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First Translation Activities in Islamic Science History and their Contribution to Knowledge Production *

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First Translation Activities in Islamic Science History and their Contribution to Knowledge Production

Abstract: With economic relations and conquests, Muslims have spread to a very wide geographical area. Consequently, they have encountered many different cultures. Muslims have had great interest and curiosity towards new cultures especially those of Byzantine (Helen / Greek), Iran and partly of the Indian cul tures. Especially, the conquest of cities such as Alexandria, Harran and Jundīshāpūr and the scientific tradition in these cities had great influence on Muslims. After these conquests, Muslims not only studied Islamic sciences but also began the activities of translation into Arabic to get familiar with ancient tradition of thought and culture. These first translation activities, which are extremely important in terms of Islamic civilization and the history of science, have been studied extensively to date. However, it is observed that during the studies performed, the only information mentioned were usually the names of the translated works, the domains of study they were written for and the names of interpreters. This study aims to shed light on the first translation activities in the History of Islamic Science, as well as the fields in which these translations were done, the knowledge and the accumulation of Muslims in these fields before translation activities and the contribution of translation activities in develop- ment or change in these fields by providing examples from Muslim scientists in different centuries, whose works are also known in the West. The golden era of Muslims in science and technology between the 8th and 11th centuries and some important scientific activities carried out within this period are analyzed in three periods; "acquisition of the information", "systematization of the information" and "production of original information".

Keywords: Islam, Science, Translation, Bayt al-Ḥikma, Muslim Scientists.

İslam Bilim Tarihi'nde İlk Tercüme Faaliyetleri ve Bilgi Üretimine Katkısı

Öz: Ekonomik ilişkiler ve fetihler sonucu çok geniş bir coğrafyaya yayılan ve bunun bir sonucu olarak da birçok farklı kültürle karşılaşan Müslümanlar, özellikle Bizans (Helen/Yunan), İran ve kısmen Hint kültürleriyle temasları sonucunda bu kültürlere karşı büyük bir ilgi ve merak duymuşlardır. Özellikle İskenderiye, Harran ve Cündişâpûr gibi şehirlerin fethedilmesinin ve bu şehirlerdeki ilmî geleneğin Müslümanlar üzerinde önemli etkileri olmuştur. Nitekim bu fetihler akabinde Müslümanlar, sadece dinî ilimlerle yetinmemiş, bunun yanında antik düşünce geleneğini ve kadim kültürleri tanımak amacıyla o kültürlere ait eserleri Arapçaya çevirmek üzere harekete geçmişler, yani ilk tercüme faaliyetlerine başlamışlardır. İslam medeniyeti ve bilim tarihi açısından son derece önemli olan bu ilk tercüme faaliyetleri, bugüne kadar pek çok çalışmaya konu olmuştur. Ancak yapılan çalışmalar sırasında genellikle tercüme yapılan eserlerin isminin, yapıldığı alanların ve bu tercümeleri yapan mütercimlerin zikredilmekle yetinildiği görülmektedir. Bu çalışmada ise İslam Bilim Tarihi'ndeki ilk tercüme faaliyetleri ve yapıldığı alanlar yanında, tercüme faaliyetlerinden önce Müslümanların bu alanlardaki bilgi ve birikimlerinin ne olduğu ve tercüme faaliyetlerinin bu alanlardaki gelişim

veya değişime olan katkısı, yazmış olduğu eserler Batı'da da tanınan farklı yüzyıllardaki Müslüman bilim adamlarından örnekler verilmek suretiyle ortaya konulmaya çalışılacaktır. Bu bağlamda Müslümanlar açısından bilim ve teknolojide II. (VIII.) ile V. (XI.) yüzyıllar arasında yaşanan parlak zaman ve bu zaman dilimi içerisinde yapılan bazı önemli bilimsel faaliyetler; bilgiyi elde etme, bilgiyi sistemleştirme ve özgün bilgi üretme dönemi olmak üzere üç ana bölümde incelenecektir.

Anahtar Kelimeler: İslam, Fen Bilimleri, Tercüme, Beytü'l-Hikme, Müslüman Âlimler.

SUMMARY

Science is one of the most important mutual heritage of civilization and human history. Those who give importance to science, scientific studies and scientists are the ones who contributed this heritage mostly. Muslims, who are religion members with the first command "recite", also have a respectful place among the societies that have signed important works.

With economic relations and conquests, Muslims have spread to a very wide geographical area. Consequently, they have encountered many different cultures. Muslims have had great interest and curiosity towards new cultures especially those of Byzantine (Helen / Greek), Iran and partly of the Indian cultures. Especially, the conquest of cities such as Alexandria, Kharrān and Jundīshāpūr and the scientific tradition in these cities have great influence on Muslims. After these conquests, Muslims have not only studied Islamic sciences but also began the translations into Arabic in order to recognize ancient tradition of thought and culture.

This study, which is considered to be extremely important in terms of Islamic civilization and the history of Islamic science, deals with the contribution of translation activities to information production. The golden era of Muslims in science and technology between the IInd/VIIIth and Vth/XIth centuries and some important scientific activities carried out within this period are analyzed in three periods; "acquisition of the information", "systematization of the information", and "production of original information."

The Qur'ān and the hadiths of the Prophet which are regarded as two main sources of Islam, include many orders and recommendations praising and encouraging science. Moreover, according to these verses and the hadiths, science has impulsive power in religion, and consequently in whole human life. Therefore, the scientific activities having started in Mecca with Prophet Muhammad's being prophet and continued in Medina, go on dramatically during the period of Rightly Guided Caliphs. Especially the first Islamic conquests conduce Muslims to encounter different civilizations specially Byzantine and Iran, to make use of the works of these civilizations and to begin translation activities intensively during the periods of Umayyad and ʿAbbāsid. As a result, Muslims have improved in social, applied and health sciences as well as religious sciences. What Muslims have tried to do first is to understand the existing knowledge and then to improve and dedicate it to the use of world.

In this study, the period called as "acquisition of the information" encompasses the time when cities as Alexandria, Kharrān and Jundīshāpūr were conquested and the scientific tradition in these cities influenced the Muslims and consequently the translation activities began. The purpose in that period was to get the knowledge wherever it was and translate it into Arabic.

"Systematization of the information" period addresses process in which translation activities go on and the knowledge acquired via translation is systematized. The purpose of the period is to produce knowledge, make it utilizable and dedicate it to the society. In that period, also, science is praised and encouraged. Administrators and scholars of the period have believed that all problems can be solved through science. Centers of translation (*Bayt al-hikmas*) and observatories are established in this period. Appealing and influencing the Muslims, translations of the period have enriched their culture but never led them lose their genuine identity. On the contrary, Muslim scholars, investigating the works of early scholars and criticizing them when necessary, have never accepted them as absolute authority and have produced their authentic works.

In the period that we call "production of original information", the level of development reached in terms of science, is revealed presenting the notable scholars of these period and the ones recognized by European science community. Aforementioned period encompasses the era when scholars such as al-Fazārī (d. 190/806), Jābir b. Ḥayyān (d. 200/815), al-Khwārazmī (d. 232/847), al-Farghānī (d. 247/861), ʿAli b. Rabbān al-Ṭabarī (ö. 247/861), Abū Bakr al-Rāzī (d. 313/925), al-Battānī (d. 317/929), Abū l-Wafāʾ al-Būzjānī (d. 388/998), Ibn Sīnā (Avicenna) (d. 428/1037), ʿAlī b. ʿĪsā al-Kaḥḥāl (d. 430/1039), Ibn al-Haytham (d. 432/1040) and al-Bīrūnī (d. 453/1061) are at the top. In this period (between the 8th and 10th century), translations have continued intensively, moreover, investigations have gained qualifications in terms of rules, technics and concepts. Islamic science has experienced its golden age. The most inspiring works of the period have been on mathematics, medicine, physics, Alchemy/chemistry and astronomy. These knowledges could be recognized by the western world which was in the darkness of scholastic idea between the Vth and XIth centuries, only after the XIth century via translations from Arabic.

INTRODUCTION

Science is one of the most important common heritages of human history. The ones who have contributed to it most are those who have given due importance to science, scientific studies and scientists within the community they lived. As followers of a religion that primarily orders to "recite", Muslims as well occupy a respectful place among the societies that treasure the science and thus have managed to produce significant works.

Muslims first made a distinguished name for themselves in science history with the first translation activities. The first translation movement having started with an Umayyad crown prince Khālid ibn Yazīd ibn Muāwiya (d. 85/704), who is considered among the

precursors of chemistry, culminated in Bayt al-hikmas founded during ʿAbbāsid era not only introduced Muslims to diverse disciplines but also conduced to the production of original works related to these disciplines and thus gave rise to the initiation of a reverse translation activity.

When many works conducted in this field such as articles and encyclopedia entries are examined, it is seen that researchers mostly make mention of the fields, works and translators of the first translations done by Muslims. Independent works on science history, on the other hand, mostly refer to the studies done by Muslims within diverse fields and schooled Muslim scientists. Taking the knowledge presented by both kinds of studies above into consideration, we are going to seek answers for the questions: how competent were the Muslims in astronomy, mathematics, medicine, chemistry and physics before the translations done within the disciplines?, what works were translated and from where and how were they acquired during the initial translation activities, what sort of contribution these translated works made to the Muslim scientists between the IInd/VIIIth - Vth/XIth centuries. Then we will seek to reveal the scientific level Muslims reached in aforementioned fields throughout four centuries by means of covering the exemplar Muslim scholars that stood out and whose works, after having been translated, were included in the textbooks in the West's first universities.

