

Parviz Azkāei

Abu- Rayḥān-e Bīrūnī

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1. Biography

1. The time of Bīrūnī

During his life, Abū Rayḥān Bīrūnī (362-440 A. H./ 972-1048 A. D.) was contemporary with the Arian dynasties Sāmānians and Khwārazm-Shāhs in the eastern Iran, both overthrown by Maḥmūd Ghaznavī (in 389/ 998 and 408/ 1017 respectively) and also with the Iranian Daylamīd dynasties of Ziyārīds in Gurgān and Ṭabaristān, and Būyīds in the western Iran, i.e. Jibāl, Fārs and Irāq, again both overthrown by Ṭuḡhrul of Saljūq (in 433/ 1041 and 447/ 1055). Descended from the Arians of Khwārazm, the Khwārazm-Shāhs, as the tributaries of the Sāmānians for more than a century, claimed to be the offsprings of Kay Khusraw, the great mythical Iranian king. The capital city of the Shāhīd dynasty and the house of Irāq, a branch of that dynasty, was the town of Kāth, to the North of Khwārazm and west of Oxus and the capital city of the Ma'mūnīds, another branch of the Khwārazm-Shāhs, was the city Gurgānāy/Jurjāniya, to the south of the city (the modern Khīva or Kuhana of Urganj in Turkistān).¹

The last rulers of the house of 'Irāq were Abū Sa'īd Aḥmad Ibn Muḥammad Ibn Irāq who corrected the calendar of Khwārazm, and (martyr) Abū Abdullāh Muḥammad Ibn Aḥmad 'Irāq, killed after the invasion of Ma'mūn of Khwārazm-Shāh to the town of Kāth (385/ 995) and their dynasty was accordingly overthrown. Another member of the dynasty, Abū Naṣr Maṣṣūr Ibn Alī 'Irāq can be considered as one of the greatest mathematicians and astronomers in the fourth century A.H. and a student of the great Iranian mathematician, Abū al-Wafā Bujgānī (328-388/ 939-998) who came to be the master and patron of Abū Rayḥān Bīrūnī. He was one of the scholars accused of heresy and hung from the gate of Kāth by Maḥmūd Ghaznavī in his invasion of 408/1017 to Khwārazm.²

After Abū al-'abbās Ma'mūn Ibn Muḥammad Khwārazm-Shāh who seized the territorial possessions of the house of 'Irāq (385/ 995), his son, Abū al-ḥasan 'Alī Ibn Ma'mūn, succeeded to the throne (387/ 997) and then the other son of Abū al-'abbās, Ma'mūn Ibn Ma'mūn ascended the throne until the year 407/ 1016 in which he was killed. Afterwards, his nephew, Abū al-ḥārith Muḥammad Ibn 'Alī, succeeded him and was in turn captured by Sulṭān Maḥmūd in 408/ 1017. Khwārazm was occupied by the Ghaznavīds, and the Ma'mūnīd dynasty was vanquished. The court of Abū al-'abbās Khwārazm-Shāh in Jurjāniya served as an assembly of sciences where greatest scholars of the time gathered. Bīrūnī was one of the members of the assembly and a political counselor of the Khwārazm-Shāh.

Moreover, the Ziyārīd Daylamīds (316-433/ 928-1041), though always fighting against the Būyīd Daylamīds (320-447/ 932-1055) over their territorial possessions, often ruled over the

¹For an account of the rulers of the house of 'Irāq and the house of Ma'mūn, see the author's exhaustive monograph, "Khhāndān-e Shāhīye-ye Khwārazm" in *Faṣḥnāme-ye Irān Shenākht*, no. 10, Autumn 1377/1998, part 1, pp. 136-181; no. 11, Winter 1377/1989, part 2, pp. 112-114./ The Appendices of *Al-āthār al-bāqiya*, (ed.) Parviz Azkaei, Tehran, 1380/2001, pp. 488-492.

²See "The biography of Abū Naṣr 'Irāq" in this book, Appendix II, section 3, pp. 139-145.

states of Gurgān and Ṭabaristān. Among them, Shams al-ma‘ālī Qābūs Ibn Vushmgīr extended his territory in the second half of his sovereignty (totally 388-403/ 998-1012) as far as the modern Rūyān and Gīlān to the west. He was both a cruel ruler and a generous Amir and also an eloquent poet, always keeping a company of great men of literature and science, including Bīrūnī who lived in his court for some years. After conquering Bagdad (334-337/ 945-948) and vanquishing the ‘Abbāsīds, the Būyīds attached Iraq or Mesopotamia to the provinces under their reign including Jibāl, Luristān, Fārs, Khuzistān and Kirmān. The courts of the Būyīd and the Kākūyīd Daylamīds of Jibāl, viz. the provinces of Ray, Hamadān and Iṣfahān, served as the scientific and cultural centers and shelters for the philosophers and scholars of the time. This was especially true with the court of Majd al-dawlat Daylamī (387-420/ 997-1029), famous for learning philosophy and reading books meticulously. Unfortunately, his invaluable library was set on fire by Maḥmūd Ghaznavī in his invasion to Ray when he hung a number of the scholars and philosophers of the city over the accusation of heresy (420/ 1029) and overthrew the Daylamīd dynasty.

Yamīn al-dawla Sultan Maḥmūd Ghaznavī (360-421/ 970-1030) had, in his previous invasions to Khwarezm, massacred a great number of people (in 408/ 1017) and had captured about five thousand people, including Abū Rayḥān Bīrūnī, all sent to Ghazna in chain. The impetuosity of the Sulṭān was not limited to his tendency to shed blood and kill his opponents with cruelty. When he arrived in Khwarezm, he set the libraries on fire and ruined the cultural foundations established and encouraged by Khwarezm-Shāhs. Most of his reputation simply comes from the flattery of his fanatical contemporaries who pretended his plundering and destructions in India as examples of Islamic ghazwa (religious war), while once considered realistically, they turn out to be great loss for Iranian people. Accordingly, the years of his reign were, in general, one of the dark and cruel periods in the history of Iran. The anti-philosopher Sultan, unable to appreciate the subtleties of Persian literature due to his Turkish descent and incapable of comprehending science and philosophy because of his deep Sunni biases, has indeed no such good reputation in the history. The way he treated Firdawsī and Bīrūnī meanly has been highly notorious. He simply made them suspect and subject to death. Even, the love he expressed for poetry was solely due to the fact that there were always a good number of celebrated insatiable eulogists in his court who were to praise his power and glory.

2. Biography

Abū Rayḥān Muḥammad Ibn Aḥmad Khwarezmī (Dhu al-Ḥijjah 3rd, 362/ September 4th, 972), one of the greatest scholars of human civilization and a celebrated Iranian scholar of the Islamic period, was born in Bīrūn (‘outside’) of the town Kāth, to the north-east of Khīva, on the right bank of Āmū Daryā/ Oxus, in a family of Khwarezmian descent which he described as “a branch of the big Iranian tree” (*Al-āthār*, p. 56). He revealed great love for research from the very young age.

Amīr Abū Naṣr Maṣṣūr Ibn ‘Alī ‘Irāq Ja’dī (cr. 350-408/ 961-1017), from the Afrīghīd Shāhīd dynasty of Khwārazm (the house of ‘Irāq), one of the great Iranian mathematicians and astronomers, undertook the education of the young Bīrūnī in Kāth. The pupil later mentioned the favor of the Shāhīd family of Khwārazm in an ode: “So the ‘Irāq family gave a taste of their goodness to me/and Maṣṣūr of them cherished the young sapling of my existence” (*Mu‘jam al-udabā’*, 17, 186). He, then, wrote several mathematical tracts for the pupil and dedicated them to him (*Rasā’il Abī Naṣr*, ed. Haydar Abad Dakan, 1948).

Another teacher of Bīrūnī in the field of philosophy and rational sciences was ‘Abd al-Ṣamad Ḥakīm who was seized and killed by Maḥmūd Ghaznavī over accusation of Karmatian (heretical) thoughts, or bāṭinī (esoteric) and Ismailite Shiite trends (408/ 1017). He also intended to join the pupil to the teacher, but as Yāqūt Ḥamavī said: “Death’s looseness happened to befriend him and came to save him from murder” (*Mu‘jam al-udabā’*, pp. 17, 186). As philosophical inclination has been often a common feature of Shiite sects, the freethinker Bīrūnī’s faith was perhaps influenced by such an inclination, in addition to scientific and mathematical methodologies.

After the Shāhīd dynasty of ‘Irāq in Kāth was overthrown by the Ma’mūnīd dynasty of Gurgān in 385/ 995 and the struggles of the two old Iranian dynasties served a major interruption to Bīrūnī’s studies and astronomical observations, he went to Khurāsān inevitably and from thence to Ray and then he had hard times for a while (388/ 998). Next, apparently having failed to join the court of Majd al-dawlat abu Ṭalīb Daylamī Būyī (387-421/ 997-1030), he left for Ṭabaristān. He spent a while there with Sharvīnī rulers and wrote a book, *Maqālīd ‘ilm al-hay’a* (*Keys to Astronomy*), dedicated to Ispahbad Marzbān Ibn Rustam, the author of the Ṭabarī *Marzbān Nāme*, and was introduced by him to the court of Shams al-Ma’ālī Qābūs Ibn Vushmgīr Ziyārī (388-403/ 998-1012) in Gurgān.

At the court of Qābūs, Bīrūnī wrote and dedicated *Al-āthār al-bāqiya* (Chronology of Ancient Nations) to him (391/ 1000). It should be noted that it was the first edition of the book, because later he produced another edition with more additions. He lived highly respectfully in Gurgān for about six years and left for his homeland, Khwārazm, possibly for the fear of the severity and cruelty of the literary Qābūs and partly because of the authoritarian Ma’mūnīd dynasty of Khwārazm-Shāhs and their good reputation for rewarding scholars. He joined the court of Amīr Abū al-‘Abbās Ma’mūn Ibn Ma’mūn Khwārazm-Shāh which was one of the most important centers for the intellectual and scientific movements of the age, in about 394/ 1003 in Jurjāniya (Gurgān).

‘Arūḍī Samarqandī says: “Abū al-‘abbās Ma’mūn Khwārazm-Shāh had a vizier named Abū al-ḥusayn Aḥmad Ibn Muḥammad Suhaylī, philosopher by nature and generous by disposition and learned, and Khwārazm-Shāh was also sage-lover and hence several philosophers and learned men had gathered in that court, such as Ibn Sīnā, Abū Sahl Masīḥī, Abū al-Khayr Khammār, Abū Rayḥān Bīrūnī and Abū Naṣr ‘Irāq ... (this one) being a second Ptolemy in mathematics and all its branches, and Abū al-Khayr Khammār was a third Hippocrates or Galen in medicine, Abū Rayḥān (was) a substitute of Abū Ma’shar (Balkhī) and Aḥmad Ibn ‘Abd al-Jalāl (Sajzī), and Ibn Sīnā and Abū Sahl Masīḥī were successors of

Aristotle in philosophy which includes all sciences. These men were free from want of the worldly riches and were always in intimate conversations, enjoying writing together” (*Chahār Maqāla*, p. 118).

Out of them, Bīrūnī enjoyed reputation and reverence before Khwārazm-Shāh due to his extraordinary knowledge and insight, in so much that he became the Amīr’s political counsel and reconciled complicated issues, for instance, the case of performing homilies in the name of Sultan Maḥmūd Ghaznavī, and also the ties with the tribal chiefs of Turkistān and the like (*Beyhaqī History*, pp. 671-673). We believe that Bīrūnī anticipated the threatening hazard of the plundering eastern Turks and wrote the political book of *Al-taḥdhīr min qibal al-turk* (*Warning About the Eastern Turks*) which does not exist. As a political counsel, he says: “I was at the service of Amīr Abū al-‘abbās for seven years (400-407/ 1009-1016)” (*ibid.* p. 668). It should be added that during this period, he did not cease to read and research, and some of his recorded observations or the invention of astronomical instruments belong to this period.

Amīr Abu al-‘abbās Khwārazm-Shāh was killed after a rebel of his army in 407/ 1016 and thence, Bīrūnī came under the service of Abū al-ḥārith Muḥammad Ibn ‘Alī Ibn Ma’mūn. However, a year later (Rabi al-Awwal 408/ 1017), Ma’mūn Ghaznavī overthrew the Amīr, conquered Khwārazm, set the libraries on fire and captivated the scholars. In 403/ 1012, Ibn Sīnā and Abū Sahl had fled to the courts of the Ziyārīds of Gurgān and the Būyīds of Ray and Hamadān, respectively. According to the most correct report by Yāqūt Ḥamavī, Bīrūnī “was captivated with his teacher, ‘Abd al-ṣamad Ḥakīm. Maḥmūd killed the teacher under the accusation of being a Karmatian [blasphemous Shiite] and tried to make Abū Rayḥān join him, but death’s looseness happened to befriend and save him from murder for a reason unknown to us. When the Sultan was told that the scholar was the leading figure of the time in astrology and that kings would not be needless of a man as him, the Sultan seized him and took with himself to India” (*Mu‘jam al-udabā’*, pp. 17, 186).

Nevertheless, the hard-hearted Sultan was always suspicious and worried about the scholar, expect the time when he imprisoned him for about six months in the castle of the city Nandana (in western Punjab, 100 km to the south of Islam Abad, Pakistan)- the city where Bīrūnī completed his astronomical observations. Ignoring the legendry details of the report by ‘Arūḍī Samarqandī on the imprisonment, his report seems acceptable at least to the extent that Khwāja Aḥmad Ḥasan Maymandī, the vizier of the Sultan, interceded on Bīrūnī’s behalf, as he had done on Firdawsī’s behalf, when “he found the Sultans mild-tempered in the hunting-ground” and helped him free (*Chahār Maqāla*, p. 93). The Sultan returned to Ghazna, but he continued to be suspicious about the scholar.

In short, as Sachau found out, Bīrūnī was never pleased with Maḥmūd and was still viewed with contempt because of his ties with the heretical Shiite philosophers. He was indeed a political prisoner in the court of Ghazna for thirteen years (408-421/ 1017-1030) far from his homeland (*India*, XI, XVI). What helped him survive was astrology, the superstitious knowledge which he did not believe in, but the Sultan bitterly needed in the prophecy of auspicious and evil days and actions.

In the beginning of Jumada al-Thani of 409/ 1018, Bīrūnī observed the latitudes of the region in the village Jayfur in Kabul and it seems that he was busy with the task until the end of the year. Afterwards, he spent times successively or periodically in Ghazna, for instance, observing a summer solstice in 410/ 1019, and recording the lunar eclipse of Jumada al-Awwal 13 of 410/ 1019 there. He was in Ghazna in the years 412/ 1021 and 415/ 1024. Therefore, what is unknown to us is the exact dates of his various journeys to India after he had joined the Sultan. The only definite date of a trip to India recorded by him is the year of the conquest of Sūmanāt (416/ 1025) by the Sultan: “on what I witnessed in the year of the destruction of Sūmanāt” (*India*, pp. 347-348).

