the Atlantic Ocean and wanted to get the map made in Maragha observatory. I think Bartolommeo informed Christopher about mentioned map and he copied it. It is known that, Christopher Columbus and Florentine cosmographer were close friends. The traveler considered him his teacher.

Tusi's map and ***"Zij-i Ilkhani"*** were especially important for Columbus, who sailed across coasts of England, Ireland, Spain, Guinea and Madeira Islands. The coastline described there was a great stimulus for starting new expedition. Christopher wanted to find that coast. If really it was situated in the west of the Atlantic Ocean, N. Tusi would be the most phenomenal scientist of the world. Afterwards mentioned coastline was discovered, but Columbus was obliged to keep this fact secret.

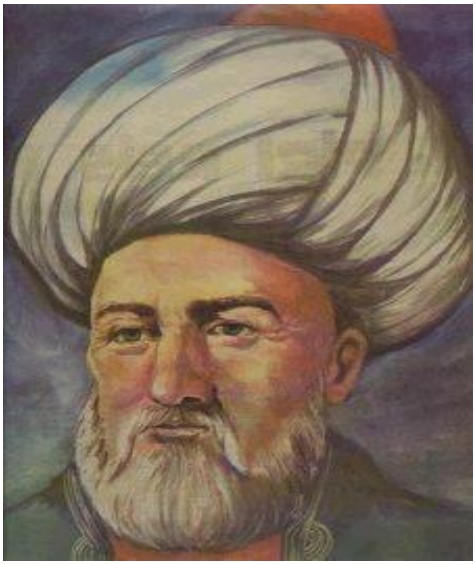
A question appears: "What happened to the map, which was made in Maragha observatory and described outlines of America?" As mentioned map hasn't remained until present time, most experts didn't believe that, such map had been made in Maragha. It is impossible to accept this thought.

According to some historical sources, Columbus used the map made in 1474 by Toscanelli during his first travel. That map has been described in most literatures. But its lines have been reconstructed. Its initial version doesn't exist.

The sensational map found in the Topkapi Palace Museum of Istanbul

The admiral Piri ibn Haji Mammad Reis (1475-1554) was an experienced captain, talented navigator, skilful navy captain, well-known navy commander, professional navigator officer and educated cartographer of his time. His maps were the most necessary aids for the science of navigation. Besides it, Piri Reis could combine different maps, which had different scales, in one map. All captains and navigator officers wanted to have such maps.

German scientists – Professors Gustav Adolf Deissmann and Paul Kohl found an ancient map drawn on the pergament made of the gazelle skin when they carried out restoration works in the Topkapi Palace Museum of Istanbul in 1929. That map was made in Chelibolu in the month of Muharram of 919th year of the Islamic calendar (1513).



Admiral Piri Reis (1475-1554)

Piri Reis made an atlas in 1528 and included this map in that atlas by fixing the date as 1513. Afterwards it turned out that, mentioned historical material was copied from ancient manuscripts kept in the library of Constantinople.

Most cartographers, geographers and historians of Europe did their best for being in that library, but couldn't achieve it. Libraries of Pergamum, Babylonia, Alexandria, Baghdad, Tabriz, Maragha, Damascus and Athens were moved to Istanbul during wars. Everybody knew that, there were a lot of ancient manuscripts, maps, anthropological

and ethnographical information in mentioned library and it was possible to get sensational information by getting acquainted with them. Piri Reis's map, where outlines of the Western Hemisphere were described, was one of such materials.

According to historical sources, Piri Reis often visited that library in order to analyze ancient documents and maps. Mentioned map could attract attention of Turkish scientists for its exactness. It was almost the first map, which described outlines of America. Besides it, the sensational material included outlines of North America and Antarctica. It was made 21 years after the first travel of Columbus. But the Genoese admiral hadn't visited the continent besides eastern coasts of Panama, Nicaragua and Honduras. Antarctica was discovered after more than 300 years by Fadday Bellingshausen and Mikhail Lazarev (1819). That's why most scientists made radical steps in order to analyze the map. Author of the map and date of its preparation were interesting for them.

Piri Reis had copied lines from other ancient maps and included notes of Columbus made during his travel in his map. The Turkish admiral admitted that, he had copied western part from Columbus's map. It means that, the well-known traveler had unique maps, which stimulated his first

travel. It should be taken into consideration that, historians and geographers carried out unsuccessful researches during hundreds of years in accordance with "Columbus's lost map" made by Columbus in West End islands.

Piri Reis's map (1513)

There is no doubt that, the map found in the Topkapi Palace Museum of Istanbul by Adolf Deissmann and Paul Kohl was a sensational discovery. It wasn't similar to maps

made at the end of XV century and XVI century. Though necessary devices and equipments didn't exist then, coordinates of South America and Africa had been determined exactly. Could such map be made by any well-known cartographer, geographer or sea traveler of Europe? German and Turkish scientists investigated found map attentively.

The American secretary of state Henry Stimson also was interested in this investigation. He thought that, *"Columbus's map"* could be in Turkey. He ordered the ambassador of USA in Turkey to start researches in order to find mentioned map. Though the Turkish government supported researches comprehensively, any success couldn't be achieved.

Piri Reis mentioned that, he had used about twenty maps made during the age of Macedonian Isgandar in accordance with exact calculations. But scientists didn't believe his explanation about the map found in 1929.

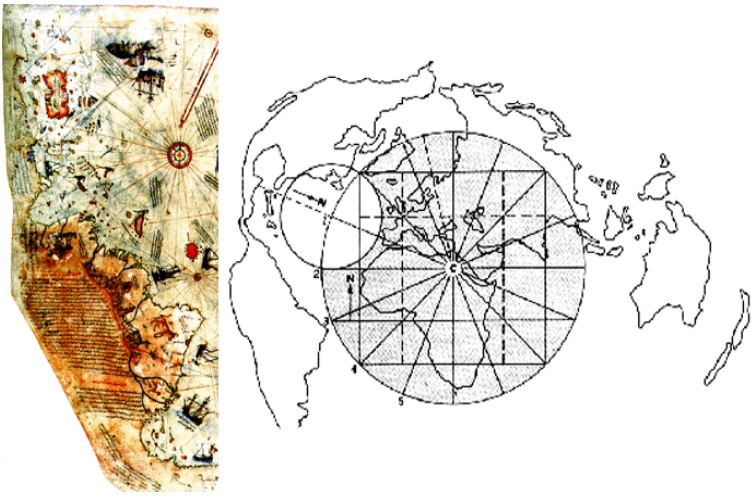
Scientists couldn't believe the Turkish admiral's statements as aerocosmic technology didn't exist then. There wasn't any copy of maps made during the age of Macedonian Isgandar. The Turkish admiral's map caused great resonance in Turkey.

The map was published in many editions in the state publishing house in 1935 in accordance with the order of the president of Turkey Mustafa Kamala Ataturk, who was proud that, cartography had been developed in Turkey even in XVI century.