In our study, we have consulted the first period authors, who should be necessarily referred to, such as Ibn al-Nadīm (d. 385/995), Ibn Juljul (d. 384/994), Ibn Abī Uṣaybiʿa (d. 668/1269) and their works, along with the works of Prof. Dr. Fuat Sezgin, one of the modern prominent representatives of the tradition of science history, and the research on the history of science that have reached to this day starting from the middle of the XIXth century in the West, and we have also tried to utilize many self-contained works, articles and encyclopedia entries written in this field.

Regarded as the main sources of Islam, the Qur'ān and the Prophet's ḥadīths include lots of orders and recommendations that praise and promote the wisdom.[1] In fact, according to these āyahs and ḥadīths, the role of knowledge or science are considered to be as fundamental motive for the religion and hence for the entire life of human.[2] Therefore, the scholarly activities, which started in Mecca with the prophet entrusted as prophet and continued in Medina, went on increasingly during the period of Rightly Guided Caliphs. Especially the first Islamic conquests enabled Muslims to become acquainted with numerous civilizations, Byzantine and Iran in particular, to utilize the works created by these civilizations and to undertake intense translation activities as well in the Umayyad and ʿAbbāsid periods. Thanks to the foregoing, Muslims started to advance in the fields of health, physical and social

[1] For numerous orders and recommendations praising and promoting the science in the verses and hadiths see al-Baqarah 2/269; Āl ʿImrān 3/18; al-Nisā 4/162; Ṭā-Hā 20/114; Fāṭir 35/28; al-Zumar 39/9; al-ʿAlaq 96/1-5; al-Bukhārī, "ʿIlm", 10, 15; at-Tirmidhī, "ʿIlm", 19; Abū Dāwūd, "ʿIlm", 1.

[2] Ramazan Şeşen, "İslam Dünyasındaki İlk Tercüme Faaliyetlerine Umûmî Bir Bakış (Başlangıçtan h. IV./m. X. asrın sonlarına kadar)", *İslâm Tetkikleri Enstitüsü Journal* 7/3-4 (1979): 3.

sciences, in addition to theology. The first thing Muslims intended to do in this regard was to recognize and comprehend existing fund of knowledge and to present it to the world after improving it.

When Islam emerged, Arabian Peninsula was living the period called Jāhiliyyah and it is not possible to voice any improved scientific activity for the mentioned period, apart from the knowledge, accumulation of works and developments related to the literature. However, in that period in Egypt, Syria, Anatolia and Iraq-Iran, which lied within the boundaries of Byzantine and Sasanian Empires, and in India, different scientific activities in some important cities or regions of these geographies that could be assessed as advanced for that period attract our notice. Yet, Muslims' meeting with the civilizations of above geographies and their fund of knowledge began with economic relations and conquests, and peaked with translation activities. During the first Islamic conquests, the cities within the regions conquered by Muslims such as Alexandria (21/642),[3] Kharrān (18/639)[4] and Jundīshāpūr (17/638)[5] were knowledge centers, each of which were conquered during ʿUmar's caliphate (13-23/634-644).

Founded by Alexander the Great in Egypt in 332 BC, Alexandria has become, in the course of the time, one of the most significant knowledge and cultural centers of Hellenistic and Semitic teachings. Besides, it was at the center of the developments in Greek history of philosophy and science and partly preserved this feature in the Roman/Byzantine period.[6] As one of the most preferred places by those who wanted to receive education in the early years of Islam and the first Islamic conquests, Alexandria stood out as a science center with education offered in a variety of the fields such as philosophy, medicine, astronomy, mathematics, chemistry etc.[7]. Established in ʿUmar's period, the link between Muslims and Alexandria's scientific accumulation, culture and civilization was stiffened dramatically during the later periods.

Kharrān, which was among the key centers of Mesopotamian idolatry, was in Sassanid power during the period of the Prophet. However, Byzantine emperor Heraclius annexed the

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3 Muḥammad b. ʿUmar b. Wāqid al-Wāqidī, *Futūḥ al-Shām*, ed. ʿAbd al-Laṭīf ʿAbd al-Raḥmān (Beirut: Dār al-Kutub al-ʿİlmiyya, 1997), 2: 67-78; Abūl-ʿAbbās Aḥmad b. Yaḥyā b. Jābir al-Balādhurī, *Futūḥ al-buldān*, ed. ʿAbd Allāh Anīs al-Tabbāʿ (Beirut: Muʾassasat al-Maʿārif, 1987), 309-314; Abū ʿAmr Khalīfa b. Khayyāṭ, *Tārīkh Khalīfa b. Khayyāṭ*, ed. Akram Ḍiyāʾ al-ʿUmarī (Riyadh: Dāru Ṭayba, 1985), 150.

4 Al-Wāqidī, *Futūḥ al-Shām*, 2: 118-120; al-Balādhurī, *Futūḥ al-buldān*, 239-242; Khalīfa b. Khayyāṭ, *Tārīkh,* 139.

5 Khalīfa b. Khayyāṭ, *Tārīkh,* 140; Abū Jaʿfar Muḥammad b. Jarīr al-Ṭabarī, *Tārīkh al-umam wa-l-mulūk*, ed. Muḥammad Abūl-Faḍl Ibrāhīm (Cairo: Dār al-Maʿārif, 1967), 4: 93-94.

6 Abū Dāwūd Sulaymān b. Ḥassān al-Andalūsī Ibn Juljul, *Ṭabaqāt al-aṭıbbāʾ wa al-ḥukamāʾ*, ed. Fuʾād Sayyid (Beirut: Muʾassasat al-Risāla, 1985), 51; Aḥmad b. al-Qāsim al-Khazracī Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbâʾ fī ṭabaḳāt al-aṭıbbāʾ*, ed. August Müller (Frankfurt: Institut für Geschichte der Arabisch-Islamischen Wissenschaften, 1995), 1: 9; İbrahim Sarıçam ve Seyfettin Erşahin, *İslam Medeniyeti Tarihi* (Ankara: TDV Pub., 2012), 30. Also see Şeşen, "İlk Tercüme Faaliyetleri", 4; Chikh Boumrane, "Ortaçağ İslam Dünyasında Bilim ve Gelişmesi", trans. Hüseyin Şimşek, *İSTEM* 14 (2009): 384.

7 Şeşen, "İlk Tercüme Faaliyetleri", 4; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 30; Ahmet Turan Yüksel, *İslam'da Bilim Tarihi* (Istanbul: Kitap Dünyası Pub., 2015), 41.

region by defeating Sassanids in 627. Kharrān was still in the hands of Byzantines when armies of Islam entered into the region in ʿUmar's period.[8] The city was conquered in ʿUmar's period[9] and thereon the last living representatives of Hellenistic school of Alexandria, which were shut down at the time of Umayyads, moved to Kharrān and Antioch.[10] Inhabited by Muslims, Christians and idolaters in that period, Kharrān grew into one of the most remarkable centers for scientific studies beginning from Islam's first periods and witnessed a large scientific movement thanks to the translation of the works on Greek philosophy and medicine by the Jacobite and Nestorian scholars, who were resident in Kharrān, first into Syriac and later into Arabic.[11]

Dating back to very ancient times, Jundīshāpūr was founded by Sasanian emperor Shapur I (241-273) in Khūzistān region of modern-day Iran. In a battle between Sasanids and Romans, Shapur I defeated the Roman Emperor Valerian and sent him to Jundīshāpūr after taking him and his army as captives. Alongside the captives, also a bevy of people consisting of artists, workers and scholars banished from Antioch were settled into the city. Furthermore, with settling in Jundīshāpūr, of the Nestorian scholars exiled from Edessa (Urfa) in 489 due to sectarian conflicts and Neoplatonists deported from Athens in 529 after declared idolaters, the city thus started to host a plenty of Syrian, Greek, Indian and Persian men of science. Khusraw I (531-579), commonly known in Islamic history as Anushiruwān the Just, established a school in Jundīshāpūr, in which medicine, philosophy and several other disciplines were taught, and during his reign the city evolved into an outstanding center of science. In this period, *Kalila and Demna,* together with a number of works belong to Aristotle and Plato were translated into Pahlawi and Syriac from Greek and Sanskrit. Again in this period, Greek doctors as well served alongside the Indian doctors in the medical school founded by Khusraw I. Deeply influenced by Indian and Greek cultures, the foregoing institute, in which the language of instruction was commonly Aramaic, inspired profoundly the Islamic culture of medicine in later periods.[12] For instance, al-Ḥārith ibn Kaladah (d. 13/634), who was among the well-reputed Arab doctors in the Prophet's period, is recounted to have received his medical education in Jundīshāpūr.[13] Peacefully incorporated into Islamic territory during ʿUmar's reign, Jundīshāpūr maintained

8 Georg Ostrogorsky, *Bizans Devleti Tarihi*, Trans. Fikret Işıltan (Ankara: TTK Print., 2011), 88-89, 93-97.

9 Al-Wāqidī, *Futūḥ al-Shām*, 2: 118-120; al-Balādhurī, *Futūḥ al-buldān*, 239-242; Khalīfa b. Khayyāṭ, *Tārīkh,* 139.

10 Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, 1: 116; Ramazan Şeşen, "Harran", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1997), 16: 237-238; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 31.