By the way, it is a well-known fact that, during these journeys (between 408 to 421/ 1017-1030), he learned Sanskrit, accomplished in-depth research in the field of Indian history, sociology, ethnography, religions and sciences, translated several books from Sanskrit to Arabic and vice versa. However, the greatest scientific gift that he brought from India is indeed his masterpiece, *India*, the final compilation finished in 421-422/ 1030. It should be added that in 418/ 1027, he invented a special chronometer based on the [solar order](#) for the congregation mosque in Ghazna, and visited the Chinese and Uighur travelers in the court of Maḥmūd Ghaznavī and obtained valuable information.

After the death of Sultan Maḥmūd Ghaznavī (421/1030) and the accession of his son, Sultan Mas‘ūd Ghaznavī (421-432/ 1030-1040) to the throne, Bīrūnī’s condition improved. Due to the young Sulṭān’s care for astronomy, Bīrūnī wrote his valuable book, *Al-qānūn al-Mas‘ūdī* (*The Mas‘ūdī Canon*) in astronomy and mathematics, dedicated to the young Sultan -the book considered as having the same importance as Ptolemy’s *Almagest*. This book includes Bīrūnī’s astronomical tables (Zigs) too. As a reward of such a great work, Sultan Mas‘ūd is said to have sent an elephant loaded with silver objects to him, but the scholar declined and showed his needlessness of the worldly riches. Later, at the time of Sultan Shahāb al-dawlat Mawdūd Ibn Mas‘ūd (433-440/ 1041-1048), Bīrūnī wrote, among other books, *Al-jamāhir fī ma‘rifa al-jawāhir* (*Gems*) on the study of jewels and minerals and dedicated it to the Sultan.

We can guess that after Maḥmūd (421/ 1030), Bīrūnī had a chance to take some trips to his homeland, Kh̲wārazm, until his death (440/1048). In the meanwhile, he wrote the history of his homeland, *Al-musāmara fī akhbār Kh̲wārazm* (*Stories about the History of Kh̲wārazm*) which is unfortunately lost totally except some fragments quoted in the *History of Beyhaq*. The date and place of Bīrūnī’s death has been a matter of controversy. Yāqūt Ḥamavī reports his death in Ghazna (*Mu‘jam al-udabā’*, pp. 17, 186). But, the most correct date must be what Ḥakīm Ghaḍanfar Tabrīzī writes: “It was seen in the work of his pupil, Abū al-faḍl Sarakhsī that the scholar died on Friday Rajab 2nd of 440/ 1048” (*Al-mashāṭa*, p. 80). Professor Kennedy regarded this date as erroneous (*Dictionary of Scientific Biography*, p. 311), but he unwittingly made an error in his own calculations.

3. List of Works

The numerous works of Bīrūnī are not limited to the frontiers of the technical courses at his time, rather they encompass all dimensions of human knowledge. Putting aside the narrative branches of knowledge, i.e. ḥadīth (the study of the quotations relating to the prophet Mohammed), Islamic jurisprudence and theology, Bīrūnī is a man of inquiry with astute views in rational sciences, especially in all branches of positive and human sciences. His works, both existing and lost, can be numerated according to the general classification of sciences and arts. The number of the writings, including treatises, articles and books, as reported by him, amounts to some 160, and if we add the 25 treatises by Abū Naṣr ‘Irāq and Abū Sahl Masīḥī, all dedicated to him and reported by him as his own works, the total number will be 185. Of these writings, 40 works are available as manuscripts in the libraries of which 30 ones are printed and 25 are translated into Persian and European languages.

The subject classification of Bīrūnī’s works, according to the existing records, is as following: **(a)** mathematics: arithmetic (8 works), geometry (10), trigonometry (2), technical pro (4), land-surveying (1), **(b)** astronomy: general astronomy (50), meteorology (6), astronomical instruments (11), astrology (20), cosmology (1), **(c)** geography: mathematical geography (10), [projection plane and cartography/ map projection](#) (4), geodesy (4), climatology (4), **(d)** physics (1), **(e)** mechanics (2), **(f)** natural sciences (1), **(g)** mineralogy (2), **(h)** botany (1), **(i)** medicine (1), **(j)** literature: bibliography (1), grammar (1), poetry (5), narrations (12), **(k)** history: elements (5), events (4), **(l)** religion studies: beliefs (3), religions and sects (4), **(m)** philosophy (7). Subjects such as chronometry, chronology, Indiology, linguistics, pharmacology, gemology, etc. are included in the relevant classes in the list.

In what follows, the complete list of Bīrūnī’s works will be presented in the two sections of (a) the list provided by Bīrūnī himself (numbers 1 to 138) and (b) the appendix list of the works later found (numbers 139 to 185).

A

Bīrūnī’s Catalogue

1. **B.** *Al-masā’il al-mufīda wa al-jawābāt al-sadīda.*

Useful Questions and Firm Answers.

2. **B.** *Ibṭāl al-buhtān bi irād al-burhān ‘alā a‘māl al-Khwārazmī fī zījehī.*

Abortion of the False Accusation by Bringing Arguments Against Khwarazmi’s Effort in His Zig.

3. **B.** *Al-wasāṭa bayn al-Khwārizmī wa al-Ahwāzī.*

Mediation Between Khwārizmī and (Abū al-Ḥassan) Ahwāzī.

4. **B.** *Takmīl zīj Ḥabash bi al-‘ilal wa tahdhīb a‘mālihī min al-zilāl.*

Perfection of the Habash al-Ḥasib’s Zigs by Stating the Causes and Purifying His Work From Errors.

5. **B.** *Jawāmi‘ al-mawjūd li khawāṭir al-hunūd fī ḥisāb al-tanjīm.*

Compendium of the Existing Indian Ideas on Astrological Calculation (on Siddhanta).

6. **???** *Tahdhīb zīj al-Arkand.*

Correction of the (Indian) Arkand Zig.

7. **B.** *Maqālīd ‘ilm al-hay’a.*

Keys to Astronomy.

8. **B.** *Khayāl al-kusūfayn ‘ind al-Hind.*

Indian Vision of the Two Eclipses.

9. **B.** *Amr al-mumtaḥan wa tabṣīr Ibn Kaysūm al-Muftatan.*

On the al-Mumtahan (Examined) Zig and Giving the Quarrelsome Ibn Kaysum Insight.

10. **Tr.** *Ikhtilāf al-aqāwīl li istikhrāj al-taḥwīl.*

Differences of Opinions in the Calculation of the Revolutions (of the Years).

11. **Tr.** *Al-taḥlīl wa al-taqī‘ li al-ta‘dīl.*

Resolution and Analysis for Equation (of the Sun).

12. **Tr.** *Tahdhīb al-ṭuruq al-muḥtāj ilayhā fī istikhrāj hay’a al-falak ‘ind al-mawālīd wa taḥwīl al-sanīn wa ḡhayruhā min al-awqāt.*

Correction of the Ways Required in Calculating the Configuration of the Sphere as for the Zigs/ at the Time of the (Person’s) Birth and Revolutions of the Years and so on.

13. **Tr.** *Miftāḥ ‘ilm al-hay’a.*

The Key of the Science of Astronomy.

14. **B.** *Tahdhīb fuṣūl al-Farghānī.*

Correction of Farghānī’s Kitab al-Fuṣūl.

15. **B.** *Ifrād al-maqāl fī amr al-ẓilāl.*

The Exhaustive Treatise on Shadows.

16. **B.** *Isti‘māl dawā‘ir al-sumūt li istikhrāj marākiz al-buyūt.*

Employing the Azimuthal Circles for Calculating the Centers of the Mansions.

17. **Tr.** *Ṭāli‘ qubba al-‘arḍ wa ḥālāt al-ṭhawābit dhawāt al-‘urūḍ.*

The Ascending Cupola of the Earth (qubba al-‘arḍ) and the Positions of Fixed Stars Endowed with Latitudes.

18. **Tr.** *I‘tibār miqdār al-layl wa al-nahār fī jami‘ al-‘arḍ li ta‘rīf kawn al-sana yawman taḥt al-quṭb bi ḡhayr tashkīl.*

Consideration of the Duration of Day and Night Worldwide to Make Known the Existence of the One-day-year under the Pole Without Formation.

19. **B.** *Taḥdīd nihāyāt al-amākin li taṣḥīḥ masāfāt al-masākin.*

Fixation of the Limits of the Places for Correcting the Distances of the Habitats.

20. **B.** *Taḥdhīb al-aqwāl fī taṣḥīḥ al-‘urūḍ wa al-aṭwāl.*

Purification of the Remarks on the Correction of the Latitudes and Longitudes.

21. **Tr.** *Taṣḥīf al-manqūl min al-‘arḍ wa al-ṭūl.*

Distortions in What is Remarked about Latitudes and Longitudes.

22. **Tr.** *Taṣḥīḥ al-ṭūl wa al-‘arḍ li masākin al-ma‘mūr min al-‘arḍ.*

Correction of the Longitudes and Latitudes as for the Inhabited Zones of the Earth.

23. **Tr.** *Ta‘yīn al-balad min al-‘arḍ wa al-ṭūl kilāhumā.*

Determining Both the Latitudes and Longitudes of the Cities.

24. **Tr.** *Istikhrāj qadr al-‘arḍ bi raṣad inḥiṭāṭ al-ufuq ‘an qulal al-jibāl.*

Calculation of the Amount of the (Circumference) of the Earth by Observing the Dip of the Horizon from above the Mountain Peaks.

25. **Tr.** *Ḡhurūb al-ṣhams ‘ind manārat Iskandarīya.*

The Sunset from the Lighthouse of Alexandria.

26. **Tr.** *Al-ikhtilāf al-wāqi‘ fī taqāsīm al-aqālīm.*

Disagreements Happened in the Divisions of the Climes.

27. *Ikhtilāf dhawi al-faḍl fī istikhrāj al-‘arḍ wa al-mayl.*

Disagreements of the Learned people in Calculating Latitude and Inclination.

28. **B.** *Al-ajwibah wa al-as'alah li taṣḥīḥ samt al-qibla.*

Questions and Responses for the Correction of the Direction of the Qibla.

29. **Tr.** *Īdāḥ al-adilla 'alā kayfīya samt al-qibla.*

Clarification of the Reasons (Presented) on the quality of the Direction of Qibla.

30. **Tr.** *Tahdhīb shurūṭ al-'amal li taṣḥīḥ sumūt al-qibal.*

*Rectification of the **Operation Conditions** in Correcting the Directions of Qiblas.*

31. **Tr.** *Taqwīm al-qibla bi Bust bi taṣḥīḥ ṭūlihā wa 'arḍihā.*

Determination of the Qibla in Bost (a City in Sistan) by Correcting its Longitude and Latitude.

32. **Tr.** *Al-inbi'āth li taṣḥīḥ al-qibla.*

Embarking upon the Correction of the Qibla.

33. **???** *Talāfī 'awāriḍ al-zilla fī kitāb dalā'il al-qibla.*

Compensation for the Errors Made in the Book The Guide to Qibla (Dalā'il al-qibla).

34. **Tr.** *Tadhkirat fī al-ḥisāb wa al-adad bi arqām al-Sind wa al-Hind.*

Memoir on Counting and Numeration by the Sind Hind Digits.

35. **B.** *Istikhraj al-ki'āb wa aḍlā' mā warā' ahū min marātib al-ḥisāb.*

Calculation of Cubes and the Higher Roots at the Levels of Calculation.

36. **???** *Kayfīya rusūm al-Hind fī ta'allum al-ḥisāb.*

The Quality of the Indian Manners of Learning Calculation.

37. **Tr.** *Anna ra'y al-'arab fī marātib al-'adad aṣwab min ra'y al-Hind fihā.*

That the Arabic Opinion of the Levels of Numbers is More Correct than That of the Indians.

38. **Tr.** *Rāshikāt al-Hind.*

The Indian Rules of Proportions (Rashikat).

39. **Tr.** *(skl...?) al-a'dād.*

On (skl...?) of Numbers.

40. **Tr.** *Mā fī Barāham siddihānd min ṭuruq al-ḥisāb.*

What is in Brahmasiddhanta on the Methods of Calculation.

41. ??? *Manṣūbāt al-ḍarb.*

The Methods of Multiplication.

42. **Tr.** *Tajrīd al-shu‘ā‘āt wa al-anwār ‘an al-faḍā’ih al-mudawwana fī al-asfār.*

Keeping the Rays and Lights Far from the Scandals Compiled in the Books.

43. **Tr.** *Taḥṣīl al-shu‘ā‘āt bi ab‘ad al-ṭuruq ‘an al-sā‘āt.*

Obtaining the Rays from Sundials by the Least Likely Methods.

44. **Tr.** *Maṭraḥ al-shu‘ā‘ thābitan ‘alā taghayyur al-biqā‘.*

The Projection Place/ Projectio Radiorum of the Rays in an Unchanging Manner Despite the Changing Places.

45. **Tr.** *Tamhīd al-mustaqarr li taḥqīq ma‘nī al-mamarr.*

Preparation of the Established (Mustaqar)/ Preparing the Ground for the Inquiry of the Signification of the ‘Passage’ (Mamar).

46. **B.** *Istī‘āb al-wujūh al-mumkina fī ṣan‘a al-aṣṭurlāb.*

A Comprehensive Study of the Possible Ways of Making Astrolabes.

47. **Tr.** *Tashīl al-taṣḥīḥ al-aṣṭurlābī wa al-‘amal bi murakkabātihī min al-shamālī wa al-janūbī.*

Fascilitation of the Astrolabic Correction and Employing its Northern and Southern Combinations/ Types.

48. **Tr.** *Taṣḥīḥ al-ṣuwar wa tabḥīḥ al-kuwar.*

Projection plane/ Map projection of the Constellations and Regions.

49. **Tr.** *Fīmā ukhrija mā fī quwwa al-aṣṭurlāb ilā al-fī‘l.*

On the Actualization of What is Potential in the Astrolabes.

50. **Tr.** *Istī‘māl al-aṣṭurlāb al-kurī.*

On the Use of/ Employing the Spherical Astrolabes.

51. **Tr.** *Ta 'bīr al-mīzān li taqdīr al-azmān.*

Indication of the Balance for Measuring Time.

52. **B.** *Taḥṣīl al-ān min al-zaman 'ind al-Hind.*

Getting/ Making Known the Idea of the Moment of Time According to the Indians.

53. **Tr.** *Tadhkira fī al-irshād ilā ṣawm al-naṣārā wa al-a 'ayād.*

Memoir on Guidance on the Christian Fasts and Feasts.

54. **Tr.** *Al-i 'tidhār 'ammā sabaqa lī fī tārikh al-Iskandar.*

Apology for What I Have Already Written about the Era of Alexander.

55. **B.** *Takmīl ḥikāyā 'Abd al-malik al-Ṭabīb al-Bustī fī mabda' al- 'ālam wa intihā 'ihī.*

The Accomplishment of the Anecdotes Related by Abd al-Malik al-Tabib al-Bosti on the Origin and the End of the World.

56. **Tr.** *Dilāla al-āthār al- 'ulwīya 'alā al-aḥdāth al-suflīya.*

Indication of the (Impact of the) Celestial Phenomena upon the Lower Events.

