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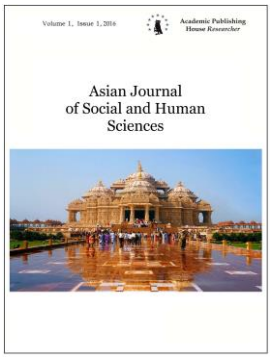

Studies of Scientific Works of Central Asian Scholars in the Medieval Spain: from al-Khwarizmi to Ibn Sina

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Abstract

The article provides new information about translations into Latin of 25 works of Central Asian scientists on natural, exact and humanitarian Sciences, carried out in the translation centers of medieval Spain. Based on the disclosure of the significance of translations of the works of al-Khwārizmī (783–850), al-Balkhī (787–886), al-Farghānī (approx. 798–861), al-Fārābī (873–950) and Ibn Sina (980–1037), carried out in the medieval of Spain, the place of the scientific heritage of Central Asian scientists in the emergence of the Renaissance process in Europe is revealed.

Scientifically substantiated solution of fallacies (including the perceiving interpreters of John of Seville and John of Spanish, as well as Domingo and Dominic Gundisalvi Gundisalvi as one person, due to the similarity of their names), the available science related to the translation of works such as «Kitab al-jam' wa'l-tafriq al-ḥisāb al-hindī» al-Khwārizmī, «Kitāb fī Jawāmiʿ ʿIlm al-Nujūm» al-Farghānī, «Iḥṣa al-ʿulūm» al-Fārābī, «Kitāb aš-Šifā» Ibn Sina performed in the translation centers of medieval Spain.

Identified 15 works of Central Asian scientists, are absent in the national scientific funds, currently stored in the libraries of USA, UK, Egypt and Qatar, and their instances are included into a scientific turn for research.

The purpose of the research is to reveal the place of medieval Spanish translation centers in the study of the works of Central Asian scholars in Europe. The main object of research is the translation school, which was active in the XII–XIII centuries in the Spanish city of Toledo.

This research was performed as part of a doctoral (DSc) dissertation on the topic: «Studying the scientific heritage of East scholars in the translation centers of medieval Europe».

Keywords: translation, translators, Arabic, Latin, scholars of antiquity, scientists of medieval Central Asian, translation centers, medieval Spain, investigation and application.

1. Introduction

The processes of globalization on a global scale show that science is the main factor in the development of humanity. Therefore, the disclosure of the relevance and necessity for modern civilization of the scientific heritage of thinkers of the medieval East, even deeper study and dissemination of this priceless scientific heritage, is recognized as the main problem of world Oriental studies.

Large-scale work is underway in our Republic to study ancient manuscripts, which are an integral part of the rich history and culture of our people, and are crucial for spiritual and scientific

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development. In particular, the object of extensive and deep research was the scientific heritage of the great Central Asian thinkers who lived and worked in the IX–XII centuries.

However, it should be mentioned that the translation of the works of Central Asian scientists in Europe in the XII–XIII centuries has not yet been studied. In particular, in this regard, often limited information about the age of translation creation, little attention is paid to such questions as who is the author of the translation, what method, when, where the translation was created, its significance in the development of regional science, means the relevance of research in this field.

In a number of countries around the world, special attention is paid to translation activities carried out in cities in Spain, such as Toledo, Saragossa, Segovia, Navarre, Seville and Barcelona in the XII–XIII centuries. Among the listed centers, the role of the Toledo school in the history of science is considered very important, as a result, research is conducted in priority areas of this subject. Despite this, questions about the creation of the school, its composition, translation works, scientific activities at the school, the life and work of translators and scientists have not yet been fully studied in its entirety.

We have been conducting scientific research in this area for several years, and the results of this research will be published in scientific journals around the world (Makhmudov, 2017a–g; Makhmudov, 2020a–b). This article is the following result of these studies.

2. Materials and methods

The research uses such methods as the principle of historicism, comparative analysis, systematization, classification, problem-chronological approach.

The reliability of the results of the study is the fact that were the original sources of the translations of «Zīj al-Khwārizmī», «Kitab al-jam' wa'l-tafriq al-ḥisāb al-hindī», «Kitāb al-mukhtaṣar fī ḥisāb al-jabr wal-muqābala» al-Khwārizmī, «Kitāb al-mudkhal al-kabīr», «Kitāb mukhtaṣar al-mudkhal» al-Balkhī, «Kitāb fī Jawāmiʿ ʿIlm al-Nujūm» al-Farghānī, «Iḥṣa al-ʿulūm», «Kitāb at-tanbīḥ ʿalā sabīl as-saʿāda», «Risāla fī ʿuyūn al-masāil», «Maḳāla fī maʿnā al-ʿaḳl», «Šarḥ kitāb al-maḳūlat», «Kitāb al-ḳīyās», «Kitāb al-amkina al-muğliṭa» al-Fārābī, «al-Qānūn fī al-Ṭibb», «Kitāb aš-Šifā», «Manzūma fī al-Ṭibb» Ibn Sina, carried out in the school of Toledo, stored in foreign funds. Also used were: modern commentaries and translations of books by members of the Toledo school, such as «Liber algorithmi de practica arismetrica» («Book of al-Khwarizmi on arithmetic practice»), «Liber de Judiciis Astrologiae» («Book of judgments about the stars»), «Tablas Alfonsies» («Tables of Alphonse»), «Liber introductorius» («Book of introduction»), «De mensura» («Measure»), «De utilitatibus astrolabii» («Advantages of the astrolabe»), «De Compositione et astrolabii» («Structure and application of the astrolabe»), «De Divisione Philosophiae» («On the division of philosophy»), «De Unitate» («On unity»), «De processione mundi» («On the origin of the world»), «De immortalitate animae» («On the immortality of the soul»), written on the basis of the above-mentioned works.