11 Boumrane, "Bilim ve Gelişmesi", 384.

12 Abū al-Faraj Muḥammad b. Abī Yaʿqūb Ibn al-Nadīm, *al-Fihrist*, ed. Riḍā Tajaddud (Tehran: Marvi Offsett, 1971), 300-303. Also see Mehmet Mahfuz Söylemez, *Bilimin Yitik Şehri Cündişâpûr* (Ankara: Ankara Okulu Pub., 2015), 81-86; Şeşen, "İlk Tercüme Faaliyetleri", 4-5; Recep Uslu, "Cündişâpûr", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1993), 8: 117-118.

13 Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbāʾ*, 1: 109-110; Uslu, "Cündişâpûr", 118

its importance after taken by Muslims and the city's educational establishments kept providing service without any interruption the same as before.[14]

1. THE PERIOD OF ACQUISITION OF KNOWLEDGE (IInd/VIIIth CENTURY)

This period, which we denominate as the period of acquisition of the information (IInd/VIIIth century), is the era that witnessed the initiation of translation activities as a manifestation of the conquests of the cities as Alexandria, Kharrān and Jundīshāpūr and soon after the crucial impacts of their scientific tradition on Muslims. In this period, predominant efforts were to acquire information wherever it is and the principal goal was to acquire it no matter where it comes from and to translate it into Arabic.[15]

Muslims' relations with members of other civilizations, which started especially with economic bonds and conquests, came to a climax with translation activities and Muslims consequently presented a new civilization and thought system to the world history through the contributions of these translations.[16] Besides, apart from the Arabic culture of Jāhiliyyah and Islam, the translations from ancient civilizations especially on philosophy, logic, mathematics, astronomy, physics, chemistry, medicine, botany and zoology also have an important position among the sources of the thought system developed by Muslims.[17]

When the history of civilizations is examined, all notable thought systems can be seen to have started in conjunction with a large translation movement. To exemplify, we can say that the Ancient Greek's line of thinking was shaped with Sumerian-Anatolian, Phoenician and Egyptian translations; Islamic notion was formed by the help of Greek, Persian and Indian translations alongside its own sources of information; and the West's mental picture was molded through Islamic, Jewish and Greek translations. In other words, throughout the history of civilizations, humanity lived through three transitions given below:

a) The transition from the thinking of Ancient Egypt, Mesopotamia, India and Persia into the Greek language and philosophy (VIth-IVth centuries BC).

b) The transition from Greek and other ancient thinking to Arabic and thus to the world of Islam (VIIIth -Xth centuries).

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[14] Söylemez, *Bilimin Yitik Şehri Cündişâpûr*, 86.

[15] For the translations made in this period from different languages and cultures on many fields see Ibn al-Nadīm, *al-Fihrist*, 306-315, 325-328, 347-352, 360.

[16] Şeşen, "İlk Tercüme Faaliyetleri", 3.

[17] al-Fārābī, who molded his own philosophical thought out of philosophical and scientific heritage acquired thanks to the translations, explains the situation as: "Philosophy came into existence among Chaldeans. Then it was passed on to Egyptians and afterwards inherited by Greeks, surviving there until its transmission to Assyrians and Arabs. All ideas this faculty expressed were voiced respectively in Greek, later in Syriac and lastly in Arabic. See Abū Naṣr Muḥammad al-Fārābī, *Mutluluğun Kazanılması (Taḥṣīl al-saʿāda)*, trans. Ahmet Aslan (Ankara: Vadi Pub., 1999), 88-89.

c) The transition of Islamic fund of knowledge from Arabic to Latin, Hebrew and other western languages (beginning from the XIth century).[18]

When Islam emerged, northern part of Arabian Peninsula had been already molded by a scientific and philosophical tradition that could be regarded as advanced for the era. Muslims, who spread to a considerably large geography especially with the conquests that began in the period of ʿUmar, encountered Hellenistic, Persian and Indian cultures and their close relations with the people from different cultures with the passing of time triggered a number of religious and philosophical conflicts. As a consequence, Muslims henceforth had to be closely acquainted with scientific and philosophical traditions and practical implications of the people with whom they shared the same geography in order to protect their beliefs and thoughts consistently and to demonstrate the supremacy of Islam with its evidences.[19]

What Muslims did in first place within this scope was to come into contact with scientific and philosophical works of the ancient world held by their neighbors, in other words, to initiate the translation activities. These activities were barely prolific until the time of ʿAbbāsid caliph al-Maʾmūn, in fact, they were only consisted of few individual attempts. The figure who started these activities was heir to the Umayyad throne Khālid ibn Yazīd ibn Muʿawiyah (d. 85/704). Khālid, after suspended from his right to the throne by Marwān ibn al-Ḥakam, devoted himself to the disciplines such as chemistry, medicine and astronomy/astrology and had the works related to these fields in Greek and Coptic translated into Arabic through the Alexandrian priests Stephanos and Marianos.[20]

The translation movement, which had been started with Khālid ibn Yazīd's attempts, continued in the field of medicine during the periods of Umayyad caliphs Marwān ibn al-Ḥakam (r. 64-65/684-685) and ʿUmar ibn ʿAbd al-ʿAzīz (r. 99-101/717-720). Māsarjawaih, Marwān's doctor, translated the medicine-related work named *Kunnash* written by Aaron (Kharon/Khārūn), one of the doctors of Alexandrian Academy, into Arabic. The mentioned translation was later taken out from the library of ʿUmar ibn ʿAbd al-ʿAzīz by himself and presented to the use of the people after reproduced. In Abd al-Malik ibn Marwān's period, financial council reports, which were in Coptic in Egypt, in Greek in Syria and in Old Persian in Iraq and Iran, were translated into Arabic.[21] Fuat Sezgin, a prominent science historian,

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18 Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 36-37.

19 Şeşen, "İlk Tercüme Faaliyetleri", 3-4; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 37; Yüksel, *İslam'da Bilim Tarihi*, 43.

20 Ibn al-Nadīm, *al-Fihrist*, 303, 419; Abū al-Abbās Shams al-Dīn Aḥmad b. Muḥammad b. Abī Bakr Ibn Khallikān, *Wafayāt al-aʿyān wa anbāʾ abnāʾ al-zamān*, ed. İḥsān ʿAbbās (Beirut: Dāru Ṣādir, 1994), 2: 224. Also see Fuat Sezgin, *İslam'da Bilim ve Teknik*, Trans. Abdurrahman Aliy (Istanbul: Büyükşehir Belediyesi Kültür A.Ş. Pub., 2008), 1: 4; Muhammed Abdülkadir Hureysât, "Hâlid b. Yezîd b. Muâviye", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1997), 15: 292-293.

21 Ibn Juljul, *Ṭabaqāt al-aṭıbbāʾ*, 61; Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbâʾ*, 1: 3-4; Şeşen, "İlk Tercüme Faaliyetleri", 7-8; Yakıt ve Durak, *İslam'da Bilim Tarihi* (Isparta: Tuğra Print., 2002), 68; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 37; Yüksel, *İslam'da Bilim Tarihi*, 44. Also see Ibn al-Nadīm, *al-Fihrist*, 303.

comments on these translations of Umayyad period as: "The translation of Aaron's medical work named *Kunnash* which nearly has the characteristics of a textbook and the activities of Khālid ibn Yazīd, the first Muslim in history of Islam, that was interested in chemistry and produced works in the field, can be regarded as the initial period sciences were received in the Islamic culture."[22]

Limited to only the fields of medicine, chemistry and astronomy in Umayyad period apart from few aforementioned attempts, the translation activities expanding in al-Manṣūr's period (r. 136-158/754-775), also included the fields of mathematics, logic and metaphysics. ʿAbd Allāh Ibn al-Muqaffaʿ (Ibn al-Muqaffaʿ), who was of Persian origin and the most prominent man of letters of his own time, stood out among those who did translations from Persian to Arabic in this period was. One of the foremost translations he did was his translation of *Kalila and Dimna*, a fabled "siyāsatnāmah (book of politics)". Furthermore, some of Aristotle's works on logic collected under the name *Organon* and also Porphyry's *Isagoge* (*Isāghūjī*) are among the works translated by him.[23]

Beginning from the period of al-Manṣūr and Barmakids known in history as the family of viziers, Assyrians, Indians, Kharrānians and Nabataeans in academy of Jundīshāpūr started to take part in translation activities. They translated numerous works into Arabic from Greek, Pahlavi, Indian/Sanskrit, Syriac, Nabataean/Babylonian language and Coptic. In this period, the scholars that had come from India translated several works they brought along related to mathematics and astronomy into Arabic with the help of Persian scholars. Among these works, a voluminous treatise on astronomy, *Siddhanta* was translated by name *al-Sindhind* by Muḥammad ibn Ibrāhīm al-Fazārī, one of the youngest representatives of Sasanian astronomy in Islam, in 154/771 or 156/773; Ptolemy's *Syntaxis*, also known as *Almagest*, was translated by name *al-Majisṭī* and Euclid's *Elements of Geometry* by name Uṣūl al-Handasah. Yet another notable translation activity of the mentioned period was the relocation of Jundīshāpūr medicine school's chief physician Jurjīs ibn Jibrīl ibn Bukhtīshū to Baghdād on invitation and his translating some works on medicine from Greek and Persian into Arabic while performing as chief physician in al-Manṣūr's court. Al-Manṣūr established a private space in his court as a library for the works he had translated from many languages and in diverse fields and named it Khizānat al-ḥikma. In fact, Bayt al- ḥikma's foundation was laid with the library founded in Baghdād.[24] Fuat Sezgin, particularly about the translation activities and other scientific movements from al-Manṣūr's period, says that while sciences was intensely received going on

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22 Sezgin, *İslam'da Bilim ve Teknik*, 1: 4.