57. **B.** *Ibṭāl ḡunūn fāsida khaṭarat 'alā qulūb ba 'ḍ al- 'aṭibbā' fī amr al-kawākib al-hāditha fī al-jaww.*

Falsification of the Corrupted Doubts Occurred to the Minds of Certain Physicians Concerning the Stars Appearing in the Atmosphere.

58. **Tr.** *Al-kalām 'alā al-kawākib dhawāt al-adhnāb wa al-dhawā 'ib.*

Remarks on Comets and Maned Stars.

59. **Tr.** *Maḍī'āt al-jaww al-hāditha fī al- 'alw.*

Luminous Bodies Appearing High in the Atmosphere.

60. **Tr.** *Taṣaffuḥ kalām Abī Sahl al-Qūhī fī al-kawākib al-munqaḍa.*

The Scrutiny of Abī Sahl Kūhī's Remark on Shooting Stars.

61. **B.** *Taḥqīq manāzil al-qamar.*

Research on the Lunar Mansions.

62. **B.** *Al-faḥṣ ‘an nawādir Abī. Ḥaḥṣ Umar Ibn Farrukhān.*

Examination of the Rare Points of Abī Ḥaḥṣ (/Dadui) Umar Ibn Farrukhan (Ṭabarī).

63. **Tr.** *Al-nisab allati bayn al-filizzāt wa al-jawāhir fī al-ḥajm.*

Proportions between Metals and Gems According to Volume.

64. **B.** *Istikhrāj al-awtār fī al-dā’ira bi khawāṣṣ al-khaṭṭ al-munḥanī fihā.*

Calculation of the Cords in the Circle by the Properties of the Curved Line in It.

65. **Tr.** *Tadhkira fī al-masāḥa li al-musāfir al-muqawwī.*

Memoir on Surveying for an Estimator Wayfarer.

66. **Tr.** *Naql khawāṣṣ al-shakl al-qaṭṭā’ ilā mā yughnī ‘anhu.*

Transferring Properties of the Transversal Figure to What (the Figure) Dispenses Us With.

67. **Tr.** *Anna lawāzīm tajzī’ al-maqādīr lā ilā nihāya qarība min amr al-khaṭṭayn al-ladhīna yaqrabān wa la yaltaqīyān fī al-istibād.*

That the Consequences of the Ad infinitum Division of the Qualities Would Seem As Strange As the Case of the Two Lines that Approach But Do Not Meet.

68. **Tr.** *Ṣifa asbāb al-sukhūna al-mawjūda fī al-‘ālam wa ikhtilāf fuṣūl al-sana.*

Description of the Causes of the Heat Existing in the World and the Differences Between the Seasons of the Year.

69. **Tr.** *Al-baḥṭh ‘an al-ṭarīqa al-muta‘arrafa al-madhkūra fī kitāb al-āthār al-‘ulwīya.*

Discussion on the Known Method Mentioned in the Book, Meteorology.

70. **B.** *Al-masā’il al-balkhīya fī al-ma‘ānī al-muta‘allaqa bi inkisār al-ṣinā’a.*

Bakterian Questions on the Sense Attached the Fracture of the Art... (?).

71. **B.** *Al-jawābāt ‘an al-masā’il al-wārida min munajjimī al-Hind.*

Answers to the Questions Addressed to Him by Indian Astronomers.

72. **???** *Al-jawābāt ‘an al-masā’il al-‘aṣhr al-kashmīrīya.*

Answers to the Ten Kashmiri Questions.

73. **B.** *Al-tafhīm li awā’il ṣinā’a al-tanjīm.*

Instruction for the Elements of the Art of Astrology.

74. **Tr.** *Taqṣīṭ al-quwā wa al-dalāla bayn ajzā' al-buyūt al-athnā 'ashar.*

Equal Partitioning of the Strength and the Significations among the Divisions of the Twelve Houses.

75. **Tr.** *Ḥikāya ṭarīq al-Hind fī istikhrāj al-'umr.*

The Account of the Indian Method for Calculating One's Age.

76. **Tr.** *Sayr saḥmay al-sa'āda wa al-ghayb.*

Directing the Part of Happiness and of the Unseen.

77. **Tr.** *Al-irshād ilā taṣḥīḥ al-mabādī' ishtamala 'alā al-namūdhārāt.*

Guidance to the Correction of the Elements Including the (Astrological) [Indications/](#)
[Diagrams](#).

78. **Tr.** *Tabyīn ra'y Baṭlamyūs fī al-Sālkhudāh.*

Explanation of Ptolemy's Opinion about the Lord of the Year (Salkhodah).

79. *Al-mawālīd li Barāhīmīhr.*

T. of *The booklet of Horoscopes by Varahamithra.*

80. *Wāmiq wa 'Adhrā.*

T. of *The Story of Wamiq and 'Azra.*

81. *Qasīm al-surūr wa 'ayn al-ḥayāt.*

T. of *The Story of Qasīm al-surūr (the Allotted-with-joy) and 'ayn al-ḥayāt (the Life-Spring).*

82. *Urmuzdyār wa Mihryār.*

T. of *The Story of Urmozdyar and Mihryar.*

83. *Ṣanamay al-Bāmīyān.*

T. of *The Story of the Two Idols of Bamyan.*

84. *Dādhmeh wa Karāmī dukht Ḥ?hlī al-wādī.*

Translation of The Story of Dazmeh and Garamidikht... (?).

85. *Nīlūfar fī Qiṣṣa Dabīstī wa Barbuhākīr.*

T. of *The Story of the Lotus (Nilufar) in the Tale of Dabisti and Barbohakir.*

86. ??? *Qāfīyat al- 'alif min al-itmām fī shi'r Abī. Tammām.*

Verses Rhymed in the Letter Alif from the Final Section of Abū Tammām Taī's Divan./ A Commentary of Verses Rhymed in the Letter Alif from the Complete Book on the Poetry of Abū Tammām Taī.

87. *Al-istibhār fī qadd al-ashjār.*

T. of *The Treatise, Skillfulness in Cutting the Trees (Longitudinally).*

88. *Taḥṣīl al-rāḥa bi taṣḥīḥ al-masāḥa.*

T. of *Gaining Repose Through the Correction of Land-surveying.*

89. *Al-taḥdhīr min qibal al-Turk.*

T. of *Warning about the (Eastern) Turks.*

90. *Al-qur'a al-muṣarraḥa bi al- 'awāqib.*

T. of *Casting Lots, Revealing the Consequenses.*

91. *Al-qur'a al-muṭḥammana li istinbāṭ al-ḍamā'ir al-mukḥammana wa sharḥ mazāmīr al-qur'a al-muṭḥammana.*

T. of *(Casting) the Eight-sided Lot for Inferring the Suspected Minds, and an Account of the Psalms of the Eight-sided Lot.*

92. *Kalab Yāreh wa huwa maqāla li al-Hind fī al-amrāḍ allatī tajrī majray al- 'ufūna.*

T. of *Kalab Yāreh, an Indian Treatise on the Diseases Causing Infection/ Resembled to Infection.*

93. **B.** *Taḥqīq mā li al-Hind min maqāla maqbūla fī al- 'aql aw mardhūla.*

India: the Inquiry of Whatever Pertaining to It, from Remarks Accepted by Reason or Rejected by Reason./ Critical Study of What India Says, Whether Accepted by Reason or Refused

94. **Tr.** *'Illa 'alāmāt al-burūj fī al-zījāt min ḥurūf al-jummal.*

The Cause of the Designation of the Zodiac Signs by Means of the Jummal Letters (Alphabets) in the Zigs.

95. **Tr.** *Kalām fī al-mustaqar wa al-mustawda '.*

Exposition of the Established and the Deposited/ Trustee.

96. **Tr.** *Bāsdīw al-Hind 'ind majī'ihī al-adnā.*

The Indian Savior, Vāsudeva, When His Coming Approaches.

97. Kitāb shāmil fī al-mawjūdāt al-maḥsūsa wa al-ma‘qūla.

T. of A Comprehensive Book on Sensible and Intelligible Beings

98. Kitāb Bātanjalī fī al-khalāṣ min al-irtibāk.

T. of The Book Patanjali on Deliverence from Entanglement.

99. **B.** Al-tanbīh ‘alā ṣinā‘a al-tanwīl wa hīya aḥkām al-nujūm.

Warning about the Art of Misrepresentation, i.e. Astrology.

100. ??? Tanwīr al-minhāj ilā taḥlīl al-azyāj.

Illumination of the Path to the Analysis of the Zigs.

101. ??? Al-taṭarruq ilā taḥqīq ḥaraka al-shams.

Seeking a Way to the Study of the Motion of the Sun.

102. ??? Al-burhān al-munīr fī a‘māl al-tasyīr.

Luminous Demonstration Concerning the **Operations** of Astrological **Direction**.

103. **B.** Tanqīḥ al-tawārīkh wa amthāl dhālika.

Correction of the Dates and the Like.

104. **B.** Al-qānūn al-Mas‘ūdī.

Mas‘ūdī Canon (for Sultan Mas‘ūd Ibn Maḥmūd Ghaznavī).

105. **B.** Al-āthār al-bāqīya min al-qurūn al-khālīya.

Vestiges of the Past (the Chronology of Ancient Nations).

106. ??? Al-irshād ilā mā yudrak wa lā yunāl min al-ib‘ād.

Guidence to that which is Percieved (But) Not Attained because of Distance.

107. ??? Al-kitāba fī al-makāyīl wa al-mawāzīn wa sharā’iṭ al-ṭiyār wa al-shawāhīn.

The Writing on Measures and Weights and the Conditions of the Indices and Beams.

108. ??? Jam‘ al-ṭuruq al-sā’ira fī ma‘rifa awtār al-dā’ira.

Gathering the Current Methods on the Knowledge of the Circle Chords.

109. ??? Taṣawwur amr al-fajr wa al-shafaq fī jihatay al-sharq wa al-gharb min al-ufuq.

The Conception of the Phenomena of Dawn and Twilight in the Two Directions of the East and the West of the Horizon.

110. ??? *Takmīl ṣinā'a al-tasfīh.*

Perfection of the Art of Projection-plane.

111. ??? *Jalā' al-adhḥān fī zīj al-Battānī.*

Polishing the Minds Concerning Albategnius (Al-battānī's) Zīg (of Sabi).

112. ??? *Taḥdīd al-mā'mūra wa taṣḥīḥuhā fī al-ṣūra.*

Delimitation of the Inhabitable Zones of the World and Its Correction for Mapping/ Map projection

113. ??? *Ilal zīj Ja'far al-Mukannā bi Abī Ma'shar.*

Defects of the Zīg by Ja'far Known by the Surname of Abū Ma'shar (Balkhi).

Works dedicated to him by Abū Naṣr 'Irāq.

114. **B.** *Al-sumūt.*

The Azimuth.

115. **B.** *'Illat taṣnīf al-ta'dīl 'ind 'aṣḥāb al-Sindhind.*

Reason for Halving the Equation by the Followers of Sidhanta.

116. **B.** *Taṣḥīḥ kitāb Ibrāhīm Ibn Sinān fī taṣḥīḥ ikhtilāf al-kawākib al-'ulwīya.*

Correction of Ibrahim Ibn Sinan's Book on the Corection of the Dissimilitude of the Upper Planets.

117. **Tr.** *Barāhīn a'māl Ḥabash bi jadwal al-taqwīm.*

Demonstrations of Ḥabash al-Hāsib's Efforts at His Table of Rectification.

118. **Tr.** *Taṣḥīḥ mā waqa'a li Abī Ja'far al-Khādhin min al-sahw fī zīj al-ṣafā'ih.*

Correction of the Mistakes Abū Ja'far Khazin Has Made in the Tables of the Disks/Plains/ Spiders (Zīgs of Safa'ih).

119. **Tr.** *Mujāzāt dawā'ir al-sumūt fī al-aṣṭurlāb.*

Passages of the Azimuth Circles in the Astrolabe.

120. **Tr.** *Jadwal al-daqa'iq.*

The Table of Minutes.

121. **Tr.** *Al-barāhīn ‘alā a‘māl Muḥammad Ibn al-Ṣabbāḥ fī imtiḥān al-shams.*

Demonstrations on the Efforts by Muḥammad Ibn Ṣabbāḥ into Examining the Sun.

122. **Tr.** *Al-dawā’ir allatī taḥuddu al-sā‘āt al-zamānīya.*

The Circles that Delimit the Temporal Hours.

123. **Tr.** *Al-burhān ‘alā a‘māl Ḥabash fī maṭālī ‘al-samt fī zījīhī.*

Demonstration on the Effort by Ḥabash al-Ḥasib into the Ascension of Azimuth in his Zigs.

124. **Tr.** *Ma‘rifa al-qusī al-falakīya bi ṭarīq ghayr ṭarīq al-nisba al-mu‘allaḥa.*

Knowledge of the Spherical Arches by a Method Other Than Composed Proportion.

125. **Tr.** *Ḥall shubha ‘araḍat fī al-thalātha ‘ashar min kitāb al-uṣūl.*

Solving a Difficulty Presented in the Thirteenth Treatise of Euclid’s Book, Principles.

Works dedicated to him by Abū Sahl Masīhī

126. **B.** *Mabādi’ al-handasa.*

Elements of Geometry.

127. **B.** *Rusūm al-ḥarakāt fī al-ashyā’ dhawāt al-waḍ‘.*

Rules of Motions in the Objects with Positions.

128. **B.** *Sukūn al-arḍaw ḥarakatuhā.*

The Earth, at Rest or Moving?

129. **B.** *Al-tawassuṭ bayn Arasṭūṭālīs wa Jālīnūs fī al-muḥarrik al-awwal.*

Mediation Between Aristotle and Galen Concerning the First Mover.

130. **Tr.** *Dilāla al-lafẓ ‘alā al-ma‘nī.*

Signification of Words (Semantics).

131. **Tr.** *Sabab bard ayyām al-‘ajūz.*

The Cause of the Coldness of the Old Woman’s Days.

132. **Tr.** *‘Illa al-tarbīya (?) allatī tusta‘mal fī aḥkām al-nujūm.*

The Cause of the Amelioration (/Lord-making?) Employed in Astrology.

133. **Tr.** *Ādāb ṣuḥba al-mulūk.*

Manners of Companionship of the Kings.

134. **Tr.** *Qawānīn al-ṣināʿa.*

Canons of the Art.

135. **Tr.** *Dastūr al-khaṭṭ.*

Instructions as for (Geometric) Line.

136. **Tr.** *Al-ghazalīyāt al-shamsīya.*

The Solar Risings.

137. *Al-risāla al-Narjisīya.*

Book of Narges (Qābūs Daughter?).

138. *Al-risāla al-muʿanwana bi min wa ʿan.*

Treatise Entitled as Min and ʿAn (Dedicated by Abū ʿAlī Gili).

B

Appendix catalogue

139. ??? *Istīʿāb fī tasḫīḥ al-kura.*

A Comprehensive Study on Projection-plane/ Map projection of Spheres.

140. ??? *Al-zīj al-ʿAlāʾī.*

The ʿAlāʾī's Zigs (for ʿAlāʾ al-Dīn Nīshābūrī).

141. *Al-zīj al-masʿūdī.*

The Masʿūdī Zigs (perhaps the same as no. 104).