Experts of the USA and especially captain Arlington X. Mueller, who was considered professional expert in the fields of cartography and navigation analyzed mentioned map in 50s years of XX century and get sensational result. The coastline of the Queen Maud Land covered in ice had been described in the southern part of the map. Probably, the map was made when mentioned territory wasn't covered in ice. Of course, this sensational result amazed experts.

As opponents of Mueller didn't accept his result, he resorted to help of the director of Weston observatory attached to Boston College Daniel L. Lainhen and director of the observatory attached to Georgetown University Francis Hayden for verification of his result. Mentioned experts participated in the radio discussion made on August 26, 1956 on this theme. The theme was spread all over the world. After it, the Professor of Kinsk College located in New Hampshire Charles H. Hapgood began to be interested in mentioned theme. The map was included in the program

of scientific investigations of Kin-State College owing to his efforts.



Combination of Piri Reis's map with the modern map

After long investigations, Ch. Hapgood sent request to the technical-intelligence escadrille of the cartography department number 8 of Air Forces of the USA. Joint work lasted for more than two years and it was proved that mentioned map had been made before the Queen Maud Land was covered in ice.

Afterwards Ch. Hapgood continued investigations independently and got the next sensational result. Latitudes

of popular islands located near Antarctica had been fixed on the map in detail. Probably, they were found by means of maps made before by applying modern spherical trigonometry. It is obvious that, authors of the map knew that, the Earth was spherical and they knew the Earth's length with 50 miles error.

Several optimist sea travelers believed existence of **"Southern land"** in the middle of XVI century. One of them was well-known Spanish seaman, architect and annalist Pedro Sarmiento de Gamboa, who defended that idea even before publication of popular "Atlas" of Gerhard Mercator. The well-known Spanish sea traveler Alvaro de Mendana de Neyra organized expedition towards the south of the Pacific Ocean in accordance with his offer in order to find the mythical country Ophir located in the south of the Earth.

…Mendana saw atoll or reef (Ontong Java or Rocador) on February 1, 1568 and approached **"large land"** separated from the ocean with coral reeves (Santa Isabel) on February 7… Mendana thought that, he had discovered Ophir in the southern continent (the king Solomon had sent vessels to Ophir to find gold in order to decorate Jerusalem temple in

the myth). But he had discovered archipelago, which was named Solomon Islands.[1]

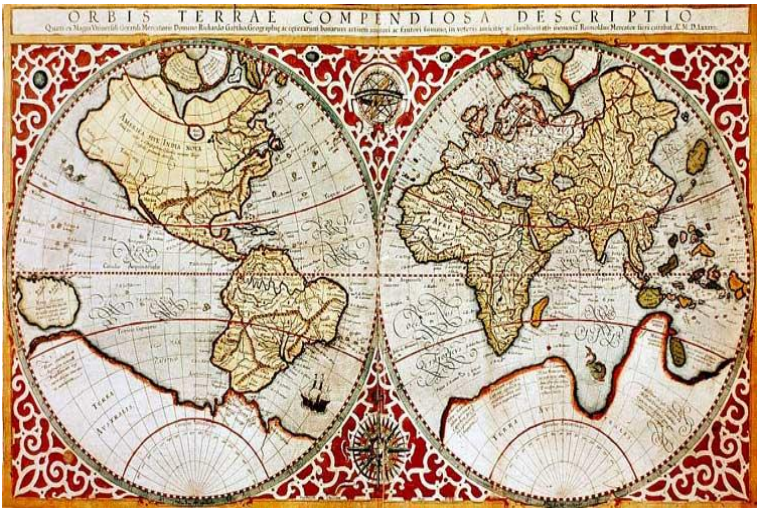
All coordinates were restored in accordance with investigations carried out by American architects and cartographers Blanche, Mueller and Walter. It turns out that, coastlines of the Old World, New World and Antarctica were described on the map exactly. The coastline of Antarctica wasn't covered in ice in 11-4 thousand BC. It means that, cartography had developed 6 thousand years ago as highly as the present time. Besides the eastern coast of South America, the western coast and Ant Mountains also were described on the map of Piri Reis.

The well-known Flemish cartographer Abraham Ortelius described **"Southern land"** in the southern part of the Pacific and Indian Oceans on his map ***"Theatre of the world"*** consisted of 53 maps. This idea was supported by another well-known Flemish cartographer Gerhard Mercator, who described **"Southern land"** in his atlas.[2]

This fact caused all scientists to think. How could the Turkish admiral describe mentioned places exactly? There is no doubt that, mentioned map wasn't made by Piri Reis

[1] R. Qasımov. Müqəddəs missiya. Bakı, "Çaşıoğlu", 2001. səh. 66-67
[2] R. Qasımov. Müqəddəs missiya. Bakı, "Çaşıoğlu", 2001. səh. 67

only. Who was the real author of the map and when was it made?

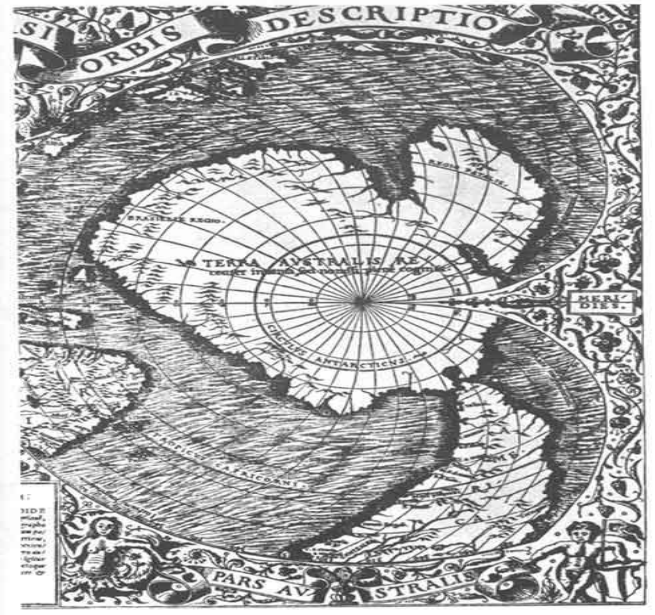


The world map of the middle ages.
The author – Gerhard Mercator

Ch. Hapgood came to the following conclusion when analyzed the map: "Exact information is exchanged between nations. The map was made by unknown nation and was found by Phoenicians and Creteans, who were considered genius seamen during more than thousand years, in ancient times. It became clear that, such maps were kept in the

Great Library of Alexandria located in Egypt before being annihilated by the Crusaders in VII century".[1]

The ancient Greek scientist Fukidid wrote: "The most famous tsar of Creteans Minos had established navy and occupied large part of the Ellyn Sea and Kirkland Islands".[2]



The Orontius Finaeus map of Antarctica made in 1532

[1] Ч. Хепгуд. Древние карты морских королей.
[2] Фукидид. История. I том, Москва, 1915. стр.5

As if they were in a hurry. Other nations living around the Mediterranean Sea couldn't use navigation, vessels and maps as professionally as they did. But their appearing and disappearing were very enigmatic. It is known that, they lost their hegemony in the Sea of Crete in 1150 BC, when Doris moved to Peloponnesian Peninsula.[1]

The map made by Philippe Buache in 1739

[1] Хульмут Ханке. Люди, корабли, океаны. Москва, «Прогресс», 1984. стр. 33

Almost everybody knew that, Phoenicians were skilful seamen. They systematically sailed to the Atlantic Ocean from the Strait of Gibraltar and investigated coasts of Europe and Africa. Phoenicians used ancient maps for sailing in the ocean safely.