23 Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbâʾ*, 1: 308; Sezgin, *İslam'da Bilim ve Teknik*, 1: 8; Şeşen, "İlk Tercüme Faaliyetleri", 9-10; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 68; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 37; Yüksel, *İslam'da Bilim Tarihi*, 44. Also see Ibn al-Nadīm, *al-Fihrist*, 303.

24 Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbâʾ*, 1: 123-127, 203, 205; Sezgin, *İslam'da Bilim ve Teknik*, 1: 8-9; Şeşen, "İlk Tercüme Faaliyetleri", 10-11; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 68; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 38; Yüksel, *İslam'da Bilim Tarihi*, 44-45. Also see Ibn al-Nadīm, *al-Fihrist*, 325-327.

in the first half of the VIIIth century and also in the following century, their internalization period as well started concurrently.[25]

2. PERIOD OF SYSTEMATIZATION OF KNOWLEDGE (IIIrd/IXth CENTURY)

This period (IIIrd/IXth century) is a process during which both translation activities continued increasingly and the knowledge acquired through the translations was started to be systematized. The aim in this period was to utilize the knowledge after producing it and to put it at the disposal of the community. Again in this period, not only science obtained the concession of being appreciated and promoted but also the period's administrators and science devotees embraced the idea that all problems could be solved by the light of the knowledge and took steps toward this idea. Bayt al-ḥikmas and observatories are the establishments emerged as a fruit of this period.

The translation activities are seen to have gathered momentum in the time of Hārūn al-Rashīd (r. 170-193/786-809) and important studies mainly related to medicine were conducted. Especially the books seized after the conquests of Ankara and Amorium[26] from these regions were taken to Baghdād and translated into Arabic by a commission created under the presidency of Yūḥannā ibn Māsawaih.[27] Moreover, Abū Sahl al-Nawbakhtī, who was originally Persian, also made translations from Persian by order of the caliph in the same period.[28] As a matter of fact, the books translated in this period were so abundant that Khizānat al-ḥikma which Caliph al-Manṣūr ordered to be constructed was not anymore capable of storing them and thus a larger site was created, to be used as a library. The latter library was also mentioned in relevant sources with the names of Khizānat al-ḥikma or Bayt al-ḥikma.[29] The last years of Hārūn al-Rashīd and the first years of al-Maʾmūn who would succeed al-Rashīd, i.e. the first twenty years of the IXth century, was an interval that could be regarded as the initiation of the era of creativity in terms of advancement, during which the sciences gained a completely new characteristic.[30]

Yet the major developments in translation took place at the time of ʿAbbāsid caliph al-Maʾmūn (r. 198-218/813-833), founder of Bayt al-ḥikma, which can be considered as Middle Age's most significant science academy. In this period, scientific and philosophical works associated with the cultures of Ancient Greece, India, Persia and Nabataea were introduced to the world of Islam through translations. al-Maʾmūn brought the books collected by his order during his successful campaign against Byzantine Empire in 215/830 to the library situated in

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25 Sezgin, *İslam'da Bilim ve Teknik*, 1: 9-10.

26 An ancient city near modern-day Emirdağ, Afyon.

27 Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbâʾ*, 1: 175; Ibn Juljul, *Ṭabakāt al-aṭibbāʾ*, 65.

28 Ibn al-Nadīm, *al-Fihrist*, 333.

29 Ibn al-Nadīm, *al-Fihrist*, 118, 333; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 68; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 38; Yüksel, *İslam'da Bilim Tarihi*, 45-46.

30 Sezgin, *İslam'da Bilim ve Teknik*, 1: 10.

his palace's annex, Bayt al-ḥikma. Furthermore, in order to widen and enrich the library, he sent a committee comprised of the administrator of the library, Salm Kharrānī along with Yūḥannā ibn Māsawaih, al-Ḥajjāj ibn Maṭar and Ibn al-Bitrīq to Byzantium so that they would procure books.[31]

With the books brought from both the church schools within the state's borders and neighboring geographies, Bayt al-ḥikma grew to be the richest library of medieval period and a science center encompassing intense scientific studies. In the foregoing science center were a director, authors and interpreters with clerks working under them, scribes copying the books and bookbinders responsible of binding. According to information given by Ibn Al-Nadīm, who closely examined Bayt al-ḥikma and utilized its library, the number of translators that translated from Greek to Syriac and after Syriac to Arabic or directly from Greek to Syriac could reach to 47; the count of those who translated from Persian to Arabic was 16 and those who translated from Sanskrit to Arabic were 3.[32]

Another translation activity and the most important scientific labor after Bayt al-ḥikmas from the period of al-Maʾmūn was the observatories. Al-Maʾmūn's deep interest towards astronomy and advancement of this discipline led him to establish observatories first at Baghdād's gate of Shammāsiyya and later on Mount Qasioun near Damascus. Al-Maʾmūn thereby can be remarked to be the first person that built genuine observatories in the history of astronomy. His intention was to obtain more precise results than those inferred from the previous measurements, by means of larger devices and ceaseless observations. Moreover, regarding the knowledge in Ptolemy's Syntaxis/Almagest/al-Majisṭī and the equipment used in astronomy unsatisfactory, al-Maʾmūn had more developed observation devices and cosmographic maps created. Besides, in one of the two observatories established in that period, Qasioun Observatory, which was more developed than the other, the sun, the moon and some other planets were continually observed for one year, which is a feature that the West could hardly initiate in the XVIth century.[33]

Also certain wealthy families are known to have spent a lot establishing a library for translations and scientific studies. For instance, Mūsā ibn Shākir's sons, al-Ḥasan, Muḥammad and Aḥmad, who were commonly known in history as Banū Mūsā with their works on geometry and astronomy, imported a great deal of books to be translated in the same way as Caliph al-

[31] Ibn al-Nadīm, *al-Fihrist*, 304; Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbâʾ*, 1: 187; Şeşen, "İlk Tercüme Faaliyetleri", 12; Yüksel, *İslam'da Bilim Tarihi*, 45-46. Also see Yakıt ve Durak, *İslam'da Bilim Tarihi*, 68-69; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 38.

[32] Ibn al-Nadīm, *al-Fihrist*, 304-305; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 69; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 38; Yüksel, *İslam'da Bilim Tarihi*, 46-47.

[33] Sezgin, *İslam'da Bilim ve Teknik*, 1: 9-10; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 69; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 167; Yüksel, *İslam'da Bilim Tarihi*, 47.

Maʾmūn by sending another committee led by the prominent translator Ḥunayn ibn Ishāq to Byzantium at the expense of vast sums.[34]

The interpreters in this period are reputed to have been backed by the leaders, rich science devotees and scholars and they were even occasionally rewarded with gold as heavy as the works they translated. Caliph al-Maʾmūn, according to a narration included in the sources, spent 300.000 dinars only for the translations from Greek.[35] Another narrative suggesting that the translators were rewarded with gold dust weighing the same as the translations after measured on balance scales.[36]

As a result of the translations carried out after al-Maʾmūn's reign in the periods of al-Muʿtaṣim (r. 218-227/833-842) and al-Mutawakkil (r. 232-247/847-861), namely during the century subsequent to the foundation of the city of Baghdād (144-149/762-766), numerous works on philosophy, logic, mathematics, astronomy, physics, chemistry, medicine, botany and zoology were translated into Arabic. Within the fields of philosophy and logic, Aristotle's *Organon* and *De Anima (Kitāb al-Nafs)*, Plato's *Politeia (the State/Kitāb al-Siyāsa)* and *Nómoi (the Laws/Kitāb al-Nawāmīs)* were translated. Several works of other Greek thinkers such as Theophrastus, Ammonius and Proclus were also translated. Galen's books on philosophy such as *Kitāb al-Akhlāq, Kitāb al-ādāt, Kitāb al-ārāʾi Buqrāṭ* and *Aflāṭūn* are also among the works translated within the field.[37]

On mathematics, astronomy, physics and chemistry, Plato's *Kitāb Uṣūl al-handasah*, various glosses of Aristotle's *Physika*, Euclid's *Stoicheia/Elements (Uṣūl al-handasah)* along with some of his other works were translated. Euclid's *Elements* has formed the basis of Islamic geometry. Likewise, works of Archimedes, Ptolemy's *Syntaxix/Almagest (al-Majisṭī)*, *Geōgraphikè Hyphḗgēsis (Geography)* and other books were translated.[38]

On medicine, alongside the treatises ascribed to Hippocrates such as *Kitāb ʿAhdi Buqrāṭ, Ṭabiʿat al-insān, Kitāb al-Fuṣūl, Taqdimat al-Maʿrifah, al-Amrāḍ al-hādda and Kitāb Buqrāt fī l-ahlāt*; Galen's especially anatomy-related books and the works of many physicians apart from the two

[34] Ibn al-Nadīm, *al-Fihrist*, 304; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 69; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 38; Yüksel, *İslam'da Bilim Tarihi*, 46-47.