3. Discussion and results

The total number of works that have been translated at the Toledo school is 98 works, they belong to the pen of 43 authors, including 11 of the ancient period, 32 scholars of the East of the middle ages. 49 works are related to exact Sciences, 25 natural Sciences and 24 Humanities, of these, 25 belong to the pen of Central Asian scientists.

Below, we will analyze the history of translation of works in Latin of the great thinkers' al-Khwārizmī, al-Balkhī, al-Farghānī, al-Fārābī and Ibn Sina related to astronomy, mathematics, medicine, philosophy and other Sciences.

3.1. Al-Khwārizmī's works. It should be noted that the mathematical knowledge and its development is closely connected with the scientific heritage of Central Asian scholars. Obviously, the list of the scholars who had great contributions to this development starts with Uzbek Muḥammad ibn Mūsā al-Khwārizmī (780–850). Al-Khwārizmī was the founder of mathematics, its branches and basic teachings. It is the proof that he was recognized as the founder of modern algebra as his contribution to the subject was great.

«Kitāb al-Jamʻwa-l-tafrīq bi-ḥisāb al-Hind» («The Book of Addition and Subtraction According to the Hindu Calculation») is the earliest work of the scientist which was translated into Latin and studied in translation centers of Spain. The book was about operations like addition,

subtraction, multiplication, division, root, fraction of numbers using figures 0–9. The scientist called this book «Hindu Calculation» as it was used by Indians before. The scientist proved that the figures 1–9 and special symbol «0» can be used to form any numbers. Authentic version in Arabic language was not preserved and the Latin title «Algoritmi de numero Indorum» was used as the name of it. G.P.Matvievskaya and B.A.Rosendfield in their collaborative research agreed upon the name «The Book on Arithmetic», but they stated that the name might be «The Book of Addition and Subtraction» (Matvievskaya, Rozenfel'd, 1983: 41).

This book has been translated into Latin 2 times. It was first translated into Latin by Adelard of Bath in 1126. The translation is called «Liber Ysagogarum Alchorismi» («Book of introduction to al-Khwārizmī»). John of Seville, having revised the work based on the translation of Adelard, creates a treatise called lat. «Liber Algorithmi de practica arismetrica» («Book of al- al-Khwārizmī on arithmetic practice») (Hispalensis, 1857). The important significance of the treatise is that it contains information about parts of the work of al-Khwārizmī that have not come down to us. The second translation of the work refers to Domingo Gundisalvo and John of Spain, it was implemented in the period 1176–1190 years. The translators did not give a special title to the work, but instead used the first line of the first page of «Algorithmi de nemero indorum» («al-Khorezmi on the Indian calculus of numbers»).

Although it was translated into official Latin language by Domingo Gundisalvo and John of Spain, Khwārizmī's calculation system and Arabic numerals were not popular till the mid XIII century. Popularization of Khwārizmī's arithmetic and Arabic numerals are connected with the name of a trader Leonardo Fibonacci (Pisano) from Pisa. The prominent mathematician of the west Fibonacci in his work «Liber abaci» explained the simplification of arithmetic operations of decimal numbers basing on Khwārizmī's work. According to experts' opinions, Leonardo's technique of explaining a problem was the same as Khwārizmī's in this work which was finished in 1202. Besides, there were footnotes from Khwārizmī's works in the margin of its manuscript.

Furthermore, another mathematician of the XIII century Jordan Nemorari wrote about different calculation systems in his book «Demonstration of Algorithm» («Algorismus Demonstratus») and found Khwārizmī's decimal position system very practical comparing to decimal position system and sixty calculation system which were in practice in Europe. In spite of it, Jordan Nemorari had a number of works as «The Root of Arithmetic Art» («De elementis arismetice artis»), «Numeral Data» («De numeris datis») and geometry related «Triangles» («De triangulis») and the scientist applied Khwārizmī's instructions extensively (Makhmudov, 2017e: 91).

It is essential to underline that the decimal position system developed by Khwārizmī eased writing large, small, whole numbers and fractions and simplified all operations between these numbers and it led to discard of old methods. As a result «Arabic numerals» are being in practice all over the world.

Adelard of Bath translated this work into Latin under the name «Khwārizmī's table». But it is not known where it was translated. Yet his travel to Spain in 1110–1130 was the cause of our interest as our translation was developed in this land. This translator is considered as an author of the early translations of Khwārizmī's works in Europe.

Second mathematical work translated into Latin was «al-Kitab al-mukhtasar fi hisab al-jabr wa'l-muqabala» («The Compendious Calculation by Completion and Balancing»). The importance of the book can be seen as «al-jabr» was the origin of the contemporary subject and the term algebra.

This book of the scientist was translated into Latin «Liber algebrae et almucabola» by Robert Chester in Segovia in 1145. Robert's translation has been preserved to these days and its English translation with additions was printed in London and New York in 1915 (Robert of Chester, 1915). If we have a look at this work, we realize that Robert Chester translated it perfectly. Today the copy of Robert's translation is preserved in the library of Columbia University.

Nevertheless, some parts, precisely two pages of manuscript of «Al-jabr» are in Paris, and experts inform that it was developed by Gerard of Cremona. But the date is not known. Gerard named this translation «Liber Alchoarismi de iebra et almucabila tractaus». This translation was studied by B.Boncompani. Gerard's translation repirint in 1986 by B.Huges.