Most researchers wrote that, Piri Reis's map was used by other cartographers too. It means that, those maps were kept in Alexandria in several copies. They were spread all over the world after Egypt was occupied. Descriptions of Antarctica also were spread in several countries. I think, Gerhard Mercator, Oronteus Fineus and Philipp Buache also had such maps.

Some scientists including Ch. Hapgood wrote that, sensational maps made by above mentioned experts were kept in the Library of Alexandria and were taken to the library of the Byzantine Empire afterwards together with other documents. Probably, most copies of mentioned maps were taken to Venetia in 1204 owing to Venetian seamen. But nobody can surely mention that, that material was given to the Turkish admiral by Venetian seamen or merchants. It couldn't happen as there was a war between Ottoman Empire and Venetia. All these facts prove that, cartography is one of the most ancient science branches and there were professional cartographers – authors of exact maps even

15000 years ago. Afterwards mentioned maps began to be spread in new civilization centers of the world.

Who is the real author of the map – admiral Piri Reis or Nasiraddin Tusi?

Ancient maps were kept in well-known libraries of Alexandria owing to Phoenicians and Creteans.

Babylonia was one of ancient civilization centers of the world before the ancient time. The most talented experts, well-known scientists and wise persons had gathered there.

Probably, maps of other parts of Antarctica and the whole Earth were taken to Babylonia by unknown people during unknown civilization. Afterwards Macedonian Isgandar started his marches in order to conquer the world and declared Babylonia center of his empire founded at the beginning of IV century BC. The conqueror of the world founded Alexandria in 332 BC in Egypt and it became one of scientific and cultural centers of the ancient time during a very short time. So, ancient maps kept in Babylonia began to be moved to the famous library of Alexandria. That's

why the admiral Piri Reis mentioned that, those maps had been made during the age of Isgandar.

One of annalists, who lived during the age of Isgandar, Vitruvius wrote: "Isgandar saw the real port near the settlement of fishermen Rakotis located near Faros Island, between the Mediterranean Sea and Lake Mariut when he reached the rank of the Nile River. Isgandar ordered the architect Deinocrat, who accompanied him during marches, to establish a town in the place, where they went". Really, Deinocrat established large town there during a very short time and gold sarcophagus of Isgandar were brought to that town after ten years.

Though Alexandria was very young, it could become scientific and cultural center of the ancient world. Well-known scientists and philosophers of all countries located around the Mediterranean Sea visited that town. The town was famous for its magnificent library, Temple of Muses and Academy of Sciences.[1]

Scientists gathered in the temple, worked on manuscripts kept in the library of Alexandria and kept several copies of their works there. There are a lot of similarities between Maragha observatory and Temple of Muses. It is necessary to analyze this fact.

[1] М. Гумилевская. Как открывали мир. Москва, «Д.Л», 1977. стр. 38

The most progressive period of the temple was during the age of Ptolemy Everget III. He used to buy original manuscripts and could get articles of Eschil, Sofokl and Euripid by convincing Athenians… So, about 200000 manuscripts were collected in the temple during the age of Ptolemy and his heirs continued his mission afterwards.

Number of manuscripts kept in the temple grew significantly after the library of Pergamum was moved to Alexandria and became 700000. There were hundreds and thousands of manuscripts among them and most of them were spread in most cities of the world…

The poet Callimachus was the head of the temple after Demetrius of Pharia. He was a poet and scientist. Callimachus had created 120-volume ***"Catalogue of the library of Alexandria",*** which resembled encyclopedia of history and culture, there.[1] But the temple had a very tragic ending.

Tsaritsa of Egypt Cleopatra moved manuscripts to the Temple of Serapes in 48 BC in order to save them. The consul of Rome Gaius Julius Caesar ordered to burn part of manuscripts in the port when he came to Alexandria in order to prevent rebellion.

[1] Н. А. Ионина, автор-составитель. Сто великих чудес света. Москва, «Вече», 2000. стр. 146,148

So, great part of valuable sources, which were collected during several centuries, was annihilated there. But some of them were taken abroad.

Expeditions were organized towards the coastline of Africa hundreds of years ago and surely, successful travels were realized owing to made maps. Seamen, who lived on coasts of Egypt, Levant and Arabian Peninsula, were considered the most skilful experts. Probably, some of maps made during that period were kept in libraries of the ancient time and scientists used those materials in their scientific works. Arabs organized successful expeditions around the Indian Ocean and Phoenicians could do it on eastern coasts of the Atlantic Ocean.

There were a lot of maps made by Arabs and Piri Reis learned most of those maps. Portuguese used materials of Arabs and especially well-known seaman and skilful navigator Ahmad ibn Majid when sailed from the Atlantic Ocean to southern coasts of Africa. He had sailed to the south of Africa together with Bartolommeo Dias and to India together with Vasco da Gama (as a navigation officer). It is known that, Ahmad ibn Majid was a professional seaman and had learned this profession by means of corresponding documents. He had described his knowledge in about 40 scientific works and two books – ***"Collection of***

main principles about seas" (1462) and ***"Book about bases and laws of navigation"*** (1490).

Those materials were often used by Piri Reis as they were spread in several countries. Piri Reis got acquainted with several parts of ***"Hatainame"*** after M. Polo in order to expand his knowledge. The Ottoman traveler Ali Akbar Hatai was in that country in 1505-1506 when the emperor of Chine Chu Kou Chao came to the throne and he published mentioned book in Persian in Istanbul in 1520.

Besides it, the Turkish admiral had read scientific works of the most famous geographers and astronomers of Europe including Toscanelli. It means that, Piri Reis was enough educated and didn't fall behind other geographers and cartographers.

It is known that, Piri Reis was a head admiral of Egypt and had great competencies. As he ruled the Mediterranean Sea and especially the territory between the center and eastern coasts, he could control many routes. As vessels sailing from France and Spain to kingdoms located in the Apennine Peninsula and cities of Greece, from Venetia Genoa and Naples to France, Spain and cities of Greece were controlled, they were often attacked by the navy of Piri Reis. Besides it, his spies gathered important information about expeditions, which sailed from the Mediterranean Sea

and ports of Portugal, Spain, France, Netherlands and England, and sent gathered materials to Piri Reis. Thus, the admiral had a lot of secret materials about kingdoms of Europe. Piri Reis wrote his ***"Book of navigation" ("Kitab-i Bahriye"),*** which had a significant role in the field of navigation, owing to mentioned materials.