[35] As a consequence of Abd al-Malik ibn Marwān's reform, Islamic dinar started to be minted weighing 4,25 g. Therefore, 300.000 dinars weighed around 1.275.000 g or 1.275 kg. For detailed information see Halil Sahillioğlu, "Dinar", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1994), 9: 352-353.

[36] Ibn Abī Uṣaybiʿa, *ʿUyūn al-anbâʾ*, 1: 187; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 69-70; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 38; Yüksel, *İslam'da Bilim Tarihi*, 47.

[37] Ibn al-Nadīm, *al-Fihrist*, 306-315, 349; Şeşen, "İlk Tercüme Faaliyetleri", 15-16; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 38-39.

[38] Ibn al-Nadīm, *al-Fihrist*, 307, 310-311, 325-328; Şeşen, "İlk Tercüme Faaliyetleri", 17-21; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 39.

were translated. Moreover, a number of medical books were translated from Indian and Persian into Arabic as well.[39]

The translations were made from Greek and Nabataean in botany. Aristotle's *Kitāb al-Nabāt*, Apollonius of Tyana's *Kitāb al-Filāḥa,* Theophrastus's *Asbāb al-nabāt,* Dioscorides's *Kitāb al-Hashāish,* Democritus's *al-Filāḥat al-Rūmiyya* are among the works translated into Arabic. .[40]

In zoology, Aristotle's works *Historia Animalium*, *De Generatione Animalium* and *De Partibus Animalium* were translated as one book named *Kitāb al-Ḥayawān. Kitāb Manāfiʿ al-Ḥayawān*, which attributed to Hippocrates, Hermes and Democritus, is another work translated into Arabic.[41]

Some individuals and families in particular are observed to have assumed a crucial role in translation activities, having received state's support. Among them the names as Yūḥannā ibn Māsawaih (d. 243/857), Ḥunayn ibn Ishāq (d. 260/873), Hubaish ibn al-Ḥasan, Banū Mūsā brothers, Thābit ibn Qurrah/his sons/his grandsons, Bukhtīshū family, Abū Sahl al-Nawbakhtī, al-Ḥajjāj ibn Maṭar, al-Kindī (d. 252/866) and Qusṭā ibn Lūqā (d. 300/912-13) stand out.[42]

Having exerted an enormous influence on Muslims, the disciplines which we could include above to a limited extent and the translations produced within these fields have enriched the Muslim's knowledge and culture; yet have never caused them to lose their distinctive identity. Far from it, Muslim scholars have examined and utilized the works on different fields that preceding scholars studied; still never have regarded them as absolute authority. Furthermore, they have demonstrated the mistakes and omissions of those scholars when necessary and at the end produced genuine works by presenting their own observations, experiments and opinions.

3. PERIOD OF PRODUCING ORIGINAL KNOWLEDGE (IIIrd - Vth / IXth - XIth CENTURIES)

Concerning this era (between IIIrd - Vth / IXth - XIth centuries), which we denominate as the period of producing original information, we will seek to portray the level of development the mentioned period witnessed by scrutinizing a number of scholars that came to the forefront in the century they lived and also were recognized afterwards by the scientific world of Europe and by looking into the fields which they studied on. This period is an interval during which culminated the scholars and thinkers such as al-Fazārī (d. 190/806), Jābir ibn Ḥayyān (d. 200/815), al-Khwārizmī (d. 232/847), al-Farghānī (d. 247/861), ʿAlī ibn Rabbān al-Ṭabarī (d. 247/861), Abū Bakr al-Rāzī (d. 313/925), al-Battānī (d. 317/929) Abūl-Wafā Būzhjānī (d.

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[39] Ibn al-Nadīm, *al-Fihrist*, 347-352, 360; Şeşen, "İlk Tercüme Faaliyetleri", 21-23; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 39.

[40] Sezgin, *Tārīh al-turāth al-ʿArabī*, trans. ʿAbd Allah b. ʿAbd Allah Ḥicāzī (Riyadh: Cāmiʿat al-Malik Suūd, 1986), 4: 463-476; Şeşen, "İlk Tercüme Faaliyetleri", 23-24; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 39.

[41] Ibn al-Nadīm, *al-Fihrist*, 312; Sezgin, *Tārīh al-turāth al-ʿArabī*, 3: 553-564; Şeşen, "İlk Tercüme Faaliyetleri", 24; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 39.

[42] Ibn al-Nadīm, *al-Fihrist*, 304-305; Şeşen, "İlk Tercüme Faaliyetleri", 13-14; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 39-41.

388/998), Ibn Sīnā (d. 428/1037), ʿAlī ibn ʿĪsā al-Kaḥḥāl (d. 430/1039), Ibn al-Haytham (d. 432/1040) and al-Bīrūnī (d. 453/1061). In this period, while translation activities proceeded at full speed (the VIIIth-Xth Centuries) on one hand. On the other hand, research acquired new features having become a phenomenon possessing laws, methods and notions and the golden age of Islam's history of science was lived through. Some of most attention-grabbing works of this period were produced in astronomy, mathematics, medicine, chemistry and physics and the knowledge gathered during this interval was appreciated as late as the XIth century through the translations from Arabic by the West, which passed through the dark obscurity provoked by scholasticism between the Vth and XIth centuries.

One of the fields that Muslims predominantly laid emphasis on in the early periods was astronomy which they named "ʿIlm al-Hayʾa", "ʿIlm al-Falak" and "ʿIlm al-Nujūm". What has made the latter valuable for Muslims is to achieve the knowledge required for them to go on with, above all, their religious and social lives properly. The matters such as the determination of the Qibla and prayer times, direction finding on land and sea, fixing the commencement of Ramadan and the timing of agricultural works are the principal examples coming to mind in this regard. The Qur'ān's verses that ordain the examination of the universe and the phenomenon that take place in it and drawing up a lesson from them is another significant aspect that makes the discipline important for Muslims.[43] On the other hand, the translation of the works belonging to Greek and Indian worlds into Arabic has contributed to revival of Muslim's interest in astronomy and to production of numerous genuine works over time. [44]

As a matter of fact, Arabs had no knowledge on astronomy in the pre-Islamic period. Nevertheless, Ilm al-Nujūm was known to the public as an activity to obtain information about the future regarding the stars' movements, which is considered to be the extension of Chaldean astronomy. Another known fact is that some ancient civilizations carried out certain activities in the field which later guided Muslims especially through translations. However, astronomy was raised to a level of a subject based on observation and research by Muslim scholars. For realization of the latter, new observation equipment and techniques, development of trigonometric functions for precise measurements and establishment of observatories to place the equipments in are of capital importance.[45]

The first name in Islamic history of science that comes to the mind when it comes to astronomy is al-Fazārī (d. 190/806). He is the one who invented astrolabe.[46] Al-Fazārī translated

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[43] Al-Baqarah 2/29, 169; Āl ʿImrān 3/190; al-Anʿām 6/97; Yūnus 10/5-6; Yūsuf 12/105; al-Raʿd 13/2; al-Ḥijr 15/16; al-Anbiyā' 21/30-33; al-ʿAnkabūt 29/44; Fāṭir 35/41; Yā-Sīn 36/38; al-Zumar 39/5; al-Jāthiyah 45/3.

[44] Sezgin, *Tārīh al-turāth al-ʿArabī*, 6: 7-11; Mehmet Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi* (Ankara: TDV Pub., 2009), 71; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 78; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 163; Yüksel, *İslam'da Bilim Tarihi*, 62. Also see Sezgin, *İslam'da Bilim ve Teknik*, 2: 3.

[45] Ibn al-Nadīm, *al-Fihrist*, 332; Sezgin, *İslam'da Bilim ve Teknik*, 2: 3; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 78-79; Yüksel, *İslam'da Bilim Tarihi*, 62-63.