Two manuscripts of this work are preserved in the Bodleian library of Oxford University (Hunt.214, p. 1-34) and in Risat al Matbuat (20) Kabul. Besides them, two copies of the translation of al Khwārizmī's work by Turkish researcher Aydin Sayli are kept in Cairo and Germany.

Abraham bar-Hiyya (1065–1136) wrote mathematical books under the influence of al Khwārizmī's book. His book concerning algebra in Jewish language «Book about space» («Hibur ga-meshiha ve-ga-tishboret») was one of them and even it was used as textbook. Analysis of the data of Abraham bar-Hiyya's book informs us that the author made use of «Al-jabr wa-l-muqābala» in terms of solving quadratic equation and other operations concerning algebra and trigonometry. Later it was translated into Latin «Liber embadorum» by Plato of Tivoli.

Furthermore, the translator of Khwarizmi's works – Adelard of Bath applied Khwārizmī's book and his own translation «Al-Khwārizmī on the Hindu Art of Reckoning». For instance, information related to calculation system in decimal position in his book concerning arithmetic «Regulae abaci» («Regulate abaci») was completely taken from Khwārizmī's book.

Astronomical work of Khwārizmī translated into Latin was «Zīj al-Sindhind» («Astronomical tables of Sindh and Hind»). This is a work consisting of approximately 37 chapters on calendrical and astronomical calculations and 116 tables with calendrical, astronomical and astrological data, as well as a table of sine values (Suter, 1986: 473-479). This is the first of many Arabic Zijes based on the Indian astronomical methods known as the sindhind. The work contains tables for the movements of the sun, the moon and the five planets known at the time. This work marked the turning point in Islamic astronomy. Hitherto, Muslim astronomers had adopted a primarily research approach to the field, translating works of others and learning already discovered knowledge.

The original Arabic version was written c. 820, is lost, but a version by the Spanish astronomer Maslama ibn Aḥmad al-Majrīṭī (c. 1000) has survived in a Latin translation, presumably in 1126 by Adelard of Bath. The four surviving manuscripts of the Latin translation are kept at the Bibliothèque publique (Chartres), the Bibliothèque Mazarine (Paris), the Biblioteca Nacional (Madrid) and the Bodleian Library (Oxford). «Zīj al-Khwārizmī» («Table of al-Khwarizmi») was translated 3 times: in 1126 by Adelard of Bath ("Tavole astronomiche Algharizmi» that is, «Astronomical tables of al-Khwarizmi»), in 1140–1143 by Herman Dalmatian (this translation is not preserved in full), in 1144 by Robert of Chester («Ezich Elkaurezmi» that is, «Zij al-Khorezmi»). On the basis of the above translations, in 1262, a new table was compiled in the Toledo school under the name of Spanish 8 «Tablas Alfonsies» («Tables of Alphonse»). Its creation led Yahud Ibn Moses Cohen and Isaac Ibn Sid (Makhmudov, 2017f: 4-5).

In conclusion, Khwārizmī's works related to arithmetic and algebra opened new pages in the history of mathematics. Mathematics has been taught on the basis of Khwārizmī's works in Eastern and Western countries for centuries.

3.2. Al-Balkhī's works. The Muslim scientist who has become the most famous astrologer of the West and East – Abū Maʿshar was born 787 in the city of Balkh, which at that time was one of the educational centers of the Islamic world. Died 886 in Wāsiṭ, which is located in Iraq.

The famous medieval bibliographer Ibn an-Nadīm, mentioning in the set of data on literature in the Arab language, well-known al-«Fihrist», wrote that Jafar Abū Maʿshar al-Balkhī, being an expert on hadis, conducted theological disputes with al-Kindī, the first Arab philosopher. These disputes have excited at him interest in astronomy and geometry, and he became the most famous astronomer at court of Caliphs from a dynasty Abbasidov in Baghdad. Though the most part of his works on astronomy has been lost, he has become world history as the translator of works of Aristotle on natural sciences. At first, Abū Maʿshar lived in the city of Balkh. It was in full sense the cosmopolitan city where Greeks, Chinese, siriyak, Persians taught. In him the Jewish, nestoriansky, Manichean, Buddhist, Hindu and Zoroastrian religious communities peacefully coexisted. Then the young man has moved to Baghdad. The Caliph al-Ma'mun (813–833) has invited him to the yard as expert on hadis, however the debate with al-Kindi which has taken place approximately in 825 has changed his life. He has suggested it to go in for the exact sciences better to understand logical philosophical arguments and though Abū Maʿshar was about 50 years old by then, he has accepted this call and through a short period perfectly understood the Greek, Indian and Persian astronomy and mathematics texts.

In the book «Kitab al-mudkhal al-kabir ila 'ilm ahkam an-nujjum» («The big book of introduction to science about stars») he wrote that to the basic four elements of which the material world consists (the earth, air, fire and water) it is possible to add the fifth – celestial bodies which can be studied. In the scientific research, he relied on Aristotle's physics and has concluded that

some celestial bodies can influence terrestrial objects. Therefore, the theory about the nature of impact of the Moon on sea inflows and otliva was born. Like many contemporaries, Abū Maʿshar believed that transfer – the most important element of process of obtaining any knowledge. He cited as an example science about studying of hadis when mukhaddisa collected examples of statements and actions of the prophet and Allah will bless him and welcomes, separated true from false and fixed knowledge. He also believed a hadisovedeniye fundamentals of any science as the method put in studying of hadis helped to organize scientific research correctly. Abū Maʿshar's contribution to world science is indisputable: his translations of compositions of Aristotle in the middle Ages were a source of knowledge for the European scientists.