Piri Reis was mostly interested in maps describing outlines of important geographical points, especially unknown coastlines and he made his future plans in accordance with them. That's why he was considered the most skilful and experienced navy leader.

As Egypt was the colony of the Ottoman Empire, most historical documents kept there were taken to Istanbul. The Turkish admiral, who was interested in historical documents and different maps, found a lot of maps in Alexandria and Istanbul, worked on them and made his perfect atlas in 1528. But one of those maps could attract attention of modern scientists. It was the map, which was made in 1513 and described outlines of America, Antarctica and North-western Africa.

Piri Reis admitted that, he had made that map by copying several ancient maps. His admission made works of researchers easier and they could carry out systematic works in this field. Cartographers and historians wondered how the

Turkish admiral could find the most notable map of XX century. As it was mentioned above, Piri Reis wrote that, he had made western part of the map according to notes made by Columbus on the map he used during his first travel.

The American secretary of state Henry Stimson, who tried to find the origin of ***"Columbus's lost map",*** thought that, it was in Turkey. Of course, most scientists agreed with this thought. Even if Piri Reis used "Columbus's lost map", he had found it in an unknown situation. Probably, the Turkish admiral was obliged to keep mentioned map in one of strategic buildings of Istanbul as a historical document after using it. It means that, doubts of Henry Stimson weren't groundless. But long-term researches were unsuccessful. Either those researches weren't organized as well as necessary, or their participants weren't professional experts.

Several important questions appear: First, who were real authors of manuscripts found by P. Reis? Second, did Columbus have an original copy of the map (the part describing America and West Africa) during his first travel? Then, how could the Turkish admiral find mentioned map? Third, how could the Turkish admiral find mentioned map? It is obvious that, the sea traveler couldn't be the author of the mysterious map. Outlines of the New World discovered

by him in 1492 were drawn in mentioned map before the expedition left Spain. Fourth, who is the real author of the map and how could he determine corresponding outlines and coordinates? Fifth, how could the map appear in the Topkapi Palace Museum of Istanbul and why weren't historians, geographers and cartographers aware of its existence until it was found in 1929. What was the reason?

According to historical sources, Piri Reis usually spent a lot of time in the library of the Empire in order to analyze ancient documents and maps. The map, which described outlines exactly, attracted attention of Turkish scientists. That map was one of the first maps, which described outlines of America (for the first time, outlines of America were drawn by Juan de la Cosa in 1500 and then by Cantino in 1502). Besides it, the map included outlines of North America and Antarctica. It turns out that, Columbus's lost map was in Istanbul. It is possible to understand it by looking at pictures of vessels drawn on the map.

1. There were caravels, carracks and naos in the western part of the map, though Piri Reis's navy consisted of galeras, galeas, fusts and other vessels. So, the author wanted to mention that, there was an unknown continent between Eastern Asia and Western Europe and that continent was discovered by Spaniards.

2. Mentioned pictures of vessels prove Piri Reis's supposition about *"Columbus's map".* The Genoese admiral had used caravels, carracks and naos when he travelled to coasts of the New World and proved that those vessels were important during long ocean passages.

Coastlines described on the mysterious map are noteworthy. They prove that, maps describing outlines of the Earth existed in ancient times. One fact also should be mentioned. As there weren't aerocosmic technologies then, scientists didn't believe statements of the Turkish admiral. None of maps made during the age of Isgandar has remained until present time. It is known that, Isgandar returned to Mesopotamia with the help of the commander of his navy Nearh after his march to India. The navy didn't meet with difficulties during the travel. It has been mentioned in works of Arius and Strabo.

The Greek merchant, traveler and geographer from Massalia by name Pifey left his motherland and started his travel in 325 BC, when troops of Isgandar returned to Greece. He used very difficult route and reached British Isles, some coasts of North Europe including Tule Island (was described on the map of Eratosthenes) and Baltic Sea. That travel was described in Pifey's book ***"About the ocean".*** Though mentioned book hasn't remained until

present time, Strabo and Pliny the Elder gave enough information by basing on it. If the Greek traveler hadn't corresponding map, he couldn't achieve success in such difficult travel. Thus, there were a lot of maps describing most territories of the Earth during the age of Isgandar and Pifey had used those maps. It shouldn't be forgotten that, Phoenicians, who were considered skilful seamen, had travelled from the Strait of Gibraltar towards the north and south.

1. Hapgood wrote that, the map was made by an unknown nation and most of maps made in ancient times were gathered and analyzed in the library of Alexandria.[1]

It was necessary to know navigation, spherical trigonometry, astronomy, mathematics, trigonometry, geography and cartography in order prepare such material. Seamen and travelers couldn't know these fields.

2. Only skilful scientist could combine several maps in the world map. He had to know mathematical and spherical trigonometry. All scientists of the world knew that, the inventor of mathematical and spherical trigonometry was Tusi (not Regiomontanus). I think the original of the map (without the part describing Antarctica) could be made by Tusi.

[1] Ч. Хепгуд «Древние карты морских королей».

3. The Turkish admiral's navy had worked in the Mediterranean Sea and he was in Spain. Was he aware of existence of Columbus's map?

He could find such map in Istanbul either. As I mentioned above, scientists of Maragha observatory could make several maps describing outlines of America. Nasiraddin Tusi, Muayyidaddin Ordy, Gutbaddin Shirazi and Chinese scientist Fao Mun-Chi could have such maps as they had important posts in the observatory.

Probably, Gutbaddin Shirazi took his map to Alexandria when he went to Egypt as the ambassador of Mongols and afterwards the map was taken to the capital of the Ottoman Empire by means of Turks. It turns out that, Columbus wasn't aware of existence of the map kept in Istanbul, so, he couldn't find it.

Then, how and where could the Spanish admiral find "Columbus's lost map"? I have found only one answer: The Chinese scientist of Maragha observatory Fao Mun-Chi took the map made in the observatory to his motherland in 1267. According to previous chapters, Marco Polo had taken that map to Italy. It was kept in the library leaded by Toscanelli in Florentine and Columbus got acquainted with it there.

4. How were outlines and coordinates determined? It is known that, mentioned map was made in accordance with several manuscripts. I'll describe history of the part describing the north of Antarctica.

N. Tusi worked in Alexandria and carried out interesting investigations in most educational, scientific and cultural centers located there, besides working in famous cities and educational centers of the Near East. Most works and historical documents kept in the library of Alexandria were taken to the capital of the Byzantine Empire after the library of Alexandria was annihilated by Crusaders (X century). Besides it, N. Tusi got good opportunities for expanding his scientific activity after annihilation of the Baghdad Caliphate by Hulegu khan in 1258. A grandiose library was established in Baghdad during the age of Abbasids and it was full of valuable works. Those works were brought to the capital of the Caliphate from occupied cities including Alexandria. Tusi also used those works in order to expand his knowledge. Probably, the scientist had found several parts of mentioned map, which would be known as *"Admiral Piri Reis's map"* in future, in Baghdad and started to investigate that historical document before foundation of Maragha observatory (1259). Europe, Asia and Africa (of

course, partially) had already been investigated until the middle of XIII century.