[46] An instrument used to measure the inclined position in the sky of a celestial body.

the work named *Siddhanta*, which had been written by Brahmagupta, an Indian scholar, expansively in 154/771 or 156/773. Containing astronomical rulers of the planets in it and shortly known as *Sindhind*, this work formed a tradition of astronomy that continued for many years and which was exerted until the Xth century in eastern part of Islamic world and until the XIIth century in al-Andalūs. Al-Fazārī also has different works such as *Kitāb az-Zīj ʿalā Sinīl-ʿArab*, which presents the astronomical table of the planets' common movements and which outlines the basic knowledge and methods related to the calculation of the astronomical rulers that would be used for the determination of the religious holidays as to lunar calendar. He also had other treatises regarding the divination of the noontime, building astrolabe, transforming a globe into a plane and calendars of various communities.[47]

Another remarkable scholar among the important astronomers and mathematicians from the periods of ʿAbbāsid Caliphs al-Maʾmūn, al-Muʿtaṣim, al-Wāthiq and al-Mutawakkil was al-Farghānī (d. 247/861). His book named *Jawāmiʿ ʿilm al-nujūm wa uṣūl al-ḥarakāt al-samāwiyya,* notwithstanding its being a sort of summary of Ptolemy's *Syntaxis/Almagest/al-Majisṭī*, is of great importance owing to the information it gives about the calendars and dates and the objections he raises against Ptolemy. *Jawāmiʿ*, which was translated to Latin shortly as *Elementa astronomica*, is a book that influenced the western astronomers most amongst the works written by Muslim astronomers and that is the most frequently quoted work in astronomy by the West until the late XVth century. In the book, numerous subjects are treated such as Roman, Syrian, Egyptian, Persian and Arabian calendars; the Earth's position and movements in space, ecliptic inclination, important countries and cities, geodesic measurements, the positions and motions of the Moon, Sun, planets and stars, the situation of the Moon and stars, the phases of the Moon and lunar and solar eclipse. He also has *al-Kāmil fī Sinaʿat al-usturlab* which covers geometry, astral calculations, astrolabe and mathematical theories together with several other works.[48]

Regarded among the greatest Muslim astronomers and known in the West as Albatenius, Albategnius or Albategni, al-Battānī (d. 317/929) is also of great importance in the field of astronomy. Al-Battānī, being one of the most prominent scholars and observers with regard to theoretical and practical astronomy along with geometry and astrology, presented charts associated with his lunar and solar observations, corrected and improved the information given in Ptolemy's *Syntaxis/Almagest/al-Majisṭī* and wrote a remarkable book named Kitāb al-Zīj through which he imparted his discoveries. He introduces in the latter the motions of five planets and related astronomical calculations. This book of al-Battānī, who also achieved success with his discoveries such as the determination of the mean motion of the

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47 Ibn al-Nadīm, *al-Fihrist*, 332; Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 71, 89; Cevat İzgi, "Fezârî, Muhammed b. İbrâhim", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1995), 12: 540-541.

48 Ibn al-Nadīm, *al-Fihrist*, 337; Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 71-72, 77-78, 252; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 163, 254; Yüksel, *İslam'da Bilim Tarihi*, 63-64; Mahmut Kaya ve Sâmî Şelhub, "Fergânî", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1995), 12: 377-378.

Moon's longitude and the measurements of lunar and solar diameters, have made a major contribution to the development of astronomy and global trigonometry and its value was appreciated and translated into Latin in the West three centuries after it was written by Plato Tiburtinus and Robertus Retinensis. Although the first translation of the book disappeared, Plato's translation was reprinted two times afterwards in Nuremberg in 1537 and in Bologna in 1645 after its tables drawn out and its influence prolonged to the midst of the XVIIth century.[49]

al-Bīrūnī (d. 453/1061), whose period is named "al-Bīrūnī's era" and who produced remarkable works on many different disciplines, above all on medicine, physics, mathematics, history, history of religions and geography yet shone out with astronomy, devoted himself to compose a fundamental work covering the astronomy's development systematically up to the period he lived. He thus wrote a book which, apart from being primarily as an astronomical encyclopedia, also contains significant knowledge on astrology, astronomy, geodesy, geography, chronology, meteorology and trigonometry. The latter work, which al-Bīrūnī attributed to Masʿūd, the son of Maḥmūd of Ghazni, and named al-Qānūn al-Masʿūdi, became one of the most important works for medieval astronomy in the time it was written. Al-Bīrūnī mentions the argument that the Earth's revolution around the Sun would not affect the astronomical facts, going against Ptolemy's system embracing the world-centered universe. He also estimated the distance of the solar apogee, the remotest point that alters every year on the orbit between the Earth and Sun, from the vernal equinox, grounding it on the differences that appear on tables holding the increase of the velocity that goes up at the utmost and its decrease at the shortest distance; and thus he became one of the pioneers of infinitesimal calculus. Yet another remarkable achievement from the century al-Bīrūnī lived in is the development of mathematical geography in such a manner that it would transform into an independent discipline, which again happened thanks to him. His book on this discipline, *Taḥdīd nihāyāt al-amākin* is the paramount work for the field and survives until today.[50]

Another significant discipline that Muslims were concerned with beginning from the early periods is mathematics, which is regarded among "riyāḍī" sciences.[51] The mathematical

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[49] Ibn al-Nadīm, *al-Fihrist*, 338; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 163; Yüksel, *İslam'da Bilim Tarihi*, 64; Ferruh Müftüoğlu, "Bettânî", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1992), 6: 9-10. Also see Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 54, 247.

[50] Sezgin, *Tārīh al-turāth al-ʿArabī*, 6: 350-373; Sezgin, *İslam'da Bilim ve Teknik*, 1: 25-26; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 161-163. Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 74-77, 248; Günay Tümer, "Bîrûnî", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1992), 6: 210-213.

[51] "With the influence of Plato's philosophy and in accordance with the classification of Aristotelian sciences, considered as a preparation to the ʿilm al-ilāhī which is superior, Mathematical branches (arithmetic/ʿilm al-ʿadad, geometry/ʿilm al-handasa, astronomy/ʿilm al-falak and mūsiqī) were denominated as "riyāḍī sciences" meaning "what accustoms and prepares the mind", referring to the word "riyāḍa" which radically means "to exercise"; and later all these disciplines were named riyāḍiyyāt. The latter were after started to be used in the period of innovations as a name defining all the sciences dealing with numbers and amount, and is still

knowledge has been always needed for determination of the direction of Mecca, fixing the prayer times and portion of the inheritance etc. While no study or information has been encountered about mathematics in scientific terms, dating back to Jāhiliyyah or the Prophet's period, a number of sources reports that a group of Persian mathematician came to Medina in ʿUmar's period and the caliph, by the recommendation of Alī, asked them to teach "algebra and equations" to some of the companions of the Prophet in exchange for a payment from the state treasury and ʿAlī was the first person to learn this discipline.[52] Yet the major connection between Muslims and mathematics was established by their acquisition of Indian and Greek history of mathematics and their translation of the books reflecting these civilizations' accumulation of knowledge in the field into Arabic. The activities in this field mostly started during the ʿAbbāsid period and Muslim mathematicians, as a result of the mentioned translations, produced solutions for the problems that had not been able to be solved previously and developed totally new hypotheses and systems related to the field.[53]

Considered in Islamic world as the founder of algebra and mentioned in Latin sources as Alkarismi, Algoritmi, Algorismi or Algorism, renowned mathematician al-Khwārizmī (d. 232/847) occupies a position of great importance with regard to the field of mathematics. Having involved in astronomy and geography in addition to mathematics, al-Khwārizmī, who was born in Khwārizm and lived in Baghdād, served in the library of Bayt al-ḥikma of which he was an important member during the period of al-Maʾmūn. He is known to have written his extant works in the mentioned period. Among his works, *al-Kitāb al-mukhtaṣar fī ḥisāb al-jabr wal-muqābala* is the first book of mathematics that has been written in order and holds the word algebra in its name. Having earned its actual reputation thanks to the latter book, Algebra first separated from the field ḥisāb (Accounting) and thus was used as a name of a discipline. All Muslim scholars subsequent to it has taken the work as a model and even kept the equations and examples it contains unchanged. Translated into Latin in the XIIth century, the book was taught as mathematical textbook in the West until the XVIth century. In his studies, al-Khwārizmī presented systematic solutions for the first and second degree equations and as a matter of fact, no formulation giving the roots of the second degree equations could be improved for seven centuries after him. More than half of the al-Khwārizmī's work, who sought to address not only to specialists but also to merchants, qāḍīs, public servants and other people with his writings, consists of practical algebraic problems. Furthermore, solution of some geometric problems through algebra and the relation between the two fields are included among the subjects present in the book. Al-Khwārizmī is the first person to employ algebra in

in use in Arabic language." See Rüşdî Râşid, "Matematik", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Ankara: TDV Pub., 2003), 28: 129.

52 Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 159; İhsan Fazlıoğlu, "Hârizmî, Muhammed b. Mûsâ", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1997), 16: 225.

53 Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 25; Fazlıoğlu, XVI, 225-226; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 82; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 159; Yüksel, *İslam'da Bilim Tarihi*, 52.