His «The big book of introduction to science about stars» written in Baghdad in 848 has been translated into Latin under the name «Introductorium in Astronmiam» in 1133 in Toledo to school by John of Seville. It was the first European statement of astrology. John of Seville's translation published Richard Lemey (Lemay, 1962). R.Lemay has argued that the writings of Albumasar (as he was called in Europe) were very likely the single most important original source of Aristotle's theories of nature for European scholars, starting a little before the middle of the 12th century.

The second time the book it has been translated into Latin in 1140 by Herman Dalmatin in Saragossa. Both translations is published by Erhard Ratdolt in Augsburg in 1489, the famous publisher from Augsburg (Germany) which in 1475 together with two compatriots has founded printing house in Venice.

Ibn an-Nadim provides the list from more than 30 works on astronomy, written by Abū Maʿshar. Among them «Kitab al-mudkhal al-kabir ila 'ilm ahkam an-nujjum» («The big book of introduction to science about stars»), «Kitāb mukhtaṣar al-mudkhal» («The small book of introduction to science about stars»), «Kitāb al-milal wa-ʾl-duwal » («Book on religions and dynasties»), «Fī dhikr ma tadullu ʿalayhi al-ashkhāṣ al-ʿulwiyya» («On the indications of the celestial objects»), «Kitāb al-dalālāt ʿalā al-ittiṣālāt wa-qirānāt al-kawākib» («Book of the indications of the planetary conjunctions»), «Kitāb al-ulūf» («Book of thousands»), «Kitāb mawālīd al-rijāl wa-ʾl-nisāʿ» («Book of nativities of men and women»).

From them, «The small book of introduction to science about stars» an abridged version of the above, later translated to Latin under the name «Minus Liber introductorius in astronomiam» by Adelard of Bath in XII century. Adelard of Bath's translation published Charles Burnett, Keiji Yamamoto, and Michio Yano in 1994 (Abū Maʿshar, 1994).

The first type is works that provide an introduction to astrology. Included in this group is Abū Maʿshar's 106-chapter work, «The big book of introduction to science about stars» and «The small book of introduction to science about stars» which he wrote «for the establishment of astrology by sufficient arguments and proofs». Not since Ptolemy's «Tetrabiblos» had philosophical proofs of astrology been argued; Abū Maʿshar's philosophical basis was Aristotelian physics, which he had acquired through Kindi's circle. First work translated into Greek circa 1000. The Latin translations had a significant influence on western European philosophers, such as Albert the Great.

The second type of work is Abū Maʿshar's historical astrology, which was introduced from the Sasanian tradition by al-Mansur, the second caliph of the Abbasid dynasty. This was part of his political strategy for laying a solid foundation for the newborn dynasty, and indeed it was used most effectively among the early Abbasids. Abū Maʿshar's monumental book on this subject, the «Kitāb al-milal wa-ʾl-duwal» («Book on religions and dynasties»), is in eight parts in 63 chapters. The work was translated into Latin and read by Roger Bacon, Pierre d'Ailly and Pico della Mirandola (1463–1494), and discussed in their major works. Other works in this category include «Fī dhikr ma tadullu ʿalayhi al-ashkhāṣ al-ʿulwiyya» («On the indications of the celestial objects»), «Kitāb al-dalālāt ʿalā al-ittiṣālāt wa-qirānāt al-kawākib» («Book of the indications of the planetary conjunctions»), and the «Kitāb al-ulūf» («Book of thousands»), which is no longer extant but is preserved in summaries by «Sijzī».

The third and final type is Abū Maʿshar's works on genethlialogy, the science of casting nativities. Work in this genre is «Kitāb mawālīd al-rijāl wa-ʾl-nisā» («Book of nativities of men and women»). The large number of extant manuscripts suggests its high popularity in the Islamic world.

It should be noted that in those days when the science was still in embryo, original works of Albumasar gave an unknown impulse to development of the European scientific research.

In the Christian West it became known thanks to Pietro d'Abano (1257–1316) who in the 13th century in the book «Conciliator Differentiarum Philosophorum et Praecipue Medicorum» mentions Abu Said Shadsan's «Al-Mudsakaret», the pupil Abū Maʿshar who has written down answers and astrological statements of the teacher. The analysis of «Memorabilia» known among skholast as «Abū Maʿshar in Sadan's statement» thanks to distortion of names of both scientists (Yamamoto, 2007: 11).

His works have exerted considerable impact on scientists of Europe and they were widely adopted. Abū Maʿshar has united the Hellenistic astrology with the Persian. Exactly thanks to this astrologer, such concepts as a limit of interaction between planets, and many other things became known to Western Europe.

3.3. Al-Farghānī's works. Known as «Alfraganus» in the West Abū al-ʿAbbās Aḥmad ibn Muḥammad ibn Kathīr al-Farghānī was one of the fundamental founders of science and was famous and honorable scientist in the history of Middle Ages in Europe. The name of Aḥmad Farghānī is famous in the history of science while there is little information about his personal and scientific life and it is based on assumption. It is supposed that the date of birth of the scientist was 797 or 798.

The following data about al-Farghānī was preserved in Eastern resources of Middle Ages.

Ibn an-Nadim (died 993) in his work «al-Fihrist» stated that al-al-Farghānī was a great astronomer and scientist and remarked that works «Chapters of Almagest» and «Book about the sundial construction» were written by al-Farghānī. Ibn al-Qifti (1173–1248) highlighted that al-Farghānī was one of the astronomers of Ma'mūn Academy and «Elements of astronomy» was the adaption of «Almagest» with perfect style and clear interpretation. Moreover, some information about al-Farghānī was presented in works of Ibn-Usaibia, Ibn Hallikan.