142. **B.** *Tasḫīḥ al-kura.*

Projection-plane/ Map projection of Spheres.

143. **B.** *Al-durar fī saḥḥ al-ukar.*

Precious Pearls about the Surface/ Projection of Spheres.

144. ??? *Ikhtīṣār al-majisṭī.*

Abridgement of Almagest (notes on Ptolemy's work).

145. **B.** *Lawāzim al-ḥarakatayn.*

The Necessary consequences of the Two Motions.

146. **B.** *Al-istishhād bi ikhtilāf al-arṣād.*

Calling to Evidence by Differences in Observations.

147. **Tr.** *Masā'il sa'ala 'anhā Ibn Sīnā/ Al-as'alah wa al-ajwibah.*

The Questions and the Responses by Biruni and Ibn Sīnā.

148. **B.** *Al-shumūs al-shāfiya li al-nufūs.*

Healing Songs for Souls.

149. **???** *Irshād fī aḥkām al-nujūm.*

Guidence to Astrological judgments.

150. **B.** *Tārikh ayyām al-sulṭān Maḥmūd wa akhbār abihī.*

History of the Time of Sultam Maḥmūd And His Father.

151. **Tr.** *Ṣafīḥa al-tasyīr.*

The Disk/ Plate/ Spider of Directing.

152. **B.** *Al-madkhal ilā 'ilm al-nujūm wa 'alā ḥudūd al-nuḥūs wa al-mawāḍi' al-qāti'a bi al-tajārib.*

An Introduction to Astrology and the Limits of Good Fortune and Misfortune and the Definitive Positions According to Experience.

153. **B.** *Al-'ajā'ib al-ṭabī'iya wa al-gharā'ib al-ṣinā'iya.*

Natural Mirabilia and Artificial Marvels (i.e. cosmography).

154. **B.** *Taqṣīm al-aqālīm.*

Divisions of the Climes.

155. **B.** *I'tibār miqdār al-layl wa al-nahār bi tarīq tab'udu 'an muwāḍa'āt al-munajjimīn wa alqābihim.*

Consideration of the Duration of Night and Day by a Method Far From the Conventions and the Terms of Astronomers.

156. **B.** *Al-jamāhir fī al-jawāhir.*

Gems.

157. **B.** *Nuzha al-nufūs wa al-afkār fī khawāṣṣ al-mawālīd al-thalātha al-ma'ādin wa al-nabāt wa al-aḥjār.*

'Pleasure of the Souls and Thoughts' on Properties of the Three Kingdoms of Nature: Minerals, Plants, and Stones.

158. **B.** *Al-ṣaydana fī al-ṭibb.*

'Pharmacy' on Medicinal Herbs.

159. **B.** *Al-ḥijār.*

Minerology.

160. **B.** *Al-musāmara fī akhbār Khwārazm.*

Nightly Conversations Concerning the Affairs of Khwarazm.

161. **???** *Akhbār al-Muqanna'.*

Translation of the Reports of (Hāshim Ibn Ḥakīm) al-Muqanna'.

162. **B.** *Akhbār al-Mubayida wa al-Qarāmiṭa.*

Reports of the White-robed and Karmatians.

163. **B.** *Sharḥ shi'r Abī Tammām.*

Commentary on Abū Tammām Tā'ī's Poetry.

164. **B.** *Al-ta'allul bi iḥāla al-wahm fī ma'ānī naẓm ulu al-faḍl.*

Justification Through Transferring the Imagination in the Significations of the Poetry of the Learned People.

165. **B.** *Mukhtār al-ash'ār wa al-āthār.*

Selection of the Verses and Narrations.

166. *Majmū'a min al-ash'ār.*

Miscellany of Bīrūnī's Poems.

167. **B.** *Al-dastūr.*

The Rules (c. no. 135).

168. **Tr.** *Fihrist kutub Muḥammad Ibn Zakarīyā' al-Rāzī.*

Catalogue of the Books by Muḥammad Ibn Zakariyā Rāzī.

169. *Ḥikāya al-āla al-musammāt al-suds al-Fakhrī.*

Account of the Instrument Named the Sextant Fakhrī (innovated by Abū Maḥmūd Khujandī).

170. *Rīyāḍa al-fikr wa al-‘aql.*

Exercise of Thought and Reason.

171. *Ajwibah al-masā’il al-khwārizmīya.*

Responses to the Questions Made by the Khwarazmians.

172. *Al-i ‘tirāḍ ‘alā kitāb Ibn Sīnā fī Ḥujja al-Ḥaqq.*

Objections to Ibn Sīnā’s Book and His Title Ḥujja al-Ḥaqq.

173. *Majmū‘a min al-ḥikam.*

Miscellany of Bīrūnī’s Aphorisms.

174. *Kitāb Sāmkhīya.*

T. of *The Book Sāmkhīya.*

175. *Uṣūl al-handasa li-Uqlīdus ilā lugha al-Hind.*

T. of *Euclid’s Elements of Geometry into Sanskrit.*

176. *Al-majistī li Baṭlamyūs ilā lugha al-Hind.*

T. of *Ptolemy’s Almagest into Sanskrit.*

177. *Al-aṣṭurlāb li Abī Rayḥān ilā lugha al-Hind.*

T. of *Bīrūnī’s Book Astrolabe into Sanskrit.*

178. *Risāla Abī Naṣr fī jawāb masā’il al-handasa.*

Answers to Geometrical Questions (by Abū Naṣr ‘Irāq).

179. *Faṣl min kitāb li Abī Naṣr fī kurrīya al-samā’.*

A Chapter of Abū Naṣr ‘Irāq’s Book on the Sphericity of the Sky.

180. *Kitāb Abī Rayḥān ilā Abī Sa‘īd.*

Kitāb by Abu Rayhan to Abī Saeid Sajzi (a letter on spherical trigonometry).

181. *Ghurra al-zījāt.*

T. of *The Highlighted Zigs (Skt. Bejjanand Banarsi) into Arabic.*

182. *Al-luma ‘āt.*

The Bright Lights (on optics).

183. *Tarjuma mā fī Pulisat Sedhānta.*

T. of *What is in Pulisat- Siddhānta into Arabic.*

184. *Ārā' al-mutaqaddimīn... (?)*.

Opinions of the Predecessors... (?).

185. *Taṣwīr al-kawākib wa al-buldān,*

Illustration of the Stars and the Cities,....

2. Epistemology

1. Through other eyes

Bīrūnī has been considered as one of the greatest scholars of the east and, with respect to all aspects of his knowledge, as one of the most celebrated scholars of all ages. He was well-known in France, as Maitre Aliboron (the master Bīrūnī), and in the whole Europe throughout the middle ages.³ George Sarton regards the first half of the fifth century A.H./ eleventh century A.C. as ‘the age of Bīrūnī’, the summit of mediaeval thinking, since the great figures of sciences at this time outnumber so much that it makes the historian distressed. Still, among the great names two men appear more outstanding: Bīrūnī and Ibn Sīnā because of whom the age looks so glorious. Bīrūnī appears more as a critical researcher, while Ibn Sīnā looks more like a synthesizer- an organizer philosopher and an encyclopedic scholar. As a matter of fact, Bīrūnī is more similar to our conception of a modern researcher. They were both great men of knowledge; however, Bīrūnī is a better representative of that age.⁴

Edward Sachau says that he believes there was something of a modern researcher in Bīrūnī which is more similar to the critical spirit of the nineteenth century. Carra de Vaux (1867-1953) maintained that Bīrūnī had more to do with our time than his own age, because, despite the distance in time, his ideas seem new at this time. He concluded that Bīrūnī, having the same status as the world’s great thinkers such as Da Vinci and Leibniz, was a meticulous critic and an insatiable learner gathering different branches of knowledge: philosophy, history, exploration, multilingualism, narrations, literature, mathematics, astronomy and geography.⁵ German scholars have compared Bīrūnī with Gottfried Leibniz (1646-1716), both completely distinct from their contemporaries because of their remarkable works in different branches of science and their most-lasting influence on the minds of successive generations.⁶

Among Iranian advocates of Bīrūnī, Ḥakīm Ghāḍanfar Tabrīzī (7th/ 14th century), admires him as “that unique, seldom found man and [that] profound abounding sea, [that] shining bright moon”, and remarks that he was too high-ranking to be known.⁷ The Iranain professor Reza, regards Bīrūnī’s thoughts as an amalgamation of the wisdom of India, Iran, Greece and other Islamic countries at his time, the dynamic thinking which exerted great influence on the

³*Les penseurs de l’Islam* (Carra de Vaux), Paris, 1921, t. II, p. 75.

⁴*Introduction to the...* (G. Sarton), I, p. 690./*Moqaddame bar tārikh-e ‘elm* (Fārsi), vol. 1, p. 795.

⁵*Les penseurs de l’Islam* (C. de Vaux), t. II, pp. 75-76./ *Biruni Symposium*, (ar. G.H. Youssefi), p. 13.

⁶*The Commemoration Volume of Biruni International Congress in Tehran*, 1976, (ar. H. R. Rome), p. 190./*The Scholar and the Saint....* (ar. id. R. Roemer), p. 95 ff.

⁷*Al-maṣhāṭa li risāla al-fihrist*, (ed.) Mehdi Moḥaqqueq, Tehran University, 1336, pp. 78, 103./ *Chronologie Oriental...* (Vor.E. Sachau), p. XVI.

knowledge of centuries.⁸ It will undoubtedly require generations of scholars to evaluate his works and knowledge.⁹

2. Science for the sake of science

“In early youth, I found the chance to be at the service of knowledge...”¹⁰, Bīrūnī’s refers to himself as ‘a servant of science’ which reveals his true scientific humbleness. He adds that the only superiority of man over other animals is knowledge which is a source of arguments for human being, and that knowledge is required in itself through which true happiness and joy is achieved exclusively.¹¹ In his translation of *Patanjali*, he notes that when a subject is potentially unknown in the knowledge, the desire to know it increases, then the knowledge is gained and the desire is satisfied.¹² He was the great advocate of sheer knowledge and its benefits for man’s perfection. Accordingly, he can be said to believe in the slogan ‘science for the sake of science’ with respect to the aim of perfection.¹³ He recognizes knowledge as the most sublime power (al-‘ilm ya‘lū wa lā yu‘lā ‘alayh: *lit.* knowledge transcends and shall not be transcended over).¹⁴ Viewing science in the divine light, he proceeds so far as to describe knowledge the same as divine attributes.¹⁵

Bīrūnī’s free thinking was never corrupted by greed and need. He could be mentioned as the only exemplary scientist in the 5th/11th century who lived with absolute sincerity toward science and a deep faith in his responsibility. As it were, he refused to accept the kingly reward for the compilation of *Al-qānūn*.¹⁶ ‘Monarch of science’ was the becoming title he was given, as ‘Arūḍī Samarqandī reports, by the anti-science Maḥmūd Ghaznavī after he set

⁸*Yādnāme-ye Bīrūnī* (majmu‘e-ye sokhanrānīhā-ye Fārsi), Tehran, shorā-ye ‘āli-ye farhang va honar, 1353/1974, p. 276.

⁹*al-Biruni Commemoration Volume* (A. H. 362- A. H. 1362), Calcutta, Iran Society, 1951, (ar. M. Abdur Rahman), p. 175.

¹⁰*Al-qānūn al-Mas‘ūdī*, (ed.) dā‘irat al-ma‘ārif al-uthmāniya, Ḥaydar Ābād al-Dakan, 1373 A.H./ 1954 A.D., vol. 1, p. 3.

¹¹*Taḥdīd nihāyāt al-amākin*, Cairo, 1962 A.D./ 1382 A.H., p. 23./ Persian tr. Aḥmad Ārām, 1352, p. 2.

¹²*Patanjali*, (ed.) Helmut Ritter and Ṣadūqī Suhā, 1379, p. 34.

¹³*Payām-e yunesko*, no. 59, (tr. Sayyid Hossein Naṣr), p. 40.

¹⁴*Tārīkh-e Beyhaqi* (Abulfāḍl Monṣhi), (eds) Qāsem Ghani & ?? Fayyād, Tehran, 1324, p. 670./ *Mu‘jam al-udabā’* (Yāqūt Ḥamavī), vol. 17, p. 183./ *Zendegināme-ye Bīrūnī* (al-Shābbī), p. 36.

¹⁵*The Commemoration Volume* (ar. F. Rosenthal), p. 541.

¹⁶*Tatimmat ṣawān al-ḥikmat* (Zahīr al-dīn Bayhaqī), Lahur, 1351 A. H., p. 62./ *Mu‘jam al-udabā’*, vol. 17, p. 181.

the scholar free: “If you are going to enjoy my generosity, speak as I demand, not as your monarchy of science does.”¹⁷

Bīrūnī boasted his own knowledge, for instance:

“I strived to overtake all roaring pioneers,
For, unlike me, they failed to benefit from Knowledge.
Refusing to let themselves entrapped in complicated problems,
they failed to stand firm in the research station.
Ask for my ranking from Indians in the East,
And in the West, from those who tested my hard-working.”¹⁸

However, it should be noted that Bīrūnī considered science exclusively belonging to a certain group of people and went on to divide all communities into two groups of commoners and the elite, science being specific to the latter, because he believed that all people were not philosophers or intellectual enough to comprehend scientific subtleties. Common people always have an inherent tendency towards idolatry, ignorance and servitude, thinking only of the concrete, whilst the elite is always inclined to think about the intelligible and to scrutinize profound principles.¹⁹ It should be added that the difficulty of the comprehension of Bīrūnī’s scientific writings roots in this, as he admits that he writes for the ‘lovers of knowledge’ and does not care if others understand it or not, for it would make no difference to him.²⁰ Here is a piece of the treatise *Sayr saḥmay al-sa’ādat wa al-ghayb* (*Directing the Part of Happiness and of the Unseen*), explaining the slogan of science for the sake of science explicitly:

It is obligatory upon the servant of knowledge not to make a distinction between its different kinds, even if he is not gifted

enough to compass all of its disciplines. Indeed, he must know that knowledge as such is good essentially, and relatively (good) with regard to the objects of knowledge; that the pleasure of knowledge is eternal and unceasing; and that the pleasure of knowledge with respect to the object of knowledge is attained during the process of study and ceases at the time of knowing. Further, he must praise those earnestly engaged in inquiring after the contents of those kinds of knowledge whenever their efforts directed towards deriving pleasure from them, and deriving pleasure without the desire for victory in whatever debate happens to take place. He must not look at the work they have accomplished

¹⁷*Chahār maqāla*, (ed.) Moḥammad Mo‘in, Tehran, 1333, p. 94.

¹⁸*Mu‘jam al-udabā’*, vol. 17, p. 188.

¹⁹*Taḥqīq mā li al-Hind*, Ḥaydar Ābād al-Dakan, 1958 A. D., pp. 18-19, 23, 29, 474./ *India, Sachau, pp.*,
.....