The sensational conclusion of Charles Hapgood about the map was as following: “Latitudes of well-known islands located near Antarctica were described on the map in detail. Probably, those results were achieved in accordance with an older map made by using modern spherical trigonometry. It is obvious that, authors of the map knew that, the Earth was spherical and they knew the Earth’s length with 50 miles error.”

I think Tusi had an important role in this achievement. It was difficult to combine coordinates fixed on the map made 6000 years ago with modern coordinates. It is known that, N. Tusi and scientists of Maragha observatory knew spherical trigonometry enough well. Probably, the Azerbaijani scientist had found the map without the coordinate system.

N. Tusi fixed geographic latitudes and longitudes as he knew spherical trigonometry. Skilful seamen could determine approximate distance between two points located on the ocean after analyzing the map.

So, Columbus knew how long he had to travel during his first travel owing to mentioned map. Some modern scientists also accept this hypothesis. There wasn’t any

other skilful scientist, who knew astronomy, mathematics and geography enough well and was able to fix geographic latitudes and longitudes exactly, before Columbus found the map.

As it is known, Piri Reis's map included only description of the western part of the Earth. It should be mentioned that, N. Tusi had determined coordinates of 256 cities including cities of Spain and Chine. I think the Azerbaijani scientist had that map without the part describing Antarctica and some cities and their coordinates were described by him. Thus, outlines of Asia, Africa, America and even Australia were drawn on Piri Reis's map. But what about the eastern part of the Earth?

Piri Reis was interested only in geographical points of the strategic importance as he was a commander of navy. Probably, the Turkish admiral analyzed the map once used by Columbus attentively and then clipped the part describing the eastern part of the Earth of and presented it to the archive located in Istanbul in order to keep the way to **"Spice Islands",** which were especially important for the Ottoman Empire, secret. What was the reason? According to the history, the Ottoman Empire occupied most territories of the Near East until the beginning of XVI century, so, controlled **"Silk way"** and the way to **"Spice Islands"** and

was monopolist in trade of the most expensive silk clothes and spices of European markets. It means that, merchants of Europe had to use other ways in order to go to markets of East Asia. Such ways were described on mentioned map. They were the western way mentioned by ancient scientists and south-eastern way along Africa.

There is no doubt that, Turks had hidden the eastern part of the map as they wanted to keep that way secret and didn't want Europeans to be aware of its existence. But the history of the western part of the map is different, though another part was found in 1929 in Istanbul. There wasn't any need for hiding western part of the map. The huge territory located in the west of the Atlantic Ocean – the fourth continent played a role of "barrier" on the western way to East Asia and Turks knew that European seamen had to overcome a very difficult way in order to reach the eastern coast of Asia. It means that, Europeans had to refuse to use seaway for going to the eastern part of Asia and to prefer land road, which was under Turks' control. So, the admiral Piri Reis had hidden the eastern part of the map in a very inaccessible place.

Another hypothesis can also be mentioned. Probably, mentioned map was divided into two parts before being found by Piri Reis. Columbus had made special efforts for

this purpose. It was obvious that, the map was enough big. It might attract people's attention when was carried. So, the sea traveler clipped the part he didn't need of and as territories described on that part were known by people, hided it in one of cities of Italia. Columbus brought another part of the map to Spain after using it for sailing to the New World. Afterwards the map was found by Piri Reis.

Columbus prepares for his second travel

I think that, Columbus had sent the map to Italy, his native town Genoa or to the public library of Florentine by means of the trustiest herald as soon as he returned from the travel. But the map couldn't reach its address of destination. Piri Reis controlled great part of the Mediterranean Sea and often attacked vessels of Spain, Portugal, France, Genoa, Venetia and Vatican during that period. As it was mentioned above, the map was taken by Turks when it was sent from Vatican to Italy in 1505. So, the map couldn't reach its address of destination. I think that, the Turkish admiral had found the map, which was used by Columbus during his first travel, in this way.

A strange paradox occurs. Number of well-known scientists began to decrease in the West after the temple of Muses and Temple of Serapes, where the library of Alexandria was kept, were burned. A lot of remarkable scientists had appeared in the West before that library was annihilated. Probably, there were valuable materials used by almost all scientists in mentioned library. The library had been saved until the age of Macedonian Isgandar. Such hypothesis is convincing enough.

Eratosthenes, who had made great efforts for development of geography, is the author of the valuable work about the Earth.

It shouldn't be forgotten that, the scientist leaded the library of the Temple of Muses. Eratosthenes was a mathematician, philosopher, literary critic, astronomer, geographer and author of epic poems. He had determined the Earth's length with 75 km error.[1]

Piri Reis's map proves that, such maps were known even before the age of Isgandar. Were those maps used in travels resulted in significant geographical discoveries?

When I looked through ancient travels, the expedition sent by the Egyptian pharaoh Necho II to the south of Africa through the Red Sea in 597 BC attracted my attention. Travelers didn't dare to start long travels in the ancient time. The expedition had to continue its travel in the Southern Hemisphere after passing the equator. Ancient people thought that everybody, who would try to pass equator, would meet with the hell or fall into the deep cleft. They said that, nobody had sailed in that direction and returned from there. But several seamen agreed to start travel and returned back through the Mediterranean Sea after going round Africa and entered Egypt by passing the Nile River. I think that, they could complete the expedition successfully owing to convenient maps they had. It means that, as

[1] Н. А. Ионина, автор-составитель. Сто великих чудес света. Москва, «Вече», 2000. стр. 148

Phoenicians had a map similar to Piri Reis's map, they could overcome all travels successfully. It shouldn't be forgotten that, Phoenicians could easily visit Madeira Island, Azores and Canaries located on the Atlantic Ocean.

According to Ch. Hapgood, mentioned map described the world by means of ancient outlines. First of all, continents had been described on different maps and then all maps had been combined on one pergament. Such work could be carried out by N. Tusi only. Locations of continents and coordinates had been determined precisely as spherical trigonometry had been used for this purpose. The founder of Maragha observatory knew spherical trigonometry enough well.

Achieved results

1. N. Tusi, who was very honest person, was very generous man besides being well-known scientist, inventor and philologist. It should be taken into account that, Tusi had left the Alamut castle after being kept there for more than 20 years without any wealth. But he began to work as the advisor of Hulegu khan and spent most of his wage for

people serving the science. N. Tusi could get some concessions of the ruler of Ilkhanids in order to improve welfares of scientists, teachers and students, who worked and studied in Maragha observatory. It should be mentioned that, charity works were carried out by rulers, commanders and landowners then. As they had great opportunities, they tried to demonstrate their humanism by carrying out charity works. I have investigated most scientists' activities. Any scientist hadn't provided people of various strata of society with money before N. Tusi did it in XIII century. I think that, the remarkable Azerbaijani scientist had almost founded charity and it should be accepted as a fact.