There were different assumptions about scholar's death. It was stated in the book «Churches and monasteries of Egypt» that on three December Abū Kathīr al-Farghānī was executed. According to B.T. Evett's opinion, this al-Farghānī was the leader of Nilometer construction in 247/861 and he was buried in Saint Coluths church. But it has not been proved yet that Abū Kathīr al-Farghānī in this extract was the great astronomer Aḥmad Farghānī. It was written in scientific researches and works issued in our republic that al-Farghānī died in 861.

Eight works of scientist have been delivered until these days and they are preserved in different libraries of the world.

The copies of the most famous book of al-Farghānī «Kitāb fī Jawāmiʿ ʿIlm al-Nujūm» (Alfragani, 1943; Alfragani, 1590; El-Ferghānī, 1998) («Compendium of astronomy and the ways of celestial movements» In short «Compendium of astronomy») are available in the libraries of Dublin, Istanbul, Leiden, Moscow, Oxford, Saint Petersburg and Cairo. It is important to say that this book was kept under several names and they are «The book of 30 chapters: «Introduction to Al-magest» (preserved in Suleymaniye library, Istanbul), «Almagest» (Princeton), «Astronomy» (Paris), «The names of the cities and countries» (in Tehran).

This book consists of 30 chapters and it contains all spheres of astronomy. The first translation of the book into Latin was done by John of Seville in Toledo school of translators. The translator of many astronomical and astrological books John translated «A Compendium of the Science of the Stars» from Arabic into Latin under the name of «Fundamentals of astronomy».

But it is mentioned in the book by G.P.Matvievskaya and B.A.Rosenfield that this book was translated into Latin by John of Spain (Johannes Hispanus) (Matvievskaya, Rozenfel'd, 1983: 55). We suppose that the authors should be confused. Because there were two Johns and they almost worked in the same period.

We think that the reason of confusion was the short version of their names, Hispalensis and Hispanus, Hysp or Hisp or Yisp. According to data, it was common to shorten translator's name while copying later works of translation in Toledo school.

The analysis our research shows that John of Seville had more productive activity than John of Spain. John of Seville worked alone while John of Spain did in collaboration. It is an example of aforementioned statement that John of Spain translated «The Compendious Book on Calculation by Completion and Balancing» by al-Khwārizmī (783–850) with Domingo Gundisalvo (Makhmudov, 2017d: 3-7).

The analysis of the data we collected is that John of Spain not knowing Latin had to work in collaboration. Besides, John of Spain lived in 1150–1215 and the very work we discussing had been translated in 1135. It is essential to highlight that there was the sign «With the help of God» («Sub laude Dei et auxilio ejus») on that work which belonged only to John of Seville in Toledo school of translators (he signed his most works in this way).

It is obvious from evidence mentioned above that «A Compendium of the Science of the Stars» by al-Farghānī was translated into Latin under the name of «Elements of astronomy» by John of Seville. Printed Latin versions based on this translation were published in Ferara (1493), Nuremberg (1537), Paris (1546) and Berkeley (1943). Later it was edited by Regiomontanus, famous Renaissance scientist and he prepared his speeches basing on this book of al-Farghānī in 1464, Padua.

According to data, later in 1142 John of Seville mentioned about «Fundamental of astronomy» by al-Farghānī in his work «The brief summary of astrological art».

The translation of the book of al-Farghānī by John of Seville was taught as a main course book of astronomy in European universities. For instance, in XIII century John Sacrobosco, a teacher of Sorbonne University wrote a course book for university students on the basis of John's translation. «Book about the sphere» was written in 1230 and first chapter was about the Earth and space's round shape, measuring the Earth's meridian with the help of astrolabe. Second chapter was about equator, ecliptic, constellation, meridian, the horizon; third chapter was about stars rise and set, the movement of the Sun; fourth chapter was about the movements of planets in 3 cycles: quantum, deferent, epicycle. According to data, having compared al-Farghānī book and John Sacrobosco's course book scientists of Europe were convinced that all information in «Book about the sphere» was taken from «Elements of astronomy». As it noted, the book written by Sacrobosco was used as a basic resource for four centuries in Europe universities.

An English scientist Alexander Nequam in his works «About natural phenomena» («De naturis remun») (app. 1180) and «The praise of divine wisdom» («Laus sapiente divine» or «De ladibus divinal sapiential») assimilated almost all astronomical information of «Fundamentals of astronomy and the ways of celestial movements» by al-Farghānī. He introduced al-Farghānī's work with the name of «About fundamentals of astronomy» or «De rudiments astronomiae».

This evidence has not noted before in scientific resources that the works of Aḥmad al-Farghānī were known in XII century in Britain and he played important role in the development of astronomy in Europe.

Second translation of «Elements of astronomy» in Toledo school was carried out by Gerard of Cremona in 1175. Gerard's translation was not printed until 1910, but it circulated in manuscript form throughout Europe. The translation was different from John's work with its accuracy and completeness. Because John of Seville often omitted information related to geography and Muslims history.

A Hebrew translation of the Arabic text was prepared by Jacob Anatoli in 1385. This Hebrew version, together with the Latin version of John of Seville, was used by Jacob Christmann to prepare a new Latin translation, published in Frankfurt in 1590. The Arabic text, together with a new Latin translation and notes (which cover only the first nine chapters), was published posthumously by Jacob Golius in Amsterdam in 1669.