²⁰*Al-maṣhāṭa li risāla al-fihrist* (Ghaḍanfar), pp. 107, 205.

with a scornful eye. Rather, in their accomplishments, he must make it his purpose to learn (from them) and to gain the strength to accept guidance (from them), so that he may take what is best and most correct and avoid whatever differs from established facts.²¹

3. Various aspects

Bīrūnī's time welcomed the high-ranking mathematician and teacher, with his various cultural and epistemological interests, as the central figure of the scientific movements of his time. The aspects of his knowledge were numerous: apart from knowledge of narations, he was a master of almost all fields of rational or positive, natural or experimental, human or social sciences. He used to concentrate on a certain branch for a while, and then changed his course of studies to start new subject. He never lost his sincerity in such diverse fields, rather he attempted to study each subject as a specialist. The title Maitre Aliboron (master Bīrūnī) in the medieval French writings is specific to this man of whole knowledge, the scholar who succeeded to analyze and infer the entire branches of science in Europe, Iran and Asia, and to establish a new basis for mutual understanding of the East and the West in the realm of human knowledge.²²

Although a great genius, Bīrūnī has not yet been awarded by the becoming recognition and admiration of our time. Brockelmann described him as the most extensive multidimensional and technical scientist of his own civilization.²³ Bīrūnī introduces himself, as it were, as the one whose reputation has travelled to the eastern and western corners of the world.²⁴ He is, accordingly, a good example of what he wrote once in praise of Qābūs Zīyārīd:

“It is undeniable that God has the power to combine
The whole world into one individual”.²⁵

4. Personality

Bīrūnī educated in the liberal atmosphere of Khwārazm and gained great achievements because of his brilliant mind and unique teachers, Abū Naṣr ‘Irāq and ‘Abd al-ṣamad Ḥakīm. The tradition of education that cherished the young pupil, convinced him of the overall truth of Greek knowledge; therefore, we should expect to find him seeking the truth mostly in the

²¹*The Commemoration Volume*, pp. 539, 551.

²²*Payām-e yunesko*, no. 59 (tr. Jaque Boilot), p. 4, 10.

²³*Geschichte der Arabischen Literatur*, SI, 1937, p. 870./ *Zendegīnāme-ye Bīrūnī* (Ali Al-shābbi), p.71.

²⁴*Mu‘jam al-udabā’* (Yaqut), vol. 17, p. 188./ *Zendegīnāme* (Al-shābbi), p. 81, 173.

²⁵*Al-āthār al-bāqiya*, (ed.) Azkaei, Tehran, 1380, p.4./ *Chronology*, p. 2.

Greek heritage of knowledge.²⁶ He starred, for a while, as the political counsel of the court of Khwārazm-Shāh where his political thinking revealed his smartness and his logical thinking.

As it were, the first half of the 5th/11th century was the age of great intellectual activity by the Iranian thinkers. It can be said that the spirit of that age best materialized in Bīrūnī's scientific works, Ibn Sīnā's philosophy and Firdawsī's epic poetry, though other Iranian scholars too attained brilliant achievements in this century.²⁷ Bīrūnī's scientific genius has been assessed greater than that of Ibn Sīnā²⁸ and, as far as the art of writing in Arabic is concerned, his works are evaluated to have increased the prestige of Arabic as an international language.²⁹ Finally, concerning the cultural extension of Persian, it should be stressed that Firdawsī and Bīrūnī, both surprisingly out of favor in the Ghaznavī court, increased the worldwide credit of Iranian literature and science.

Bīrūnī's firm belief in the cultural unity of peoples and the humane nature of science led him to the idea of the unity of minds, and introduced him 'greater than a scientist'; he was a great 'thinker' or, to be exact, both a thinker and a human.

5. The moral face

The truth-seeking investigator, if not bound up in mental obscurity, can naturally be expected to reveal prominent attributes such as iron will, moral brevity and truthfulness. Bīrūnī's strong will and mental ability, in addition to his Gnostic needlessness of the worldly wealth, as it were, can be inferred from the fact that he looked down upon the poet who praised him, responding his verse with insulting poems.³⁰ As a matter of fact, he was, more or less, an asperser in speech, and at the same time, a man of piety and good conduct. It should be noted that the same is true with many scholars and men of letters who are well aware of the boundry of what to know and what to do, as Goethe put it in these words: "I know no crime that I cannot commit".³¹ In his ethical ideas, Bīrūnī received no influence from Greek rational and natural thoughts, rather, he took human nature as a geometrical problem, as Baruch Spinoza (1632-1677) did, and put emphasis on individual inherent values, as Emanuel Kant (1724-1804) did so too.³²

²⁶*Biruni Symposium* (ar. F. Rosenthal), p.6./*The Scholar and the Saint* (ar. F. E. Peters), p. 19.

²⁷*Al-Qānūn al-Mas'ūdī*, vol. I, 1954, (ar. H. Winter), p. 1./ *al-Biruni Commemoration...*(ar. A. Pope), p. 285.

²⁸*Tārīkh al-falsafa fī al-islām* (??, ???) tr. 'Abd al-Hādī a. Rayda, 4th edition, Cairo, 1975, p. 250./ *Moqaddame bar tārīkh-e 'elm* (George Sarton), vol. 1, p. 795.

²⁹*Al-Biruni Commemoration...* (ar. L. Massignon), pp. 217-220.

³⁰*Mu'jam al-udabā'* (Yaqt), vol. 17, p. 189.

³¹*Tārīkh al-falsafa fī al-islām* (T. J. De Boer), (ed.) Abu Rayda, pp. 306-307.

³²*Journal of The Islamic Research Institute* (Pakistan), Vol. XIII, No. 4, Dec. 1974, (ar. S. H. Nadvi), pp. 259, 261.

“A wise man enjoys nothing but spiritual affairs, while an idiot, not aware of the reality of sensible affairs, compares them with joys and looks at the earthly ornaments –what seem so pleasant to the unspeaking animals and amuses them.”³³ We have already quoted from him that the joy of science is permanent, while bodily joys, rising from animal nature, obliterate human perfect virtues. We should add that in his *Al-jamāhir* (*Gems*), Bīrūnī’s face as an ethical teacher and a philosopher of ethics can be observed well, in addition to the other scientific dimensions of him such as gemology, and mineralogy. In general, Bīrūnī’s ethics rooted in his religious beliefs and his moral ideas were basically revelatory, not in accordance with any of the ancient Greek philosophers or modern European thinkers. Only Kant’s philosophy of ethics can be apparently compatible with Bīrūnī’s ideas, in that they both regard the good absolutely independent of experimental facts and natural laws. Also, compared with dialectic rationalists, Bīrūnī seems to have put more emphasis on intuitive facts than rational or experimental facts.³⁴

Apart from the golden rule which says ‘Never do what you would not like others to do to you, inferred from his ethical conduct and philosophical aphorisms, in items (or, in Bīrūnī’s term, *tarwīhas*, *lit.* ‘strolls’) 11 and 12 of *Al-jamāhir*, he withstands, in a revolutionary manner, against the kings (implicitly, Sultān Maḥmūd Ghaznavī and his destructions in India³⁵) who violate the principles of humanity and justice, saying that kings cannot be examples of virtues.³⁶ Bīrūnī’s hatred of oppression is further revealed by his criticism of a group of Shiites who, unlike the conduct of Alī Ibn Abī Ṭālib, cannot help joining the oppressors and offering them false praise.³⁷ Moreover, while discussing a point about the (trigonometric) shades, he comments, by way of digression, on the saying that “he Sultan is God’s shadow (ḡill Allāh) on the earth, that the saying is true about learned men sent with arguments and wisdom, not those reigning with coercion and domination. God as the creator Lord, must cast a shadow becoming of Him to act in accordance with people’s advantage. However, a person who destroys the earth intentionally (again implicitly the Ghaznavi Sultan) is actually God’s ‘foe’, not God’s ‘shadow’. Never! God’s shadow on the earth and such [brutal] behavior towards God’s creatures!”³⁸

The well-known rationalist character of our scholar can be inferred specially from his conscious anti-Arab stand, where he says: “I must not reproach the Hindus only with their heathen practices, for the heathen Arabs too committed crimes and obscenities”.³⁹ We should

³³ *Al-jamāhir fī jawāhir*, (ed.) Yūsif al-Hādī, Tehran, 1374 A. H., p. 84.

³⁴ *Journal of The Islamic Research Institute*, XIII, 4, (ar. S. H. Nadvi), pp. 253-257, 260, 261, 262.

³⁵ *Taḥqīq mā li al-Hind*, p. 16/ *India* (tr. E. Sachau), I, pp. XI, XXIII.

³⁶ *Al-jamāhir*, pp. 95-97./ *Journal...* (*ibid.*, ar. S. Nadvi), p. 258.

³⁷ *Al-āthār al-bāqīya*, p. 76./ *Chronology*, p. 79./ *ʿAndishmand va ensān* (Najafi&Khalili), p. 124.

³⁸ *Ifṛād al-maqāl fī ʿamr al-ḡalāl*, Rasāʾil al- Bīrūnī, (ed.) Dāʾirat al-maʿārif al-islāmīyat al-ʿuthmāniya, Ḥaydar Ābād al-Dakan, 1367 A. H., p. 8./ *The exhaustive treatise on shadows*, tr. & co. by E. S. Kennedy, Aleppo, 1976, vol. I, p. 45./ *Andishmand va ensān* (Najafi& Khalili), p. 127.

³⁹ *India* (pr. E. Sachau), p. XIX./ *Taḥqīq mā li al-Hind*, p. 148.

explain here that the comparison appears in the context of his writing implicitly enough to make Iranians admirably reputable, as Koro Yanaki considers the statement a hint of the scholar's (cultural) Shu'ubite tendency.⁴⁰ Among other instances of his patriotism are his severe attack on Qutayba Bāhilī, the invader who devastated Bīrūnī's homeland Khwārezm, his serious criticism against Ibn Qutayba Dīnvarī about the superiority of the Arab to the Ajams (non-Arab nations), his exposition that the 'mansions of the moon' are not peculiar to the Arab, and frequent quotations from the nationalist (Shu'ūbite) Iranian scholars.⁴¹ However, Bīrūnī does not exceed in his patriotism to crude prejudice and enmity of the Arabs- a good reason of his liberality and wisdom.⁴² We should finally add that his ethical belief that man has to be 'self-flourished', than 'self-made', is most comprehensibly understood from the fore-mentioned couplets, "O poet, who came to me..., / while , by God, I know not my lineage duely/ when, by right, I know not even my grandfather ... etc."⁴³

⁴⁰*Yādnāame-ye Biruni* (majmu'e-ye sokhanrānihā-ye Fārsi), Tehran, 1353 A. H., p. 60.

⁴¹See *Al-āthār al-bāqiya*, pp. 42, 57, 299, 431./ *Chronology*, pp. 42, 58, 226, 335.

⁴²*Tārīkh al-adab al-jughrāfī* (Ignati Krachkovski), tr. Ṣalāḥ al-dīn 'Uṭhmān Hāshim, Cairo, 1963, p. 251./ *Tārīkh al-falsafa fī al-islām* (De Boer), (ed.) Muḥammad 'abd al-Hādī Abū Rayda, p. 299.

⁴³See *Mu'jam al-udabā'* (Yaqut), vol. 17, p. 189./ *Zendegināme-ye Bīrūnī* (tr. Azkaei), pp. 67, 169.

3. Methodology

1. Objective experimentation

Western historians of science believe that scientific research based on modern method started in the history of the evolution of human thought exclusively after the Renaissance in Europe and the historical precedence is mostly given to Francis Bacon (1561-1626) who wrote some books on the methods necessary to follow in order to arrive at scientific conclusions. But the founder of the inductive methodology, though praising his method in lengthy phrases, actually carried out no investigation based on it. As a matter of fact, Bīrūnī had accomplished what the European scholars were trying to do in the sixteenth century. Six centuries earlier, he had viewed the old heritage, either rational or religious narrations, firstly through skepticism and had refused to presuppose their truth, unless it could be shown by sufficient personal inquiry that the reverse was not true through definite proofs.

However, we should note that Bīrūnī was not the only scholar who believed in the precedence of the application of “experimentum” (ʿiʿtibār). His contemporary scientist, al-Hazen (354-430/ 965-1038), has always been quoted as saying “truth can be sought only in propositions with concrete matter and rational form.”⁴⁴ By comparing al-Hazen with Bīrūnī, some researchers have investigated the relationship between research methodology in natural and human sciences and have taken the appearance of the two scientists as a unique phenomenon in the history of the Muslim culture five hundred years before Bacon.⁴⁵ In the same way that some centuries after Roger Bacon (1220-1292/ 1214-1294?), Rene Descartes (1596?-1650) compiled the method of experimentation, Bīrūnī was to be the founder of experimentation in science, rejecting pure rational speculation and relying solely on experiment and objective study. He was the first person who presented a developed research method in human sciences, viewing them through rationality and reason-seeking.

Bīrūnī’s methodology appears basically in the structure of his book, *India (Taḥqīq mā li al-Hind*, shortened as *Mā li al-Hind*). The preface, beginning with an allusion to the subject matter of the book, contains the most inclusive definition of observation as the fundamental basis of inductive method in social and natural inquiries: “In the name of God..., indeed the saying ‘hearsay does not equal eye-witness’ is true, because “the observer apprehends the substance of that which is observed, both in time when and in the place where it exists”.⁴⁶ We should add that in this definition, Bīrūnī summarizes two kinds of observation, that is passive observation (“in [the] time [...] it exists”) and active one (“in the place it exists”) in a way

⁴⁴*Zendegīnāme-ye ‘elmi-ye dāneshmandān-e ‘eslāmi*, vol. 1, pp. 135, 136.

⁴⁵It should, however, be added that in the realm of the methodology of the experimental sciences, Bīrūnī was a follower of the philosopher Rāzī (251-313 A. H.), especially his total acceptance of Rāzī’s ‘natural philosophy’. We have elucidated this in our *Rāzī the Sage* (Tehran, Tarh-e No, 2003), especially in the chapters “Methodology” (pp. 133-171) and “The natural philosophy” (pp. 269-378).

⁴⁶*Taḥqīq mā li al-Hind*, p.1./ *India*, I, p. 3.

more comprehensive and more exclusive than what positive methodologists have presented. The rules of Bīrūnī's method are (1) gathering materials based on objective, and documentary observation, (2) citing the references either to written texts or audition, and (3) evaluation and criticism of which he is the founder and the master. In fact, Bīrūnī made use of induction, observation or experimentation, analogy, and even sometimes, conjecture and intuition wherever needed in any science.⁴⁷

As he says, analogy "is circular from its starting point (i.e. premises) onwards, and the experience and the experiment of it are either continuous or discontinuous."⁴⁸ However, he did not believe in consensus of opinion and says "although this matter is obtained through successive hearsay, the truth will be confirmed through experience."⁴⁹ To him, the methodical doubt is a means to discriminate truth from falsehood, not the doubt employed by the Mu'tazilites which comes to be a source of conflicts and noisy argument."⁵⁰ The basic difference between the intellectual method of Ibn Sīnā and that of Bīrūnī is that, to the former, 'Take whatever you hear as likely to be possible', but, to Bīrūnī, 'Deny whatever you hear, unless it is falsified through arguments.'⁵¹ It is now clear that Bīrūnī's method of investigation was more of experimental and inductive nature, while Ibn Sīnā's methodology bore the Aristotelian deductive character. As a matter of fact, Bīrūnī's methodology was what Europe came to discover and apply centuries later.⁵²

Indiology, as an example, was accomplished by Bīrūnī according to this method. However, *Taḥqīq mā li al-Hind (al-Hind)* and *Al-āthār al-bāqīya* involve comparative religion studies or history of religions as well; hence, he is said to be the founder of comparative studies, and celebrated scholars have performed comprehensive studies on Bīrūnī's contribution to the history of religion.⁵³ He himself points to his comparative study of Indian and Greek religions and the like in the preface of *al-Hind* and prides himself on being innovative and unique.⁵⁴ The methodology used by Bīrūnī in his Indian ethnology, both in subject and content, is exactly the same as what contemporary ethnologists have done, although none of these studies enjoys the extent and multidimensionality of Bīrūnī's work. It is true that he has performed all by himself what a dozen of ethnologists can do today. The reputation he gained in the sociology and ethnology of India, and the study of religions roots in his freedom from prejudice and zealotry- the attribute to which he himself points. However, the remark of

⁴⁷*Payām-e yunesko*, no. 59 (ar. Sayyid Hossein Nasr), p. 41.