2. N. Tusi, who had encyclopedic knowledge, wrote ***"Zij-i Ilkhani",*** which is considered masterpiece in the field of astronomy, and it could become popular in Europe soon. Ancient manuscripts of that work – 1308, 1403, 1600, 1652 and 1711 – were found and presented to specialists. The prime meridian was described at $34\text{-}35^0$ west of today's Greenwich Meridian, main elements of geocentric orbits of planets were fixed and their daily movements were determined more precisely in ***"Zij-i Ilkhani"***, which consists of four books. Ecliptic length of the Sun disc center on Maragha meridian in afternoons of certain days and tables of planets' ephemerides were also described. The

difference between values of geocentric longitudes of Mars, Jupiter and Saturn written in ***"Zij-i Ilkhani"*** and modern values is equal to one thousandth of the second. N. Tusi had determined value of the annual precession more precisely. ***"Zij-i Ilkhani"*** was used during preparation of astronomical catalogues ***"Zij-i Hagan"*** (Giyasaddin Kashi) and ***"Zij-i Ulugbek"*** (Ali Kushchi). It mainly concerns coordinates of stars and cities.

Some of tables of two astronomical catalogues – ***"Zij-i Shah Jahan"*** made during the age of Shah Jahan in Jaipur observatory and ***"Zij-i Muhammad Shah"*** made during the age of Muhammad Shah (1719-1748) were copies of tables of ***"Zij-i Ilkhani".*** Almost all astronomers of the world used N. Tusi's work as the source until the middle of XVIII century, though 500 years had passed since ***"Zij-i Ilkhani"*** was made. But it should be mentioned that, ***"Zij-i Ilkhani"*** was considered unique work in the field of astronomy for several centuries.

3. N. Tusi's masterpiece about geometry – ***"Tahriru Uglidis"*** (the first book was written in 1248) was very popular in Europe in XVI century and it was published in Arabic in Rome in 1594 and in London in 1657 after being translated into Latin. One of favorite teachers of Isaac Newton John Vallis read lectures at the University of

Oxford in accordance with ***"Tahriru Uglidis"*** and played a significant role in popularization of N. Tusi in England. Besides describing the theory of parallel lines, relations and numbers and main issues of mathematics as axiometric geometry, the Azerbaijani scientist explained some new theorems, proved them and generalized some of those theories in ***"Tahriru Uglidis".*** He proved some theorems in different ways, included new notions in mathematics and tried to explain existing ones. The theory of parallel lines had a very important role in invention of non-Euclidian geometry. Nasiraddin Tusi did his best for development of this theory.

4. Trigonometry was the product of Eastern scientists before Euler's additions, Tusi and Giyasaddin Kashani had an important role in this field. N. Tusi wrote the first perfect work on trigonometry ***("Shaklul qita")*** and modified trigonometry as an independent discipline. Assumptions of European scientists, who introduced Regiomontanus as the inventor of trigonometry, lost their convincingness after the ancient copy of ***"Shaklul qita"*** was found in Istanbul in 1891. German scientists Henry Zutter and Braunmuhl based on principle in this business. Regiomontanus, who worked on translation of original works from Greek into Latin in Italy in 1461-1468, was known as a translator of scientific

works rather than a scientist. Probably, the work ***"Joannis Reqio Montanus. De triaquius pianis et srhericis lidev v. unae curtabulus sinuum",*** which made him popular, wasn't written by him independently.

According to the encyclopedia ***"World astronomy",*** Al-Farghani's ***"Basis of astronomy"*** was published in Latin in Nurnberg in 1537 and manuscript of that work was found by Melanxton among manuscripts of Regiomontanus. Al-Battani's ***"Mohametis albeteni de Scienta Stellarum"*** was published in the same year in Nurnberg together with Regiomontanus's additions. As the scientist's works written in Arabic were published in Latin, it proves that, Regiomontanus knew Arabic and had written his well-known work in accordance with Nasiraddin Tusi's ***"Shaklul-qita".*** The French historian of mathematics Montuklo wrote that, such perfect work couldn't be written by the author of XV century.

5. Most geographers of the early middle ages didn't describe the prime meridian on the same place. Tusi had determined the prime meridian at $34\text{-}35^0$ west of today's Greenwich Meridian. It passes through San Roka Cape located on the eastern part of Brazil. So, Christopher Columbus knew the distance between Europe and New World (America). It didn't happen by chance. He had the

map found by Piri Reis in Istanbul. Abu Raihan Al-Biruni was known as a very influential Eastern scientist. That's why, Portuguese sea travelers used the prime meridian determined by Al-Biruni when looked for large territory in the western part of the Atlantic Ocean and so, they couldn't succeed. The prime meridian determined by him was at 1100 km towards the east of Brazilian coasts. But Columbus had preferred Tusi's idea.

6. It had passed ahead of "Beytul hukema" of Baghdad, "Mamun Academy" of Urgenj and other science centers of the world for astronomical observations, scientific investigations and researches, invention of astronomical equipments, achievement of scientific results, education programs, number of scientists and students and written scientific works. Though the observatory was established for astronomical observations, history, geography, geometry, botany, philosophy, mineralogy, physics, chemistry, medicine, astrology, optics, literature, aesthetics and even musicology also were learned there besides astronomy and mathematics. Well-known experts were prepared in each field. It is known that, more than hundred scientists worked under the leadership of N. Tusi. After taking into consideration above mentioned facts we may say that, Maragha observatory was the greatest academy of

sciences of the world. Unfortunately, the academy of sciences of Maragha couldn't be saved for a long time. Otherwise, remarkable scientists could be prepared and a lot of scientific results could be achieved there.

7. Five new devices were invented in Maragha observatory under the leadership of N. Tusi in order to improve astronomical observations: Device for determination of horizontal coordinates of celestial bodies, Device for determination of the Sun's height on the meridian, Rotary quadrant, Earth globe, and Star or Sky globe. It should be mentioned that, afterwards, those devices were used in Ulugbek's, Copenhagen and Jaipur observatories. Afterwards, those devices were improved and used for exact astronomical observations. The sky globe made in 1279 in Maragha observatory is considered the most ancient sky globe of the world and kept in the hall *"Physics-mathematics"* of the museum *"Picture Gallery"* in Dresden.

8. The map made by the admiral Piri Reis in "1513" was found in 1929 in Istanbul and presented to experts. Sensational result was achieved after analyze of the map. The map was the copy of ancient manuscripts prepared 6000 years ago. It concerned only the part, where outlines of Antarctica were described. The professor Ch. Hapgood, who

analyzed mentioned map, wrote that, several manuscripts had been used for preparation of the map and its author knew spherical trigonometry. This work could be carried out by N. Tusi, who knew spherical trigonometry and was inventor of mathematical trigonometry, could use astronomical equipments and devices, had determined geographic coordinates of 256 cities and the Earth's length exactly. So, the remarkable Azerbaijani scientist determined the prime meridian in the remote eastern part of South America, where San Roka Cape located and it simplified discovery of America. Unfortunately, Christopher Columbus kept existence of that source secret on his own ambitions, so, Tusi's role in this achievement remained unknown.