Michael Scott widely used Gerard's translation in Toledo school in 1209–1220, and in the first chapter of his work «Introductory book» dedicated to Fredrick II, utilized astronomical information of Aḥmad al-Farghānī's work. Scott introduced al-Farghānī with his work «About fundamentals of astronomy» («De rudiments astronomiae») (Makhmudov, 2020b: 104-108).

Besides, it was from the «Elements of astronomy» (in Gerard's translation) that Dante derived the astronomical knowledge displayed in the «Vita nuova» and in the «Convivio».

It is obvious from above mentioned information that the development of astronomy in Europe is connected with the heritage of Aḥmad al-Farghānī. In conclusion, a number of important inventions and additions were carried out by this scientist. They formed the foundation of basic studies of this subject in Europe and supported future development.

3.4. Al-Fārābī's works. Abū Naṣr al-Fārābī (870–950), known in the Muslim East philosophical tradition as the «al-Muʻallim al-thānī» («Second Master») after Aristotle, and

Alpharabius in the Latin West tradition, is one of the major thinkers in the history of Islamic philosophy. He wrote extensively on logic, philosophy of language, metaphysics, natural philosophy, ethics, and political philosophy, philosophical psychology and epistemology. His writings on the classification of the sciences, including astronomy and astrology, were influential both in the Islamic world and in Europe. He was also great musician.

Not much is known about Fārābī's early years. He studied logic with the Nestorian Christian Yuḥannā ibn Ḥaylān (d. 932) in Marw and then in Baghdad. In Baghdad, Fārābī studied Arabic and was therefore able to participate in the philosophical salons of Baghdad and to make use of Arabic philosophical and scientific works. He then went to Constantinople with his teacher during the reign of the ʿAbbāsid caliph al-Muktafī (902–908) or early during the reign of Caliph al-Muqtadir (908–932). He returned to Baghdad between 910 and 920, spending two decades there writing and teaching philosophy and allied sciences. In 942, Fārābī left Baghdad, probably to escape its instability, going first to Damascus and then to Egypt. He later returned to Damascus to join the court of the Ḥamdānid Prince Sayf al-Dawla but died a year later.

The main work of al-Farabi, which translated into Latin in the Toledo school, is «Iḥṣāʾ al-ʿulūm» («The Enumeration of the Sciences»). This work illustrates neatly Fārābī's beliefs both about what can be known and the sheer range of that knowledge. Here he leaves aside the division into theological and philosophical sciences which other Islamic thinkers would use, and divides his material instead into five major chapters. He there classifies knowledge broadly into the major divisions of the linguistic sciences, logic, mathematics, physics, metaphysics, the civic sciences of ethics and political philosophy, law, and theology. Through all of them runs a primary Aristotelian stress on the importance of knowledge.

Gerard of Cremona translated this book into Latin in between 1160-1187. The title under which this work circulated in the West is «De scientiis». Gerard's translation published González Palencia in 1953 (Fārābī, 1953), also Franz Schupp in 2005 (Farabi, 2005).

The second book of Fārābī in this field «On the origin of science». On his work, Fārābī classified more than 30 sciences, and characterized each science separately. This book became the main encyclopedias in its time. The original Arabic text not preserved, only the Latin manuscript reached us.

«On the origin of science» translated in Toledo school by Domingo Gundisalvo and Abraham ibn Daud. Firstly, Ibn Daud translated the book into Yiddish afterwards it translated into Latin by Gundisalvo. Exact date of translation is not known. However, if we consider these two translators collaborative activity during 1150–1180, it is supposed the book to be translated in this period.

Next book of Fārābī translated by Domingo Gundisalvo is «Risālah fi'l-ʻaql» («The Treatise on the Intellect»). Gundisalvo translated this book from Arabic into Latin under the name of «De intellectu». In this work, an employee of Gundisalvo was John of Spain. Firstly, John translated the book into Castilian afterwards it was translated into Latin by Domingo Gundisalvo. The translation carried out in 1176–1178.

It should be noted, in «Risālah fi'l-ʻaql», al-Fārābī divides «ʻaql» into six major categories in an attempt to elaborate the various meanings of the Arabic word «ʻaql».

Domingo Gundisalvo and John of Spain also translated two works by al-Fārābī: «Kitāb at tanbīh ʻalā sabīl as-saʻāda» («Book of the indication of ways of happiness») (Fārābī, 1987) and «Risāla fī ʻuyūn al-masāil» («The Treatise of the being of questions»). The first translation was named Liber excitativus ad viam felicitatis» and the second got the titul «Fontes quastionum». Both works carried out at Toledo School in 1176–1178.

In Toledo school were translated, two more books by al-Fārābī on rhetoric and poetry. These are «Kitāb al-ḥitāba» («The Book of Rhetoric») and «Kitāb as-shiʻr» («Book of poetry»). Translations carried out by Herman of German in between 1240–1256. The translator of many philosophical books Herman translated «Kitāb al-ḥitāba» and «Kitāb as-shiʻr» from Arabic into Latin under the names of «Ars rhetorica» and «Ars poetica».

The Arabic-Latin translation movements in the Middle Ages, led to the transformation of almost all philosophical disciplines in the Medieval Latin world. The impact of Muslim philosophers such as al-Fārābī on Western philosophy was particularly strong in natural philosophy, psychology and metaphysics, but also extended to logic and ethics.