Islamic law of descent.[54] Moreover, Indian numerals and decimal number system entered the world of Islam with his another book named *Kitāb al-Ḥisāb al-Hindī*, which was translated into Latin in the XIIth century.[55]

Yet another major figure in mathematics is Abū al-Wafāʾ al-Būzjānī (d. 388/998). Known as the father of trigonometry, al-Būzjānī is regarded as one of the most important Muslim scholars of mathematics, geometry and astronomy and called by the epithets "muhandis" and "ḥāsib". Al-Būzjānī, who was born in Būzjān located between the cities of Herat and Nīshāpūr in Khorasan region, after instructed with basic mathematic knowledge by his uncles, went to Baghdād and completed his learning alongside the prominent scholars of the period and later he began to give lectures and carry out research on mathematics and astronomy. In his works, he presented the first proofs of trigonometric theorems, introduced tangent as "zīl" and secant as "qutr al-zīl" and also compiled the tables of trigonometric functions as arc functions at 15-minute intervals. He furthermore developed several methods for some spherical triangle problems and proved the sine theorem for oblique spherical triangles. Having introduced a new method for the drawing of parabolas by dots, he also had a number of works based on Indian models to a certain degree on geometric drawings. He is also credited with drawing a square into a circle with a single radius of compass and drawing an equilateral triangle into a square and is the first mathematician to give priority to using compass systematically in the works on geometric problems. In addition, he dealt with regular polyhedra and made rough drawings of the regular polygons. He also contributed to algebra and theory of equations.[56]

We can also see that the medicine is among the disciplines that Muslims intensely got into and advanced most. As understood from the narratives given in the sources, Muslims knew a variety of medical techniques for therapeutic purpose, albeit rudimentarily. Alongside the affections such as inflammation in the eye and cough seen in pre-Islamic and early Islamic poetry, the knowledge about injuries emerged during the tribal wars is among the most significant indicators for the foregoing view. Besides, despite the use of some instruments inherited by Greek medicine such as "stylet" by Muslims, therapy styles of the period are seen to have been rather simple.[57]

Among Muslims, medicine like other disciplines made considerable progress with the medical works based on Greek and Indian notion which were acquired through translations.

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[54] A profession stuying Islamic law of descent.

[55] Ibn al-Nadīm, *al-Fihrist*, 333; Fazlıoğlu, "Hârizmî, Muhammed b. Mûsâ", 224-226; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 83; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 159-160; Yüksel, *İslam'da Bilim Tarihi*, 53. For detailed information see Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 25, 38-40, 45-48, 253.

[56] Ibn al-Nadīm, *al-Fihrist*, 341; Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 55-56; Cengiz Aydın, "Ebü'l-Vefâ el-Bûzcânî", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1994), 10: 348; Sezgin, *İslam'da Bilim ve Teknik*, 1: 21-22; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 84.

[57] Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 215; Peter E. Pormann, "Tıp", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 2012), 41: 96.

Medicine was influenced by surrounding cultures thanks to the foreign doctors that worked in the first ʿAbbāsid hospitals and improved with brand-new discoveries and arguments in a short span of time. ʿAli ibn Rabbān al-Ṭabarī (d. 247/861) is among the first scholars who produced works in the field. Firdaws al-ḥikma, which he wrote in the name of the Caliph al-Mutawakkil in 850, is the earliest pharmaceutical and medical work in Arabic. Containing innumerable materials belonging to Indian, Persian, Greek and Arab medicine, the work was a source for many physicians and cultural historians such as al-Rāzī, Ibn Sīnā, al-Bīrūnī etc.[58]

Abū Bakr al-Rāzī (d. 313/925), who is one of the most successful representatives of the physician-philosopher figure and widely known as Rhazes in the West, is one of the most important Muslim scholars that was concerned with medicine. He is called as "the Galen of Arabs" thanks to his vital contributions to medicine after Hippocrates and Galen. After his education, al-Rāzī worked as a chief physician of bīmāristān[59] in his native city, Rayy, and then went to Baghdād in his thirties, where he passed an exam to be the office of chief physician in the hospital, which would later be called Bīmāristān al-Adudī, surpassing one hundred physicians. In order to provide a decent medical service in turn, he gathered a staff of twenty-four experts comprised of oculists, orthopedists, neurologists, internists and surgeons. al-Rāzī had the patients examined at first by the physician assistants, later by chief assistants, and if there was a case that the assistants were not be able to diagnose, then he stepped in, which was a sophisticated method created by himself. During the time while he was a chief physician, all processes about inspection, diagnosis, effects of the medicines and cases were recorded on notebooks. He is also known in the history of medicine to be the first physician to have utilized chemistry for medical purposes. Regarded as the father of clinical medicine, al-Rāzī wrote a book named *Kitāb al-Shukūk*, in which he criticizes Galen whom he said repeatedly that he owed a lot. Al-Rāzī is seen to have successfully applied his observational and experimental method, which he employed on natural sciences, to medicine as well. During the examinations, he asked about the patients' age, nutrition, diseases they had gone through, their complaints and when they had begun and after that he noted down all the findings along with the diagnoses he made. It is possible to see his rich fund of knowledge on the field in his wide variety of works ranging from sixty-five to a hundred, particularly in his medical encyclopedia named *al-Ḥāwī* (*al-Jāmiʿ al-kabīr*), which he composed in fifteen years. The latter was translated into Latin as *Liber Continens* in 1279 by Faraj ben Sālim (Farragut) and reprinted five times between 1448 and 1542. As the first physician to have diagnosed the measles and smallpox correctly, al-Rāzī's book on the subject named *al-Judarī wa-l-Ḥasbah* was also translated into Latin and published in forty

[58] Ibn al-Nadīm, *al-Fihrist*, 354; Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 215, 218, 263-264; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 86; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 175; Yüksel, *İslam'da Bilim Tarihi*, 55-56; Necip Taylan, "Ali b. Rabben et-Taberî", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1989), 2: 435.

[59] A general name for the classical hospitals in Islamic world.

editions between 1498 and 1866. Another work written by him, *Akhlāq al-Ṭabīb* defined the rules to be followed concerning physician-patient relations.[60]

Ibn Sīnā (d. 428/1037), the foremost representative of medieval medicine and the greatest systems philosopher of Peripatetic Islamic School, is a figure regarded as high authority with respect to medical history by both the world of Islam and the West. The number of his works on medicine is around forty yet the most significant ones are *al-Urjūza fī l-ṭibb, al-Qānūn fī l-ṭibb* and *al-Shifā.* With his works, he left deep traces on both Islamic and European traditions of medicine. His influence on the West is considered to have extended to the XVIIth century and overshadowed the fame of Hippocrates and Galen, who are regarded as the most important authorities of ancient Greek medicine. The fact that his work *al-Qānūn fī l-ṭibb,* which is regarded as a medical masterpiece, was translated into Latin by name *Canon* in Spain a century after his death and taught as a textbook in the medical faculties of Europe's universities beginning from the XIIIth century along with the establishment of a chair of Ibn Sīnā/Avicenna in University of Valladolid in the XVIIth century are in fact clear indicators of the foregoing argument. Furthermore, a portray of him sitting on a throne between Hippocrates and Galen shown on the cover image of one of *al-Qānūn fī l-ṭibb's* Latin edition (Pavia 1510) is a sign indicating how his authority on medicine is appraised. Ibn Sīnā conducted elaborate studies towards clinical and basic medical specialties and introduced significant knowledge on basic medical sub-disciplines such as anatomy, physiology, histology, pharmacology and biochemistry through the works he wrote. In addition, he employed distinct methods as urine and pulse examinations to diagnose the complaints. In *al-Qānūn fī l-ṭibb*, Ibn Sīnā systematically evaluates the Hellenistic, Byzantine and Assyrian medical literature, which was disorderly before him, and extensively presented his own medical accumulation through his studies and observations as an encyclopedia. In the same work, he elaborates on anatomy, pathologic symptoms, sanitation, types of treatment, diseases (inflammatory diseases, abscesses, orthopedic complaints, poisonings, physical injuries etc.) and medications.[61]

Another leading physician of medieval Islamic world is ʿAlī ibn ʿĪsā al-Kaḥḥāl (d. 430/1039), who is known in the West as Jesu Hali and who earned his reputation with his work on eye diseases. Despite the limited information about his life, he is known to have spent his educational and work life in Baghdād. Shortly known as *Tadhkira* or *Tadhkirat al-Kaḥḥālīn*, his work *Tadhkirat al-Kaḥḥālīn fī l-ʿayn wa-amrāḍihā* is the most ancient and the broadest book among the work in Arabic about eye and eye diseases, that have survived to this day. Comprised of three chapters, the book covers the anatomy and physiology of the eye in the first chapter;

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[60] Ibn al-Nadīm, *al-Fihrist*, 356-357; Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 215, 266; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 175, 252; Mahmut Kaya, "Râzî, Ebû Bekir", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 2007), 34: 479, 484-485.