9. A grandiose library was established in Baghdad during the age of Abbasids and it was full of valuable works. Those works were brought to the capital of the Caliphate from occupied cities including Alexandria. Tusi had found several parts of mentioned map, which would be known as "Admiral Piri Reis's map" in future, in Baghdad and started to investigate that historical document. The Azerbaijani scientist had determined coordinates of 256 cities including cities of Spain and Chine. I think the Azerbaijani scientist had that map without the part describing Antarctica and

some cities and their coordinates were described by him. Afterwards the map was found by Piri Reis.

10. Haldat Islands were described in scientific works of most well-known scientists on the Atlantic Ocean. Tusi wrote in ***"Zij-i Ilkhani"*** that, the prime meridian started on Haldat Islands. Several scientists wrote that, Haldat Islands consisted of two large and many small islands. Some scientists mentioned that they were today's Anthelia Islands. I have written something about this theme, but should describe my consequence. Probably, Haldat Islands described by N. Tusi are America. Harrani wrote that, Haldat Islands consisted of two large islands. It may be America, as the latter also consists of two continents. Scientists described continents as large islands then. The western part of the Earth was known till those islands. Scientists thought that, the prime meridian was there. It is indisputable.

11. N. Tusi could achieve fame in Azerbaijan and territories located around it when he was too young. ***"Akhlagi Nasiri"*** had a special role in that achievement. ***"Akhlagi Nasiri",*** which is considered masterpiece in the field of ethics, brought him great fame and took him to the prison at the Alamut castle.

"Tahzibul akhlaq" of Abu Ali Miskvih written in Arabic was read a lot in Eastern countries before 30th years of XIII century. **"Akhlagi Nasiri"** passed ahead of ***"Tahzibul akhlaq"*** for all parameters and though it was written 770 years ago, is still used as educational equipment for educating Muslim generations. Even princes of some monarchies use ***"Akhlagi Nasiri"*** for being educated. Most of noble families preferred this work in order to protect their traditions and norms of behavior. It is enough to read ***"Akhlagi Nasiri"*** for understanding that, Tusi was very wise and sincere man.

Though the scientist's moral situation was unbearable during more than 20 years spent in prison at the Alamut castle, he could write several immortal scientific works there: ***"Akhlagi Nasiri", "Sherhul-Isharet"*** (Commentaries on the philosophical treatise of Abu Ali ibn Sina **"Isharet"),** "***Tahriru Al-Majisti" ("Almagest"***) and ***"Tahriru Uglidis".*** The scientist, who couldn't leave the Alamut castle, could become famous in the Caucasus, Iran, Near East, Middle Asia, India and other countries in a very short time.

12. N. Tusi was known as the great scientist. But it shouldn't be forgotten that, he was experienced and skilful politician in Hulegu khan's palace as well. The ruler of

Mongolia didn't know where he should go when approached the border of Baghdad and Eastern Anatolia. The Azerbaijani scientist knew that, Christian rulers had organized seven major Crusades against the Islamic World according to the Pope's order since 1096. Saljuk Turks participated in those battles in order to defend Islam and annihilated Crusaders. Besides it, Turks settled in Anatolia played a role of barrier and strong line of defense between the Christian world and Ilkhanids in the West. Annihilation of Saljuk Turks would make the Byzantine Empire and Crusaders stronger. So, Tusi made troops of Hulegu khan to go towards Baghdad as took all these factors into consideration and understood that, the Abbasid Caliphate wasn't able to defend Muslims.

N. Tusi, who was accompanying Hulegu khan during his march to Baghdad, could prevent death of many innocent people including scientists. The scientist's policy was right and he could have influence on Hulegu khan. Owing to his policy, the astronomical observatory was built in Maragha, but not in Peking as Khubilay khan wanted.

13. As it is known, Maragha observatory was the most grandiose observatory in Near East. Though there were only five astronomical equipments before 60^{th} years of XIII century, other five equipments were invented in Maragha

observatory and simplified astronomers' works significantly. Astronomical equipments invented under the leadership of Tusi were the most precise equipments of at least 200 years. The observation of celestial bodies was realized with Rotary quadrant and Armillary device brought from Maragha observatory in Peking observatory. Equipments and devices invented in Maragha observatory were used in Peking observatory of Chine, Ulugbek's observatory of Samarqand, Tycho Brahe's observatory of Denmark and Jaipur observatory of India and great works were carried out in order to improve those equipments.

Observations carried out in Maragha observatory were the most precise observations in Europe and Asia before improvement of observatories, but observations carried out by Tycho Brahe at the end of XVI century passed ahead of them. The grandiose library consisted of 400 thousand manuscripts was established in Maragha.

14. Most authors thought that, Columbus had listened Toscanelli's advices when he was in Italy. He didn't apply those advices only in several principles. But he didn't agree with some ideas. According to Toscanelli's calculations, measurements of the Earth were smaller than real measurements (according to calculations of the Greek scientist Eratosthenes, the length of the Earth's outline was

43625 km). If Columbus believed in Toscanelli, he would sail towards Eastern Asia through the Atlantic Ocean. Columbus declared that, he had discovered Eastern Asia though knew that, discovered territory was the land, which was unknown in the Old World according to Tusi's calculations. But he deceived himself when tried to deceive Spanish monarchs.

He kept it secret until his death and thought that, his defenders will lay bare the truth after his death and the world community would be aware of Columbus's discoveries.

15. The well-known Azerbaijani astronomer and mathematician Nasiraddin Tusi had a great role in discovery of coasts of the New World. He had drawn outlines of America and calculated its coordinates with the help of stars and celestial bodies. Columbus had determined according to his calculations that, there was a huge territory, which was unknown in Europe, in the other side of the Atlantic Ocean at about 5000-5500 km and he organized expedition towards that territory. Really, Tusi had described the huge territory located in the west on the map made in Maragha observatory. It shouldn't be forgotten that, all geographic measurements were determined with the help of the Moon, Sun and stars during ocean passages. It wasn't difficult for

Columbus to find mentioned territory as he was an experienced seaman and professional astronomer.

16. Why did Columbus describe the territory he discovered as Eastern Asia? May be, he didn't want people to move to coasts of the New World. Otherwise, Spaniards could appropriate discovered territories gradually. It contradicted Columbus's plans. But what was the difference between Eastern Asia and New World? Why wouldn't Eastern Asia be appropriated? Columbus could be considered the heir of territories he discovered, according to the contract signed with rulers of Spain Isabella of Castilia and Ferdinand of Aragon. Discovered territories were known as eastern coasts of Asia. It means that, if the expedition would discover another unknown territory, Columbus would lose monopoly of organization of expeditions towards those territories. Then, other sea travelers would organize expeditions towards mentioned part of the Atlantic Ocean.