Fārābī's divisions of the sciences influenced the Latin West mainly through Dominicus Gundissalinus' treatise «De divisione philosophiae» («Division of Philosophy»). In this text, Dominicus reuses much material from Gerard of Cremona's translation «Iḥṣāʾ al-ʿulūm» and Domingo Gundisalvo's translation «On the origin of science». But it was Dominicus's own Arabicized treatise which was the main channel of al-Fārābī's influence. The mostly anonymous introductory literature for artes students of the thirteenth century draws amply on Dominicus's treatise, sometimes referring to Gundisalvi or Gerard as «Alpharabius». The translator Michael Scot also writes his own «Division of Philosophy», in which he adopts substantial material from Gundisalvi, but arranges it according to his own scheme.

Al-Fārābī's influence is particularly obvious in the enumeration of the seven parts of grammar, the eight parts of natural science (covering the spectrum of Aristotle's «libri naturales»), and the seven parts of mathematics: arithmetic, music, geometry, optics, astrology, astronomy, the science of weights, the science of technical devices («ingenia»). As to the discipline of logic, Dominicus Gundissalinus explicitly embraces al-Fārābī's division into eight parts, following the tradition which makes Aristotle's «Rhetoric» and «Poetic» parts of logic. The Farabian division of logic into eight parts reappears, for example, in Roger Bacon and in Arnoul de Provence's «Division of the Sciences» (ca. 1250); Arnoul remarks that neither Aristotle nor common usage includes «Rhetoric» and «Poetic» among the parts of logic. Dominicus further distinguishes with al-Fārābī between five kinds of syllogistic reasoning, of which demonstration is the highest. Al-Fārābī's emphasis on demonstration as the pivotal means for the acquisition of certain knowledge is an important innovation of Muslim philosophy, which reached the Latin West via Gundissalinus.

The influence of al-Fārābī's «The Enumeration of the Sciences» extends also to specific areas such as music. In general, al-Fārābī's and Gundissalinus's works were instrumental in disseminating a systematic division of the sciences which integrated the full range of Aristotle's works and a broad spectrum of sciences, many of which were new to the Latin West.

The name of the translator-archdeacon Gundisalvi should be distinguished from the philosopher Gundissalinus, who lived at the same time in Al-Andalusia. Gundissalinus was a teacher at the school of the Cathedral of Toledo in 1150–1178. Until recently, the philosopher Gundissalinus was associated with the name of Gundisalvi and was called «the main Toledo translator». However, it is not correctly! The philosopher Gundissalinus wrote the treatises «De divisione philosophiae» («Division of Philosophy»), «De processione mundi» («On the Origin of the World»), «De immortalitate animae» («On the Immortality of the Soul») and «De unitate» («On Unity») (Gundissalinus, 1964).

3.5. Ibn Sīnā's works. Abū ʿAlī al-Ḥusayn ibn ʿAbd Allāh ibn al-Ḥasan ibn ʿAlī ibn Sīnā (980–1037) the name by which the West came to know him – Avicenna – is the Latinized version of the last two elements of his full name as it was pronounced in the peculiar Arabic dialect of Spain.

He is probably the most significant philosopher and physician in the Muslim East's tradition, arguably the most influential philosopher and physician of the pre-modern era in West. In his influence on the intellectual history of the world in the Europe, he is second only to Aristotle, as it was intuitively acknowledged in the Islamic world where he is called «al-shaykh al-raʾīs» («The Preeminent Master»), after Aristotle and al-Fārābī, whom Avicenna called «al-muʿallim al-awwal» («The First Teacher») and «al-muʿallim al-thānī» («The Second Teacher»). Proceeding from this, many historians of our time call Ibn Sīnā «The Third Teacher».

Of the 450 works he is known to have written, around 240 have survived, including 150 on philosophy and 40 on medicine. His most famous works are «Kitāb al-Šifāʾ» («The Book of Healing»), a philosophical and scientific encyclopedia that had a decisive influence on European scholasticism and «al-Qānūn fī l-ṭibb» («The Canon of Medicine»), a medical encyclopedia, which became the standard medical text in all medieval Western universities.

John of Seville in Toledo school did the first translation of the «The Book of Healing», into Latin. The work was carried out under the patronage the Archbishop Raymond, around 1133–1142. Translation received the title «Sufficientia». The title «Sufficientia» given by the mediaeval to the Avicennian version of the «Physics» of Aristotle seems to be derived from the Arabic title for the entire encyclopedia, «al-Šifāʾ». The Latinized form sometimes signifies the whole collection and sometimes the entire section of natural philosophy. Usually, however, it applies only to the first book of this section.

Second translation of the «The Book of Healing» connected with the names of Domingo Gundisalvo, Abraham Ibn Daud and John of Spain.

In collaboration from the «The Book of Healing» of Avicenna were translated the first book on logic, fragments of his «Posterior Analytics», and his own version of Aristotle's «The book about soul». This last translation was known in the West as the «Sextus liber naturalium», a name which denoted its position among the eight treatises which comprised the section on natural philosophy in «The Book of Healing». The translations of the «Metaphysics» and the «Physics» of the «The Book of Healing» also belong to this wave of Toledan translations. Domingo Gundisalvo and Ibn Daud (Makhmudov, 2017d: 5), translated Avicenna's «The book about soul» part of «The book of healing». The proposal to translate the «Kitāb al-Šifāʾ» of Avicenna, or at least the most important parts of it, came from Ibn Daud. The process of translation involved the collaboration of two translators. One, skilled in Arabic and the romance vernacular of Spain, would translate the original into the vulgar tongue. Another, a Latinist, and most probably a cleric, would translate from this early Spanish into the Latin of the final product. This tedious, word for word, phrase for phrase, procedure had pitfalls at every turn. Translation received the title «De amina». The preface to this translation tells us that the work was ordered and paid for by John, Archbishop of Toledo, to whom it is dedicated. This fixes the date of the translation between 1152, the death of Archbishop Raymond, and 1166, and the death of his successor Archbishop John of Toledo. The translation of the text by Gundisalvo and Ibn Daud is extant in fifty manuscripts but the work of editing the text was complicated by the fact that it is extant in two recessions, called «A» and «B» by modern scholars. Philosophers Dominicus Gundissalinus («De immortalitate animae») and John Blund («Tractatus de Anima») quote version «A», while Albert the Great («De Animalibus») quotes version «B». The quotations in John of La Rochelle's «Tractatus de divisione multiplici potentiarum animae» are in the wording of version «A», while those of the newly added passages in the «Summa de anima» (1235–1236) follow version «B». It seems that version «B» is a re-working of version «A».