⁴⁸*Fihrist kutub al-Rāzī*, (ed.) Mahdi Mohaqqueq, 1366/ 1987, pp. 19, 58.

⁴⁹*Al-jamāhir*, pp. 273, 294.

⁵⁰*Taḥdīd nihāyāt al-amākin* (Ar.), p. 186/ (Per.), p. 158.

⁵¹*Ekhterā'āt va ekteshāfāt-e Abū Rayḥān* (Jalāl al-din Homāee), 1353/ 1974, p. 11.

⁵²*Barrasihā-yee darbāre-ye Abu Rayḥān Bīrūnī* (ar. Morteżā Motahhari), p. 68.

⁵³*al-Biruni Commemoration Volume* (ar. A. Jeffery), pp. 125-160./ *The Commemoration Volume* (ar. Morgenstierne), pp.1-9.

⁵⁴*Taḥqīq mā li al-Hind*, pp. 5, 19./ *India*, I, pp. 7, 25.

Ḥakīm Ḡhaḍanfar Tabrīzī (7th/ 14th century) at that age of Sunnite prejudice is more revealing: “The master was fair, far from zealotry, and free from any wickedness and sins.”⁵⁵ Therefore, while keeping his own Islamic faith and avoiding prejudice, he succeeded to present clear accounts of non-Islamic beliefs.⁵⁶ Altogether, his scientific mind was consistent enough to be curious, brave and possibly safe from bias.⁵⁷

Bīrūnī considered medicine and veterinary medicine as established upon experiment and analogy, and mathematics and geometry upon arithmetic, goods exchanges and inheritance laws. He also discussed on the origin of other sciences such as logic. His standpoint is, basically, that ‘different branches of knowledge originated from inevitable human needs and developed based on them.’ He totally believed in the benefits of knowledge and, simultaneously, posed strange question: “Is man not greedy, by his nature, for knowing what is concealed from him?”⁵⁸ It should be added that, regarding the most significant aspect of Bīrūnī’s methodology, i.e. mathematics, the rules that govern everything are mathematical analysis or explanation. This is the mathematical or positive concept of science in all his works which has always made all of his readers really astonished.

Briefly speaking, Bīrūnī’s methodology varies according to the nature of the subjects: with rational speculative problems, he employs mathematical proofs and logical arguments; and as for sensuous subjects, he uses experience and individual intuition. The result was his final criterion of rejection or acceptance, and possibility or impossibility of statements, whether compatible with others’ ideas or not. Unfortunately, his time did not allow such studies and methods to continue as a system or school of thought, or to be followed by students, in the same way that no school emerged from the teachings of the great Islamic sociologist, Ibn Khaldūn (8th / 15th century).⁵⁹

2. Criticism and qualification of inference

Bīrūnī experts unanimously agree that no critic has ever appeared in the East to be comparable with Bīrūnī, the man with an almost nineteenth century critical mentality and a modern intellectual audacity.⁶⁰ His comparative method of attaining certainty, always involving criticism and explanation, and also his subject criticism of the previous works,

⁵⁵ *Al-maṣhāṭa li risāla al-fihrist* (ed.) Mehdi Mohaqqueq, p. 103.

⁵⁶ *Biruni Symposium* (ed. E. Yarshater), p. V.

⁵⁷ *Introduction to the history of science* (G. Sarton), Vol. I, p. 691. / *Moqaddame bar Tārikh-e ‘elm* (Trans. Sadri Afshar), vol. 1, p. 797.

⁵⁸ *Taḥdīd nihāyāt al-’amākin*, pp. 26, 28, 29, 35. / Pers. Trans. Ahmad Aram, pp. 5, 7, 8, 13.

⁵⁹ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), pp. 79-80. / *Soḵhanrānīhā-ye moḥaqqueqān-ye markaz-e mardom-shenāsi-ye Iran* (ed.) Parviz Azkaei, p. 17. / *India*, p. XLIII.

⁶⁰ *Chronologie Orientalischer...* (vor. E. Sachau), p. X. / *Al-qānūn al-Mas‘ūdī*, Vol. I, (ar. H. Winter), p. 1.

based on natural rules and logical evaluation, are consistent with modern philosophical-mathematical practice. This is a result of his vast culture and his firm belief in reasoning and thinking.⁶¹ His subject criticism involved methodic doubt. Sachau concludes that Bīrūnī did not accept the traditions of earlier centuries, and tried to comprehend, criticize and evaluate them. He resolved to distinguish the chaff from the wheat and to throw away whatever against the rules of nature and reason.⁶²

In his questioning Ibn Sīnā and Aristotle, he really meant seeking and stating the truth. He is not a man of noisy scholastic argumentation, on the ground that literal argumentation is no efficient way to truths. He emphasized that “we keep... aloof from pertinacious disputation on this subject, and we are willing to agree with our opponents as to the expressions if they will agree with us regarding the subject-matter.”⁶³ Moreover, in quoting and criticizing the ideas, he adopted fair and conscious stances, depending on the methodology, emphasizing repeatedly that, for instance, “[t]his book is not a polemical one. I simply relate without criticizing, unless there is a special reason for doing so.”⁶⁴ However, where he found reports covered by fancies and superstitions, he mercilessly attacked them with his weapon of criticism. His critical analysis of the documents and texts is quite similar to our contemporary methods. He criticized the reports and the variances of the manuscripts like a modern linguist, mentions the mistakes committed by the copyists, the translators and their erroneous readings and then edits the errors and distortions.⁶⁵

He was clearly free from imitation and discussed, for instance, the basic difference between the investigator and the imitator, especially in his interpretation of the Quranic verse, “Are those who know the same as those who know not?”⁶⁶, and also in the introduction of *Al-qānūn*, where he noted that he did not keep the trace of his preceding qualified scientists and did not simply follow their works and astronomical tables (Zigs), did not turn towards the followers of doubt and imitation, refusing to accept their astronomical tables totally and to deny their best achievements [...]. He says: “I have frequently performed gladly what every man has to do in accepting the qualified inferences by his preceding scholars and, without any sense of pride or shame, I have corrected the shortcomings attributed to those inferences, especially in the case of what blocks the apprehension of the true amount of motions... etc.”⁶⁷

⁶¹It should be added that, concerning criticism and qualification of inference, Bīrūnī was really a follower of Rāzī and was clearly influenced by him in his ‘subject criticism’. See my book *Rāzī, the sage*, pp. 157-167.

⁶²*India*, p. XXV./ *Abū Rayḥān al- Bīrūnī*, (? Mohammad Isma‘il Moballegh), Kabul, 1973, p. 76.

⁶³*Al-āthār al-bāqiya*, p. 10./ *Chronology*, p. 8./ *Al-as‘alah wa al-ajwibah*, (ed.) Sayyid Hossein Nasr& Mehdi Mohaqeq, 1973, p. 58./ *Tārīkh al-falsafa fī al-islām* (T. J. De Boer), (ed.) Abu Rayda, p. 300.

⁶⁴*Taḥqīq mā li al-Hind*, pp. 5, 19./ *India*, I, p. 7, 25./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 91.

⁶⁵*India*, p. XXV./ *al-Biruni Commemoration Volume* (ar. A. Pope), p. 284./ *Taḥdīd nihāyāt al- ‘amākin* (Ar.), p. 196; (Per. Trans. Ahmad Aram), p. 170./ *Taḥqīq mā li al-Hind*, pp. 13-14, 126, 409./ *India*, I, pp. 17, 18, 163; II, p. 77.

⁶⁶*Taḥdīd nihāyāt al- ‘amākin* (Ar.), p. 25; (Per. Trans. Ahmad Aram), p. 4.

⁶⁷*Al-qānūn al-Mas‘ūdī*, vol. 1, pp. 4-5./ cf. *Taḥdīd nihāyāt al- ‘amākin* (Ar.), p. 196; (Per.), p. 170.

As a matter of fact, ‘qualified inference’ is a suitable title for our diligent scientist, what he uses only in reference to real scientists. Therefore, he employs gentle words in criticizing scientists, since he has to do with facts not persons. When occasionally he uses bitter and harsh words, it seems most likely that he has found something unfaithful or non-scientific.⁶⁸

The other favorite term of him is ‘scientific prudence’ which is highly respected as the true method of inquiry, for instance, saying, “I have laid down at the beginning of this book (*The Chronology*) as the *conditio sine quâ non* for the knowledge of the proper mean between disparagement and exaggeration, and the necessity of the greatest carefulness”. Somewhere else, he notes that prudence in doubtful or unknown affairs is foresight and, in practice, a movement from possible to necessary.⁶⁹ Such an evaluation and conduct reveals his exact method, vast knowledge and his best selection of the research materials. Today, criticism as a branch of philosophy and epistemology is well-known enough. Based on what we have mentioned that in the realm of epistemology Bīrūnī was a pioneer of the unification of empiricism and rationalism, we can consider him as a founder of the school of criticism.

3. Truth seeking

One of the titles given to Bīrūnī is ‘truth lover’ on which several articles have been written.⁷⁰ The reason lies in the fact that scholars have observed his love for truth as the dominant feature of all his works and, they have concluded that critical view, tolerance, love for truth and intellectual brevity have all gathered in him simultaneously –what makes him unique in the Islamic mediaeval ages.⁷¹ He is frequently quoted from as saying “I do not refuse to accept the truth from whatever source I find”.⁷² He was deeply concerned for the possible mistakes and errors in his works and always apologized for that; however, concerning his expositions that might be far from the truth, he asks God for mercy and for making him aware of the falsehood so that he could erase and correct it.⁷³

In praising the truth and scolding the falsehood, he says, for example, that whoever escapes from falsehood and takes a firm hold of the truth is admirable, not only to the truthful, but even to the deceitful. That is why the tradition has it that “Tell the truth, even though it is against you” and Jesus the Christ said in the Bible that “Do not mind the fury of kings in

⁶⁸*The Commemoration Volume* (ar. F. Rosenthal), p. 547.

⁶⁹*Al-āthār al-bāqiya*, p. 45./ *Chronology*, p. 46./ *Al-jamāhir*, p. 391./ *Al-qānūn*, vol. 3, p. 1101.

⁷⁰cf. *al-Biruni Commemoration Volume* (ar. A. Pope), pp. 281-282./ *Biruni Symposium...* (ar. G. H. Yousef), pp. 13-26.

⁷¹*Introduction to the history of science* (G. Sarton), vol. I, p. 708./ *al-Biruni Commemoration Volume* (ar. L. Massignon), p.217./ *ibid.* (ar. a. Pope), p. 282./ *Biruni Symposium* (ar. G. H. Yousefi), p. 17.

⁷²*Taḥdīd nihāyāt al-amākin* (Ar.), p. 112; (Pers. Trans. Aram), p. 85.

⁷³*Taḥqīq mā li al-Hind*, p. 548./ *India*, II, p. 246.

speaking the truth before them, they only possess your body, but they have no power over your soul” (*Matt.* X. 18, 19, 28; *Luke* XII. 4). And this is among his creeds on real brevity... ; as justice (i. e. being just) is a quality liked and coveted for its own self, for intrinsic beauty, the same applies to *truthfulness*.⁷⁴ We should here make clear that these brave words are the opening to study of the Indian religions which were in direct opposition to the religion dominant in the Ghaznavīd court –a clear sarcasm against the Sultan of the time.

As a matter of fact, at the time when the Sultan was plundering India under the pretext of the holy religion, massacring the Indians by tens and their religious teachings and rites were all in danger, Bīrūnī was doing his best to study Indian religions, transfer their customs and cultures and to attract the Muslim attention to their intellectual and scientific ideas. Perhaps never had been so many human virtues and scientific ideals present in a single man as him.⁷⁵

⁷⁴ *Taḥqīq mā li al-Hind*, pp.2-3./ *India*, I, pp. 4, 5./ *Biruni Symposium*, p. 21.

⁷⁵ *Barrasiḥā-yī darbāre-ye Abū Rayḥān Bīrūnī* ... (Trans./ ed.??? Fathullah Mojtabae), p.291./ *Biruni Symposium*... (ar. G. H. Yousefi), p. 14.

4. Mathematical sciences

1. Preliminaries

Bīrūnī was, as he admitted, concerned with mathematics and all its branches, right from early youth⁷⁶, though he was occupied with the entire branches of science as well. Yāqūt Ḥamavī said “Bīrūnī is ahead of others in the race so much that the pioneers have lagged behind him for miles. God has extended in front of him the four directions (of mathematics) where nobody else can ride around to show off”.⁷⁷ Bīrūnī considers mathematics (ta‘ālīm) and geometry established upon arithmetic, goods exchange and inheritance laws.⁷⁸ Of his 153 works in mathematics and astronomy, 93 short and long writings are lost today and among the works available, there are 7 in pure mathematics and 15 in practical mathematics.⁷⁹

Bīrūnī was especially competent in combining arithmetic, geometry and algebra⁸⁰ and, also practical (Indian) mathematics with reasonable (Greek) mathematics.⁸¹ He was always seeking for rules and principles in mathematics and paid less attention to the inductive foundation of mathematics. Therefore, his academic works are based more on rationalization of the nature of mathematics and presentation of general rules than on deduction and induction.⁸² In the following sections, we will refer to some of his mathematical innovations.

2. Arithmetic and algebra

Bīrūnī’s expertise in arithmetic has been well-known in Iran and Europe mostly for parts of the book *Al-taḥḥīm* which was first translated, commented and published partly, on the subject of proportion, by Wiedemann.⁸³ However, Bīrūnī produced seven independent works on arithmetic which involve Indian arithmetic (Arabic numbers are derived from Indian ones) of which only one treatise, *Rāshīkāt al-Hind* (*The Indian Rules of Proportions* (*Rashikat*))

⁷⁶*Al-qānūn al-Mas‘ūdī*, vol. 1, pp.3-4.

⁷⁷*Mu‘jam al-udabā’*, vol. 17, pp. 180-181./ *Zendegīnāme-ye Bīrūnī* (Trans. Parviz Azkai), p. 72.