17. Columbus knew that, the territory he looked for was unknown for Europeans and besides it, he knew the distance between that territory and Pyrenean peninsula. The rebellion of seamen occurred near coasts of the New World proved it as the commander of the expedition asked for only there days in addition. As it was mentioned above, Guanahani

Island of Bahamas was discovered twenty six hours after added period. Thus, Columbus knew that, huge territory of the Western Hemisphere wasn't far away. The unknown territory should be located in the east of the expedition's location according to Tusi's map. May be, Columbus thought that, the route of the expedition hadn't been determined precisely. So, he thought that, the unknown territory described on Tusi's map wasn't in the east. Every day after October came, Columbus was sure that, he would meet with the land.

18. According to the Professor H. Mammadbayli, who investigated Tusi's activity, astronomers and geographers of that time were aware of existence of America in the Western Hemisphere. It means that, the map made by Tusi in Maragha wasn't kept as the personal property of Polos for a long time after being brought from Chine to the Apennine Peninsula. The map was taken out of Venetia after a short time and was found by people interested in astronomy and geography. People, who analyzed the map, thought that, the coastline described in the western coast of the Atlantic Ocean was Far Eastern Asia. Why did they think so?

Progressive-minded people of that time believed that, the Earth was spherical. Before Columbus's travel people thought that, the Old World consisted of three continents. It

was difficult to imagine existence of another continent. So, only the eastern part of Asia could be situated in the west of the Atlantic Ocean. Any huge territory located in the east of the Pacific Ocean was considered western part of Europe. Thus, if Tusi's map was known by experts before being in the library of Florentine, that territory was considered Asia. P. Toscanelli thought that, mentioned territory was remote eastern part of Asia. So, the Earth's measurements were considered very small.

19. Columbus believed that, the territory located in the west of the Atlantic Ocean, which was described on Tusi's map, was unknown territory. But he kept it secret for some reasons. If he would base on the map made by the Florentine scientist, he had to sail towards the west through $35\text{-}40^0$ north latitudes and he would reach Cipango then. According to maps of that time, Japan and Chine were situated at $35\text{-}40^0$ north latitudes. But Columbus changed his route towards south-west when he passed the Atlantic Ocean and preferred $20\text{-}25^0$ north latitudes. So, the expedition met with Bahamas (Guanahani Island).

20. Columbus usually thought about the future of geographical points he discovered. But he didn't use to explain essences of most discoveries to members of expeditions and its supporters.

The admiral knew that, there was a huge water basin at several mils towards the west and it separated the continent he would discover from Asia when he was in Belen. So, the well-known sea traveler understood that, calculations of the Greek scientist Eratosthenes concerning the Earth's measurements were right.

Besides it, Columbus used to talk to indigenous population when he approached shores and asked where large gold deposits were. Probably aborigines of Panama had explained him that, gold was mostly brought from Biru. So, it should attract the admiral's attention and surely, he would plan to visit that country. According to the history, Martin Enciso Hernandez, Diego de Nicuesa, Vasco Nunez de Balboa, Pedro Arias Avila (Pedrarias) and Francisco Pissarro heard a lot about Biru when they were in Panama. Columbus had to save his authority over Spanish monarchs. Surely, he had shared his ideas with his brother Bartolommeo.

Columbus knew that, the coastline located in the west of the Caribbean Sea would help him to realize his future plans and his children would be the richest people of Spain. The admiral declared his son Ferdinand heir of Belen and entrusted his heirs with the discovery of Biru. But

Columbus's family lost their monopoly on the Caribbean Sea and Biru was discovered by Francisco Pissarro in 1532.

21. It is possible to prove that, scientists, who wrote that, Columbus had discovered part of Asia, were wrong. As it was mentioned above, Columbus had enough information about clothes, traditions and races of population of Japan, Chine and India when he started his travel. He had discovered Haiti, Cuba and Bahamas but hadn't met with those populations.

If geographers were right, the Genoese admiral would return to Spain after he discovered Bahamas. But, Columbus travelled to coasts of Central America and investigated very large territory. That territory didn't resemble Asia. As Columbus was a skilful geographer, he couldn't mix Asia and coasts of the New World up. If the admiral did it, he couldn't overcome the expedition towards the west of the Atlantic Ocean. It was impossible for a seaman, who had made such mistake.

22. Columbus discovered Cuba after Espanola during his first travel and determined that it was at 42^0 north latitude. The error made by the well-known sea traveler was 20^0. After Anthill islands were discovered, it turned out that their geographic coordinates had been determined correctly. Then, why did he make error of 20^0 when determined

geographic coordinates of Cuba? The well-known sea traveler had described territories he discovered during his first travel with wrong coordinates in order to keep them secret. Otherwise, Spanish monarchs could organize expeditions towards the Caribbean Sea independently. That's why Columbus leaded great navy during his second expedition and could easily reach Haiti. Geographic coordinates of other geographical points discovered during expeditions were fixed correctly. Alonso de Ojeda, Pedro Alonso (Peralonso) Nino and Vicente Yanez Pinson leaded different expeditions and travelled towards the huge territory located on the southern coast of the Caribbean Sea without admiral's assistance and investigated those territories.

23. Columbus risked his life and revealed an important secret out – he proved that, the huge territory located in the west of the Atlantic Ocean wasn't eastern part of Asia, it was the fourth continent of the Earth. He proved that, the territory described on Nasiraddin Tusi's map made in XIII century on the other side of the Atlantic Ocean was unknown territory. So, investigations carried out by the Azerbaijani scientist in Maragha observatory resulted in real discovery.

Columbus should be grateful to Tusi for his success and probably, the seaman had kept the scientist's map until the end of his life. Because Tusi had described the territory located on the other side of the Atlantic Ocean together with its coordinates, divided the Earth into 24 meridians and mentioned that the first meridian was near the Atlantic Ocean, determined that, storms, cyclones and tsunamis weren't caused by winds, they were caused mostly by the Moon circulation. Those investigations were very important for geographers and navigators.

Columbus could prognosticate the weather in accordance with those results. He asked to stop the navy, which should be sent to Spain, for several days though the weather was fine when it reached Espanola in 1498, as he had prognosticated that, the weather would be stormy on that part of the Caribbean Sea. But owing to the stubborn governor, most vessels of the expedition were destroyed by the storm.

24. Columbus was the most skilful and experienced sea traveler of his time and he knew how to use winds and flows on the ocean better than any seaman. He sailed to England, Ireland and Guinea and analyzed directions of flows and winds blowing from the eastern part of the Atlantic Ocean to the west and made a diary about it before

starting difficult travels. He could sail to the western part of the Atlantic Ocean by means of the Canary current and return back by means of flows blowing towards Europe on 30^{th} and 40^{th} parallels and near the equator.

Surely, Columbus could use the flow blowing near the equator during his first travel, but he used the northern current by basing on Tordesillas treaty (1494) signed between Portugal and Spain. Thus, Columbus knew all routes, but didn't want to share his knowledge with others. N. Tusi wrote that, there were several strong flows blowing towards the west and east on the Atlantic Ocean. Columbus used this necessary information professionally.

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