The «Metaphysics» of Avicenna's «Kitāb al-Šifāʾ» have been translated at Toledo school in 1180 by Gundisalvo and him assistant John of Spain (Makhmudov, 2017g: 17). This assistant also aided Gundisalvo in the translation of Solomon ibn Gabirol's «Source of Life» («Fons vitae») as well as the «Aims of Philosophers» («Liber Algazel») of al-Ghazālī. The positive correlation of particular linguistic characteristics points to the fact that the same pair of translators were responsible for these three works, with Gundisalvo identified as the Latinist.

Some knowledge of these translators' methods helps to explain the perplexing opacity of the Latin versions of Avicenna. The works themselves are dense and concisely written, in a language which had absorbed and adapted Greek categories and syntax to the Muslim mentality. As a result they are enriched with nuances and dimensions proper to a Semitic tongue. The result is a technical philosophical vocabulary of remarkable subtlety. Any effort on the part of translators to convey these nuances through two new languages – the intermediary vernacular and then clerical Latin could not possibly be totally successful. We should not be surprised at a text which is forced to resort to unusual structures and even neologisms. The qualified success which the scholastics had in penetrating the cryptic language of these translations testifies to the enthusiasm and the intelligence which they brought to their task.

The knowledge of the philosophy of Avicenna in the West was, for the most part, the result of these Latin translations of selected treatises from the «Kitāb al-Šifāʾ». Of its twenty-two parts, nine seem to be extant in complete translations while two others are known only in part. No works from the mathematical section were translated into Latin. The most influential parts were the first treatise from the logic (Avicenna's version of the Isagoge, known to the West simply as the «Logica Avicennae») the part on general natural philosophy («Sufficientia») the «Sextus liber naturalium» and the «Metaphysics». These four sections all emerge from the Toledo milieu and seem to be the product of one or both of the principal figures of this period. Eventually the major portion of the other works on natural philosophy were translated. The translations of the «Rhetoric» and «About animals» the should be dated in the thirteenth century.

The wave of translations Avicenna's medical works is associated with the prodigious labors of Gerard of Cremona. The «al-Qānūn fī l-ṭibb» («The Canon of Medicine») and «Urjūza fī l-ṭibb» («Medicine in verse») belong to the list of Gerard's translations (Avicenna, 2003). Both works

carried out in 1160–1178. «The Canon of Medicine» received the name «Liber Canonis», and the translation «Medicine in verse»was called «Cantica de Medicina». Gerard's translation of «The Canon of Medicine» published Paganino de Paganini in 1507 in Venice, this edition was reissued in 2003.

«The Canon of Medicine» is one of the most significant books in the history of medicine; for instance it was printed in Europe at least 60 times between 1516 and 1574. «The Canon of Medicine» remained a major authority for medical students in both the Islamic world and Europe until well into the 1700.

In the early decades of the thirteenth century, a third wave of translations solidified the place of Avicenna in the universities of Europe. The foremost figure associated with this important series of works was Michael Scott. Additional parts of the Avicenna's «Kitāb al-Šifāʾ» were translated. Such as «About animals». Work of Michael carried out in 1232 and received the name «De animalibus» (Makhmudov, 2017b: 19).

In the first half of the 13th century. Another translator of the Toledo school Alfred of Sareshel translated part of «Kitāb al-Šifāʾ», which is devoted to mineralogy. Alfred's translation was called «Avicennae Mineralia».

Having seen how the works of Avicenna, and especially his «Kitāb al-Šifāʾ», came to be translated, we should now investigate the actual influence of this great Uzbek philosopher on the thought of the Latin scholastics.

Moreover, this will be a topic for a new study, and this applies to the rest of the Central Asian scientists (most of them are from Uzbekistan!) that we mentioned above...

4. Conclusion

In the scientific centers of medieval Spain, only 25 works belonging to the pen of Central Asian scientists were translated, including: 3 – al-Khwārizmī, 2 – al-Balkhī, 1 – al-Farghānī, 10 – al-Fārābī, 9 – Ibn Sina. Through these translations, the scientific theories of Central Asian thinkers entered all Western countries and prepared the ground for the formation of a new science in the region, fulfilling the role of a program for its further development. For centuries, European scientists have mostly turned to these works related to exact, natural and humanitarian Sciences as reliable sources and in educational institutions and universities of the region they served as the main textbook, which confirms the validity of the stated idea.

The information provided in this paper shows that the role of medium Spanish translation centers in the study of the scientific heritage of Central Asian scientists in Europe in the XII–XIII centuries was extremely important. If we consider that certain books of thinkers whose original manuscripts have not survived have come down to us through translations into Latin, the role of the school in this area will increase even more.

In short, the valuable works of thinkers brought up in Central Asia played the role of the most important source in raising the scientific and spiritual potential of the European peoples.

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