⁷⁸*Taḥdīd nihāyāt al-amākin* (Ar.), p. 26; (Pers. Trans. Aram), p. 5.

⁷⁹See *Kārname-ye Bīrūnī*, D. J. Boilot, Trans. Parviz Azkai, p. 86./ *Bīrūnī Nāme*, Abulqāsem Qorbāni, Tehran, Anjoman-e Athār-e Melli, 1974, pp. 31-33./ *Konjāviḥā-ye ‘elmi va adabi*, Tehran University, (ar. Gholāmhossein Rahnamā), p. 50.

⁸⁰*Abū Rayḥān Bīrūnī* (Gholāmhossein Mosāheb), Daneshgāh-e Melli-e Iran, 1965, p. 25.

⁸¹*Bīrūnī Nāme*, Abulqāsem Qorbāni, pp. 513-514.

⁸²*Andīshmand va ensān*, Najafī and Khalili, pp. 83, 90.

⁸³*Aufsätze zur arabischen wissenschafts geschichte* (E. Wiedemann), b. I, II, Hildesheim-New York, 1970 (b. II, pp.215-229).

exists.⁸⁴ The importance of this treatise, on finite proportions in Indian mathematics, lies in the fact that it is a comparative mixture of Indian and Greek mathematics. It also contains a report of the Indian figures (Agenon) and orders of the numbers, and ‘zero’, accompanied by the related tables.⁸⁵

Bīrūnī’s mathematical works are mostly concerned with algebra and even his geometry is algebraic in nature.⁸⁶ Of his algebraic writings was *Istikhrāj al-ki’āb* (*Calculation of Cubes*) is lost.⁸⁷ The doubling of chess squares, i.e. the addition of the terms of a geometric progression divided by the number of chess squares ($16^{16}-1$) is according to the present day’s rule.⁸⁸ Among other things, he posed some problems and discussions on cubic equations, for instance, on the 80 degree angel and the like. The problem $x^3=2$, asked by Māhānī, was not familiar to any of the algebraic scientists; propositions presented in the treatise *Istikhraj al-awtār* (*Calculation of Cords*); the determination of the value of the side of regular nonagon according to the cubic equation $x^3+1=3x$; and some other cubic equations whose roots are calculated by him, but the solutions are unknown to us. In all cases like this, it seems that he had access to some method that enabled him to solve the problems. It should be added that the algebraic problems posed by Bīrūnī served as a foundation for operations and solutions by Omar Khayyām and later the heritage of the two was transferred to Ṭūsī.⁸⁹

In solving some algebraic equations, Bīrūnī used a special pair of scales which were in fact the ancestors of the nineteenth century calculators and he seems to have in mind a sort of complicated pair of scales. Professor Reza remarked that according to the second chapter of *Al-tafhīm* (p. 33), where Bīrūnī says “What is unit? It is what unity... etc”, it can be clearly inferred that in addition to defining the unit (U), he considered it unchangeable with respect to the two basic arithmetic operations of multiplication and division, and also regarded the unit as the source of other numbers. Wholly, it is understood that he had in mind an ‘algebraic structure’ which is specific to the mathematic thought of the nineteenth century and one can analytically come to the conclusion that Bīrūnī was an algebraist, in the same way that Helenist philosophers such as Ibn Sīnā seems to have been geometricians.⁹⁰ We should here add that in the history of mathematics, algebra and geometry have always been Iranian and Greek domains of interest, respectively. The same inference can also be made from Plato’s saying “God is always busy with geometry”.

⁸⁴*Kārnāme-ye Bīrūnī*, pp. 36-38./ *Rasā’il al- Bīrūnī*, Haydar Abād, 1948, the second treatise.

⁸⁵*Taḥqīq mā li al-Hind*, pp. 136-144./ *India*, I, pp. 174-179.

⁸⁶*The Commemoration Volume* (ar. Roshdi Rāshed), pp. 63, 64./ *Yādnāme-ye Bīrūnī* (ar. Prof. Reza), p. 274.

⁸⁷*Kārnāme-ye Bīrūnī*, Boilot& Azkaei, p. 37 [hereafter *kārnāme* everywhere in the text].

⁸⁸*Al-āthār al-bāqiya*, pp. 177-178./ *Chronology*, p. 134./ *Yādnāme-ye Bīrūnī*, p. 108.

⁸⁹*The Commemoration Volume* (ar. Roshdi Rāshed), pp. 64-68./ *Bīrūnī Nāme*, Abulqāsem Qorbāni, p. 329./ *Barrasihā-ye darbāre-ye Abū Rayḥān Bīrūnī* (ar. Ja’far ’Āqāyāni *Chāvoshi*), pp. 351-357./ *Andishmand va ensān*, Najafi&Khalili, p. 82.

⁹⁰*Yādnāme-ye Bīrūnī* (ar. Prof. Reza), pp. 272-274.

3. Geometry and trigonometry

Bīrūnī regards geometry as the knowledge whereby the forms, abstract from matters, are rationalized, true proofs are envisaged, and the investigations do not go astray in the realm of logic. Studying geometry, one can attain the transcendence from the signs of nature to the divine forms.⁹¹ Here Bīrūnī means a sort of sarcasm against Rāzī whom he believed to have corrupted minds, void of religion, with his book *The Surplus of Geometry*. Ten independent works in geometry have been listed as belonging to Bīrūnī out of which only three ones, two of which belonging to Abū Naṣr ‘Irāq, are available (*Kārnāme*, p. 44, 86), his masterpiece being the fore-mentioned *Istikhrāj al-awtār* which contains four geometric theorems with various argumentations in solving thirty mathematic-geometric and algebraic-astronomical problems.⁹² A treatise under the title *Faṣl min kitāb li Abū Naṣr fī kurrīyat al-sama’* (A Chapter of Abū Naṣr ‘Irāq’s Book on the Sphericity of the Sky) is available on spheres (*Kārnāme*, p. 75) on which Lucky carried out an important research.⁹³ Through trigonometry, Bīrūnī calculated the value of π a little greater than 3.1466.⁹⁴ On trisection of an angle and other topics, famous as his own innovations, he accomplished what seems quite impossible with a ruler and a compass. The answer, as it were, is that he made use of algebra and arithmetic in solving geometric problems.⁹⁵

It is commonly held that Bīrūnī was the founder of the science of trigonometry, and that he made it independent of astronomy.⁹⁶ However, prior to him, Abū ‘Abdullāh Battānī (Albategnus) (cr. 244-cr. 306/ 858-918) coined the terms jayb (sine) for cord, jayb i ma’kūs (sinus versus), watar i rāji’, ḡill i muntasab (tangent) and ḡill i mabsūt (cotangent) and, as a pioneer of this knowledge, innovated new and elegant methods in spherical trigonometry.⁹⁷ The next leading figure was Abū Naṣr ‘Irāq, Bīrūnī’s teacher, as far as his existing treatises indicate.⁹⁸ Afterwards, Bīrūnī’s older contemporary, Abu al-wafā Būjgānī (328-388/ 939-998) attempted in developing trigonometry as a science specially with the tables and the

⁹¹ *Istikhrāj al-awtār fī al-dā’ira*, Haydar Abad al-Dakan, 1948, p.35; (ed.) Abulqāsem Qorbāni, Tehran, Anjoman-e Athār-e Melli, 1976, pp. 14, 58.

⁹²cf. *J. N. E. S.*, 1958, no. 17 (ar. Kennedy and A. Muruwwa), pp. 112-121.

⁹³ *Deutsche Mathematics*, 1941, no. 5 (ar. Luckey), pp. 405-446.

⁹⁴*American Mathematical Monthly*, 1926, no. 33 (ar. C. Schoy), pp. 323-325.

⁹⁵*Introduction to the history of science* (G. Sarton), vol. I, p. 709./*Andīshmand va ensān*, Najafī and Khalili, p. 85.

⁹⁶*al-Biruni Commemoration Volume* (ar. M. Kāzim), p. 162./ *Islamic Culture*, July 1932, p. 368./ *Payām-e Yunesko*, no. 59 (ar. Mohammad Salim ‘Ātaṣhghazā, p. 18.

⁹⁷*Zendegināme-ye ‘elmi-ye dāneshmandān-e eslāmi*, vol. 1, (ed.) Hossein Ma’sumi Hamedāni, pp. 260, 266./*al-Biruni Commemoration Volume* (ar. M. Kāzim), p. 162.

⁹⁸*Estudios sobre Abū Naṣr Maṣṣūr b. ‘Alī b. ‘Irāq* (J. Samsó Moya), Barcelona, 1969.

methods of solving spherical trigonometry problems (the formula $\tan = \sin/\cos$ was introduced by him). Several theorems, for instance, the ‘mughnī’ figure (the theorem of sines) are among his innovations.⁹⁹ We can see now how Bīrūnī developed trigonometry regularly in the form similar to that of the present day and applied it independently in astronomical calculations. Firstly, he made use of trigonometric tables of Būjgānī and completed them. Secondly, with respect to spherical trigonometry, he added the mughnī and the sector figure from his master’s innovations, and finally compiled the book *Maqālīd ‘ilm al-hay’a* (*Keys to Astronomy*), dedicated to Ispahbud Marzbān Sharvīnī of Gilan (c. 390/ 999) (*Kārnāme*, p.7).

Therefore, spherical trigonometry with its methods of theorem proofs is among the innovations of Bīrūnī, not of Ṭūsī, as previously held by European scholars, since Ṭūsī admitted, in his writing *Kashf al-qinā’ ‘an asrār al-shakl ul-qattā’* (*Unveiling the Secrets of the Sector Figure*), that he had made full use of Bīrūnī’s *Maqālīd*. Later, Bīrūnī’s trigonometric methods were used, for example, everywhere in *Zīj i Ulugh Beg*.¹⁰⁰ Bīrūnī’s book *Ifrād al-maqāl fī amr al-ẓilāl* (*The Exhaustive Treatise on Shadows*) is, among other things, a book of trigonometry in thirty chapters including the values and the variables of the measurement of the sun’s height, determining the latitude through trigonometry etc.¹⁰¹ Here it should be noted that Bīrūnī had, in fact, a sort of contribution with his contemporary scientist Al-Hazen in the history of science, each working on optics and perspectives independently without knowing about each other’s findings. Moreover, the theorem of trisection of an angle and calculation of the cord of one degree or calculation of the sine of one degree (chapter 4, article 3, *al-Qānūn*, vol. I, p. 292) have their own story: Bīrūnī proposed the solution of the problems through geometry (i.e. by determining the value of the cord of three degrees and dividing it by three) with the cooperation of Jamshīd Kāshhānī (9th / 15th century).¹⁰²

The third article of *al-Qānūn* on spherical trigonometry has gained a worldwide reputation and several commentaries have been written on it. The eighth article too attained the same high reputation, because Bīrūnī was the first mathematician to present, in the two articles, a general rule for determining the non-discrete coordinates of continuous functions. His (trigonometric) table of the shadows in the third article of the book (pp. 341-345) is

⁹⁹The exhaustive treatise on shadows, vol. II (co. E. S. Kennedy), p. 27./ *al-Biruni Commemoration Volume* (ar. M. Kāzim), p. 163./ Bīrūnī on sun’s altitude and shadow lengths (J. Hamadanizadeh), Tehran, Arya-Mehr University, 1973, pp. 2-5.

¹⁰⁰See “Bīrūnī va Ṭūsī” (Parviz Azkai) (in) *Peyk-e Noor*, no. 1, 2003, pp. 18-22./ *Al-qānūn al-Mas’ūdī*, vol. I, 1954 (ar. Winter), p. 4./ *The exhaustive treatise on shadows*, vol. II (co. E. S. Kennedy), p. 27./ *al-Biruni Commemoration Volume* (ar. M. Kāzim), pp. 162-163./ *Kitāb Maqālīd ‘ilm al-Hay’a*, Ed. et Tra. par Marie-Thérèse de Barnot, p. ???

¹⁰¹*Ifrād al-maqāl fī amr al-ẓilāl*, Rasā’i al- Bīrūnī, Ḥaydar Ābād al-Dakan, 1948, the first treatise./ *The exhaustive treatise on shadows*, vol. II (commentary), p. 1./ *Zendegināme-ye ‘elmi-ye dāneshmandān-e eslāmī*, vol. 1 (ar. Kennedy), pp. 315-316./ *Andishmand va ensān*, pp. 92-94.

¹⁰²*Yādnāme-ye Bīrūnī* (ar. Akbar Dana Seresht), pp. 36-38./ *ibid.* (ar. Jalal al-din Homaei), pp. 83-86./ *Ekhṭerā’āt va ekteshāfāt-e Abū Rayḥān* (Jalal al-din Homaei), pp. 12-15./ Bīrūnī Nāme, Qorbānī, p. 341./ *Sharh-e Ḥāl-e Nābeghe-yeshahir-e Irān Abū Rayḥān* (Dehkḥoda), pp. 16-17.

calculated with excellent accuracy up to four important sixty digits (instead of two digits).¹⁰³ It should finally be noted that the German physicist, Wiedemann (1852-1928), was the first scholar who investigated and introduced Bīrūnī's mathematics. He cooperated particularly with the Swiss mathematician, Heinrich Suter (1848-1922), in compiling a scientific biography of Bīrūnī¹⁰⁴ which was later completed. Moreover, Bīrūnī's trigonometry was studied by the German astronomer Carl Schoy (1877-1925) and the book *The Trigonometric Teachings of Bīrūnī of The Persian Astronomer Abu'l-Raihan... al-Biruni* was compiled by him according to the relevant chapters in *al-Qānūn*¹⁰⁵ which was published after his death by Julius Ruska.¹⁰⁶ Sayyid Mohammad Kazim Imam too endeavored in analyzing the third article of *al-Qānūn* and, among other things, remarked that Bīrūnī, prior to Ṭūsī, developed an independent science out of trigonometry, and that the formula of the expansion of the jayb (sine) of one degree as presented by Bīrūnī, is similar to the formula attributed to Newton.¹⁰⁷

¹⁰³ *al-Biruni Commemoration Volume* (ar. M. Kāzim), pp. 161-170./ *The exhaustive treatise on shadows*, vol. II (E. S. Kennedy), p. 47./ *The History of Trigonometry* (E. S. Kennedy) *Historical Topics for the Mathematics Classroom* (31), pp. 333-359./ *Al-maqāla al-thālitha min al-qānūn al-Mas'ūdī*, (ed.) Imam Ibrahim Ahmad, Cairo, 1965, p. 419.

¹⁰⁴ *Ueber al-Biruni und Seine schriften*, Beitrage zur Ges. Nat., 60-96, Erlangen, 1920-21.

¹⁰⁵ *Die trigonometrischen lehren des Persischen astronomen Abul-Raihan...al-Biruni* (C. Schoy), Hanover, 1927.

¹⁰⁶ *The Commemoration Volume* (ar. H. Roemer), p. 186./ *The Scholar and the Siant* (ar. H. roemer), p. 102.

¹⁰⁷ *al-Biruni Commemoration Volume*, Iran Society, 1951, pp. 161-170./ *Al-maqālat al-thālithat* (Imām Ibrahim Aḥmad, (moqaddame).