[61] Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 215-216, 224, 257; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 89-90; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 176, 251-252; Yüksel, *İslam'da Bilim Tarihi*, 57; Arslan Terzioğlu, "İbn Sînâ (Tıp)", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1999), 20: 331-332.

eyelids, lacrimal glands, diseases and operations on cornea and uvea along with cataract surgery in the second; while the third chapter treats the visual impairments such as myopia, hyperopia, diplopia and night/day blindness under the title of "internal eye diseases" and also some abnormalities seen in the different parts of the eye including retina, optic nerves and lenses. The mentioned work, in which 132 types of eye diseases are explained, ends with a section holding a number of recommendations towards preserving general health and explanations of the effects of 141 simple medications given in alphabetical order on eye. Another genuine feature of the work is that it introduces the very first elucidation of how to operate eye surgeries by means of the general anesthetic substances such as mandrake and opium in painful surgeries, apart from the local anesthetics known to that day. *Tadhkirat al-Kaḥḥālīn* drew considerable interest as from the beginnings of the XIth century, when it was written, and the whole book or some parts of it was expounded several times. Furthermore, it was translated into Hebrew and also twice into Latin as *Tractus de oculis Jesu b. Hali* in Middle Age, as well published by the name *Epistola Ihesu filii Haly de cognitione infirmitatum oculorum sive memoriale ocularіorum quod compilavit Ali b. Issa* alongside its retranslation into Hebrew in the early XXth century (Paris 1903). In addition, its several chapters were translated into modern languages.[62]

Chemistry is another faculty that Muslims primarily became concerned with. We can even say that the foundations of modern chemistry were laid in Islamic civilizations. Having begun with the translation activities, chemistry studies in the world of Islam were later run jointly with alchemy[63] in line with the characteristic approach of the period. The first person among Muslims known to have received chemistry education and studied on the field is Khalīd (d. 85/704), son of Caliph Yazīd ibn Muʿāwiya. Khalīd ibn Yazīd grew in Alexandria, learnt medicine and chemistry from a Byzantine monk named Marianus, whom he invited and who was considered among the period's experts on chemistry. He also had the accumulation of knowledge in chemistry in Alexandria translated into Arabic. With this order, Khalīd not only let the chemistry translated into Arabic, but also took the first steps towards physical sciences in Islamic civilizations. He also asked another monk Stephanos to translate one of his books on chemistry.[64]

The most important figure in chemistry is Jābir ibn Ḥayyān (d. 200/815), who is a nature philosopher and a sophisticated scholar at the same time. Having a distinguished position in the history of chemistry, Jābir is the one who transformed chemistry into a systematic and experimental science. Western researchers, regards the place of Jābir ibn Ḥayyān, known as

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62 Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 176, 252; Ali Haydar Bayat, "Ali b. Îsâ el-Kehhâl", *Türkiye Diyanet Vakfi İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1989), 2: 401.

63 A proffesion aiming to convert base metals into gold, ancient chemistry, a magic technique in traditional secretive learnings.

64 Sezgin, *İslam'da Bilim ve Teknik*, 4: 97; Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 150; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 91; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 170; Yüksel, *İslam'da Bilim Tarihi*, 76.

Geber in Latin, in the history of chemistry equivalent to modern-day researchers. Jābir scientifically determined and expounded the calcination (pulverization) and reduction, two main principles of chemistry. He also developed the methods used for evaporation, melting and crystallization, and classified chemical substances. At the same time, he discovered the nitric acid and introduced mercury-sulfur theory, one of the foundation theories of chemistry. Thanks to his mentioned works and inventions, medieval chemists were majorly influenced by Jābir and described him as the master. A part of his works was firstly translated by Robert of Chester into Latin, while his work named *Kitāb al-Sabʿīn*, which is composed of seventy booklets, was translated by Gerard of Cremeno as *Liber divinitatis de LXX*.[65]

Just as in the West, studies on physics in Islamic world commenced within natural philosophy and were covered within the frame of Aristotle's ideas. Muslims predominantly focused on mechanics together with optics, which is known as ilm al-manāẓir. The research on optics or ilm al-manāẓir began in the IXth century with the translations of the works belonging to Greek and Hellenistic periods and the works of scholars such as Euclid, Heron, Ptolemy and Theon and designated the notions and problems of the early research. Later, significant studies were held by two prominent figures of the field, Qustā ibn Lūqā and al-Kindī. Maintained by Utārid ibn Muḥammad, Aḥmad bin ʿIsā and Abū Saʿd ibn Sahl, optic studies grew to maturity with Ibn al-Haytham and Kamāl al-Dīn al-Fārisī and substantial works were produced in the field.[66]

The greatest physicist of the Middle Ages, known for his important contributions to the development of optics, was Ibn al-Haytham (d. 432/1040). Ibn al-Haytham, who was also interested in mathematics, astronomy and philosophy as much as physics, is known in the West as Alhazen, Alhacen, Avenetan or Avennathan. As he produced revolutionary works particularly in optics, Ibn al-Haytham is regarded as the most important figure in the history of optics up to the XVIIth century. His treatise on optics, *Kitāb al-Manāẓir* is work of vital importance. This treatise, which was translated into Latin in the late XIIth century or at the beginning of the XIIIth century, was exceedingly influential on the formation of numerous prominent scientists' theories on optics, such as John Pecham, Roger Bacon, Witelo, Johannes Kepler, Snel van Royen, Pierre de Fermat and Descartes and thus on the establishment of optics in the West. Ibn al-Haytham, in the treatise, argues that the rays that enable us to see do not come out from the eyes, but reflect from the object we look and thus the seeing becomes possible. Moreover, having noticed before western scientists that the light beams over a straight line, he carried out the experiment called "Camera Obscure" in order to prove this

[65] Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 150, 152, 154, 156, 159, 249-250; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 92-93; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 170, 253; Yüksel, *İslam'da Bilim Tarihi*, 76; Mahmut Kaya, "Câbir b. Hayyân", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 1992), 6: 534-536.

[66] Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 113; Yakıt ve Durak, *İslam'da Bilim Tarihi*, 94; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 169; Rüşdî Râşid, "İlm-i Menâzır", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 2000), 22: 129-131.

argument. His camera obscure experiment later conduced to the invention of some optic apparatus, above all, photographic and cinematographic cameras. When viewed from this aspect, he may even be considered to have invented a primitive version of camera. He furthermore expounded the structure of the eye and the reason/reasons of visual disorders in addition to how the eye is designed in a manner similar to modern-day knowledge. According to some, he even invented the reading glasses. However, reading glasses and cameras are first seen in the West in the XIVth century. He was also the first to describe a scope in shape of a tube with glass lenses at both edges. The telescope thereby can be said to have been used in observatories in Cairo, that is to say, in the world of Islam, even 600 years before its appearance in the western world of science.[67]

CONCLUSION

The first Islamic conquests not only resulted in the expansion of Muslims' cultural geography but also boosted the intellectual dynamism in the Islamic World and as well led Muslims to become acquainted with the fund of knowledge contained in Greek/Hellenistic, Persian and Indian cultural reservoirs thanks to the translation activities, which began in the IInd/VIIIth century soon after the conquests. These translation activities, which intensified during the period of acquisition of knowledge, in IInd/VIIIth century, were initiated by one of the Umayyad crown princes, Khālid Ibn Yazīd Ibn Muāwiya, who is regarded as one of the precursors of chemistry and the first translation movements in the world of Islam, and culminated with establishments like Bayt al-ḥikmas and observatories.

What Muslims obtained most from their relations with other civilizations, which began with the conquests and economic ties, was their scientific experience. Especially the conquests of the cities such as Alexandria, Kharrān and Jundīshāpūr by Muslims and later the recognition of the scientific tradition of philosophy, medicine, astronomy, mathematics and chemistry belonging to these centers through the translations were important milestones for Muslims. They soon after managed to internalize this accumulation in the IIIrd/IXth century, which was the period of systematization of the knowledge, and to dedicate it to the use of other communities after improving it in the following centuries.

Muslims did not merely meet different disciplines over translations and utilized the works in these fields, in other words they did not only learn the knowledge of ancient civilizations, they also reached to a level to correct the mistakes and deficiencies of the works they translated. Besides, they demonstrated their scientific development and produced genuine works, presenting their own observations, experiments and ideas even when the translations continued.

[67] Bayrakdar, *İslâm'da Bilim ve Teknoloji Tarihi*, 114-115, 117, 142, 255-256, 84-85; Sarıçam ve Erşahin, *İslam Medeniyeti Tarihi*, 169, 253; Yüksel, *İslam'da Bilim Tarihi*, 72; Hüseyin Gazi Topdemir, "İbnü'l-Heysem", *Türkiye Diyanet Vakfı İslâm Ansiklopedisi* (Istanbul: TDV Pub., 2000), 21: 82.

When examining the studies held by Muslims particularly between the IIIrd/IXth and Vth/XIth centuries, which we denominate as the period of the production of original knowledge. We can see that research began to feature rules, methods and notions, that Arabic language transformed into a science language and that Muslims lived the golden age of the history of Islamic science. The most remarkable works held in the mentioned period were on mathematics, medicine, physics, chemistry and astronomy and the West, which lived under the dense darkness of scholasticism between the Vth and XIth centuries, recognized the knowledge produced as a result of these works centuries later. They began to appreciate it in the XIth century through the translations from Arabic into Latin and Hebrew.

The works on medicine, which Muslim scholars such as Ibn Sīnā, al-Bīrūnī, Ibn al-Haytham, ʿAlī ibn ʿĪsā al-Kaḥḥāl, Abū al-Wafā Būzhjānī, al-Battānī, Abū Bakr al-Rāzī, ʿAli ibn Rabbān al-Ṭabarī, al-Farghānī, al-Khwārizmī, Jābir ibn Ḥayyān and al-Fazārī and others we have not been able to include in this study wrote were taught in the European universities throughout many years, even centuries after their value was appreciated in the West. This is worthy of attention as it demonstrates the level Islamic scholars reached in about the four centuries following the initiation of the translation activities.

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