5. Astronomy

1. Preliminaries

Bīrūnī's works on astronomy, astronomical instruments and observations, calendar, meteorology, and astrology, mentioned in the lists and references (*Kārnāme*, p. 68) amounts to 85 works, some of which belong to his master, Abū Naṣr 'Irāq, and a number of others being on mathematical branches; some available, but mostly lost. In sum, Bīrūnī's masterpiece in astronomy, *Al-qānūn al-Mas'udī* (*The Mas'udi Canon*) which, in Yāqūt Ḥamavī words, abolished all previous works on this knowledge¹⁰⁸, brought him the title "Ptolemy of the Time"¹⁰⁹, since Bīrūnī's *Al-qānūn* was believed to be of the same status as Ptolemy's *Almagest* in apprehension, multiplicity and extension of the subjects. In fact, he compiled the astronomical mathematics of the previous works with their dates- from *Almagest* to Abū Naṣr 'Irāq's *Kingly Almagest*, that is, whatever from Greek, Indian, and Iranian writings and the like up to his time in the form of an updated encyclopedia.¹¹⁰ It seems that, like *Al-qānūn fī al-ṭibb* (*The Canon in Medicine*) by Ibn Sīnā as an encyclopedia on medicine of its time, *Al-qānūn* was meant to be the encyclopedia of the astronomy of that age.¹¹¹

Concerning Bīrūnī's astronomical ideas especially those in *Al-qānūn*, several elucidating researches have been carried out by great scholars of astronomy such as C. A. Nallino¹¹², Sadwicz¹¹³, Rozenfeld¹¹⁴, Kennedy¹¹⁵, and particularly S. H. Barani (in the introduction of his book)¹¹⁶; however, no exhaustive analysis of the entire chapters of Bīrūnī's astronomical works has been carried out yet.¹¹⁷ It is well-known that there is a substantial distinction

¹⁰⁸ *Mu'jam al-udabā'*, vol. 17, p. 185./ *Tatimmat Ṣawān al-Ḥikmat* (Bayhaqi), p. 62.

¹⁰⁹ *Chronologie Orientalischer Vlker* (vor, E. Sachau), p. X.

¹¹⁰ *al-Qānūn al-Mas'udī...* (ar. S. H. Barani), p. XIV./ *Tārīkh al-adab al-jughrāfī* (Krachkovski), Tr. Ṣalāḥ al-dīn Uṯmān Ḥāshim, vol. 1, pp. 253-254./ *Tārīkh al-falsafat fī al-islām* (De Boer), (ed.) Abu Rayda, p. 231.

¹¹¹ *al-Qānūn al-Mas'udī*, vol. I, 1954, (ar. H. Winter), pp. 2, 12.

¹¹² *Ilm al-falak (tārīkhuhū...)*, al-jāmi'at al-miṣriya, Rome, 1911, pp. 38-40./ *Tārīkh-e nujūm-e eslāmī*, Tr. Ahmad Aram, Tehran, 1970, pp. 48-50.

¹¹³ *Biruni Sbornik*, 1950, pp. 74-87.

¹¹⁴ *Istoriko astronomicheskie Issledovaniia* (B. Rozrnfeld and M. Rozhanskaia) 1969, no. 10, pp. 63-95.

¹¹⁵ *Dictionary of Scientific Biography*, vol. II, New York, Charles Scribner's Sons, 1970, pp. 154-155./ *Zendegināme-ye 'elmī-ye dāneshmandān-e eslāmī*, vol. 1, pp. 318-319.

¹¹⁶ *al-Qānūn-Mas'udī* (Canon Mas'udicus), India, 1954-1956, (intr.), pp. I-LXXV.

¹¹⁷ *Nazar-e motefakkerān-e eslāmī darbāe-ye ṭabī'at*, Sayyid Hossein Nasr, Tehran, 3d edition, Khwarazmi Publications, 1970, p. 210./ *An Introduction to Islamic Cosmological Doctrines* (S. H. Nasr), Cambridge (U.S.A), 1964.

between astronomy and astrology, namely, between astronomical mathematics and clairvoyance- the distinction frequently made and emphasised by Bīrūnī, especially in his treatise *Ifrād al-maqāl* (*The Exhaustive Treatise on Shadows*).¹¹⁸ The significance of astronomy was for the religious time-reckoning, that is, for the recognition of the prayer times.¹¹⁹ He asserts that the treatise was written for the very purpose; however, it contains discussions on sunrise times and day lengths in terms of the sun's 'shadow', according to Iranian, Indian and Babylonian methods which is the first reference ever made to the Babylonian calculation methods.¹²⁰ The interesting point is that he presents the Babylonian and Chaldaen sources of Ptolemy.¹²¹

2. Astronomical instruments and observations

Bīrūnī's observations, as he says, started from early youth, apparently at the age of seventeen or eighteen in the town of Kāth of Khwārazm (380/ 990) by means of a graduated ring hardly able to show less than half a degree. He measured the meridian altitude of the sun, whereby he calculated the latitude of the city.¹²² Four years later (384/ 360 Yazdgirdi/ 994.), he measured the meridian altitude of the sun by a circle with a diameter of about 8100 cm at the village Būshkanāz, to the west of Āmū Daryā and Jurjānīya. He measured the obliquity of the ecliptic in the place of the summer solstice in the same village next year (385/ 995).¹²³ In 387/ 997, the aged Abū al-wafā Būjgānī, living in Bagdad and Bīrūnī planned to make a common observation of a lunar eclipse which did not actually take place.¹²⁴ During the years 393-394/ 1002-1003, he observed solar eclipses and the meridian altitude in Jurjānīya and Gurgān.¹²⁵ The contemporary astronomy scholars are strongly fascinated by the results of his observation of a solar eclipse in 399-400/ 378 Y/ 1008-1009 in which he rejected the Ptolemaic theory of constancy/ stability of the aphelion and calculated the motion of the sun to be one degree per 66 years and later, per 70 1/3 year.¹²⁶ The investigation by the two

¹¹⁸ *ISIS*, (ar. S. Pines), 1964, no. 55, pp. 343-349.

¹¹⁹ *The exhaustive treatise on shadows*, II (E. S. Kennedy), p. 143./ *The Scholar and the Saint* (ar. id.), pp. 83 ff.

¹²⁰ *Centauras*, (ar. M. Lesley), 1957, no. 5. 121-141.

¹²¹ *Al-qānūn al-Mas'ūdī*, vol. 2, p. 728./ *Naẓar-e motefakkerān-e eslāmi darbāe-ye ṭabi'at*, Sayyid Hossein Nasr, p. 177.

¹²² *Taḥdīd nihāyāt al-amākin*, (Pers. Tr. Aram), p. 218./ *Al-qānūn al-Mas'ūdī*, vol. 1, pp. 364-365./ *Zendegināme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 305.

¹²³ *Zendegināme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 306./ *Taḥdīd nihāyāt al-amākin*, (Pers. Tr. Aram), pp. 53-54, 215./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 24.

¹²⁴ *Al-qānūn al-Mas'ūdī*, vol. 2, p. 677./ *Taḥdīd nihāyāt al-amākin*, (Pers.), p. 218.

¹²⁵ *Zendegināme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 308./ *Al-qānūn al-Mas'ūdī*, vol. 2, p. 741.

¹²⁶ *Al-qānūn al-Mas'ūdī*, vol. 2, pp. 676-677./ *Turāth al-insānīya*, vol. 2, (ar. Imam Ibrahim Ahmad), p. 417./ *al-Qanun al-Mas'udi* (S. H. Barani), p. XLII./ *The Scholar and the Saint* (ar. A. Heinen), p. 60.

outstanding scholars, W. Hartner and M. Schramm, on this innovative theory of Bīrūnī can be regarded as an original scientific study.¹²⁷

It was toward the end of his stay in Khwārazm that Bīrūnī made several observations including measuring the meridian altitude of the sun in the place of the summer solstice in the year 406/ 385 Y/ 1015 by a circle with a diameter of about 3240 cm to study the obliquity of the ecliptic and also determining the latitude of that place (407/ 1016) by means of a hemisphere with a diameter of about 5400 cm on which he could specify the longitudes and latitudes in terms of distances and solve the problems of geodesy.¹²⁸ Afterwards, he was taken to Ghazna as a captive and he seems to have been under arrest for a while in the castle of Nandana in Punjab (408/ 1017), where he calculated the diameter and the circumference of the earth and the obliquity of the ecliptic with trigonometric method. It should be noted that he observed the obliquity of the ecliptic (i. e. the value of the angle formed by the intersection of the celestial equator and the ecliptic (as much as 23°, 35")).¹²⁹ Then, in 409/ 1018, he was somewhere around Kabul, where he managed to observe the eclipse of the sun and to determine the latitudes of some places, while he was desperate and distressed.¹³⁰ Next year (410/ 388-389 Y/ 1019) he had the chance to make several important observations, including observing the two equinoxes and the two solstices, the greatest/ grandest meridian altitude, and observing the eclipse of the moon with certain stars.¹³¹ The last observation reported by him was the determination of the altitude of the solar apogee, or the equation of the sun and other stars in 421/400 Y/ 1030 in Ghazna.¹³²

Several observations by Bīrūnī led him to new theories, correction of observations and the values reported by the astronomical tables (Zīj) of other astronomers, and also to revolutionary issues. One can mention the calculation of the volume of the planets and their distance from the earth according to Ptolemaic principles, and also the theory of the motions of the moon, radically different from previous ones, because his exact observations,

¹²⁷*Scientific Change*, (London), 1963, pp. 206-218./ *The Commemoration Volume* (ar. H. R. Roemer), p. 189./ *The Scholar and the Saint* (ar. id.), p. 106.

¹²⁸*Al-qānūn al-Mas'ūdī*, pp. 365-366, 618-620, 622-623, 1661./ *Taḥdīd nihāyāt al-amākin*, (Pers. Tr.), pp. 16, 50, 54, 94, 103, 122, 265./ *Zendegināme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 308./ *Payām-e Yunesko*, vol. 59, p. 24.

¹²⁹*Al-taḥfūm* (Pers.), pp. 75-76./ *Al-qānūn*, vol. 1, pp. 364-366./ *Taḥdīd nihāyāt*, pp. 54, 83, 84, 88, 215./ *Yādnāme-ye Bīrūnī* (ar. Jalāl al-dīn Homāee), pp. 91-92./ *Ekhterā'āt va ekteshāfāt-e Abū Rayḥān* (Jalāl al-dīn Homāee), pp. 20-32./ *S. P. S. M. E.*, 1926, no. 58, (ar. O. Schirmer), pp. 43-88./ *al-Qanun al-Mas'udi* (S. H. Barani), p. XXVII.

¹³⁰*Taḥdīd nihāyāt* (Pers.), pp. 93, 194, 255./ *al-Qanun*, vol. 1, p. 52./ *Zendegināme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), pp. 309, 310./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), pp. 47, 55./ *al-Qanun al-Mas'udi* (ar. S. H. Barani), p. III.

¹³¹*Al-qānūn al-Mas'ūdī*, vol. 1, p. 365./ *Taḥdīd nihāyāt* (Pers.), pp. 84, 254, 255, 265, 266./ *Zendegināme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 310./ *Biruni on sun's altitude...* (J. Hamadanizadeh), p. 6 ff.

¹³²*Al-qānūn al-Mas'ūdī*, vol. 2, pp. 997-998; vol. 3, p. 1193./ *Andīshmand va ensān* (Najafi and Khalili), p. 135.

discussions of the eclipses of the moon and the relevant calculations show great improvements over previous findings. He coined the term “*Khayāl al-kusufayn ‘ind al-Hind*” (The Indian *Image* of the Two Eclipses) on the two unified and equal orbits of the sun and the moon according to the Indian theories (*Kārnāme*, p. 29). In addition, he corrected, with exact observations, the wrong figure of the length of the solar year, calculated by Ptolemy as much as 365 days, 5 hours and 56 minutes and estimated differently by different Islamic astronomers; he calculated the length of the solar year as 365 days, 5 hours and 46 minutes and 46.5 seconds- the value different from the present day number only in one second.¹³³ Any introduction of Bīrūnī’s instruments of measurement and observation require quite an exhaustive discussion, for instance, as the comprehensive one by Widemann.¹³⁴

During his short stay in Ray (c. 387/ 997), Bīrūnī became acquainted with the astronomer Abū Maḥmūd *Khujandī*, whose astronomical instrument he admires as *al-suds al-fakhrī* (the Sixtant *Fakhrī*) and about which he wrote a treatise (*Kārnāme*, p. 730). *Khujandī* had observed the meridian altitude of the sun with that instrument in 384/ 994 (For Bīrūnī’s stay in Ray and his interactions with the scholars there, see the appendices of *Al-āthār al-bāqīya*, (ed.) P. Azkai, pp. 735-738). Bīrūnī made an astronomical instrument in Gurganaj which seems to be the circle aforementioned, of perhaps a large ring installed in the *meridian plate/board*, which he called the *Shāhīd Ring* because of his sense of gratitude to *Khāwrazm-Shāhs*. Later, when he was in the court of Maḥmūd *Ghaznavī* Yamīn al-dawlat, he made the Yamīnīd Ring for him by which he measured the latitude of *Ghazna*. He invented a special clock (to make known the prayer times) for the congregation of *Ghazna* which was rejected by the leader of the prayers in the mosque under the pretext that the calendar of the clock was *Ferangī* (Roman).¹³⁵

The most important astronomical instrument in the past was the astrolabe by means of which Bīrūnī showed the possibility of measuring the circumference of the earth for the first time. It should be added that one of the inventions of Bīrūnī was installing a ‘*disk/ plate/ spider of direction*’ in the astrolabe about which he wrote a treatise under the same title (*Kārnāme*, p. 67). The treatise is on the *projection-place/ projection radiorum* in the northern and southern astrolabes. Such an apparatus was, in fact, a mechanical astrolabe with gear by which he observed the situations of the planets and stars. The apparatus was later used by astronomers from Andalusia such as Zarqālī of Cordoba (5th/ 12th century) and the *disks/ plates/ spiders* of the planets were invented which can be said to be the origin of the

¹³³*al-Qanun al-Mas‘udi...* (ar. S. H. Barani), pp. XLIII-XLV, LVI./ *Al-qānūn al-Mas‘ūdī*, vol. 2, p. 970./ *Al-tafhīm*, pp. 153, 221./ *Naẓar-e motefakkerān-e eslāmi darbā-e ye ṭabī‘at*, Sayyid Hossein Nasr, p. 214.

¹³⁴S. P. M. S. E., 1909, no. 41, pp. 26-78./ *Aufsätze zur arabischen wissenschafts Geschichte* (Windemann), 1970, b. I, pp. 544-596.

¹³⁵*Zendegīnāme-ye ‘elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), pp. 307, 308, 310./ *Al-qānūn al-Mas‘ūdī*, 609, 612./ *Al-taḥdīd* (Ar.), 101, 108./ *Ifrād al-maqāl*, p. 36./ *Zendegīnāme-ye Bīrūnī* (Ali al-*Shābbī*), p. 55./ *Payām-e Yunesko*, no. 59, (ar. Jack Boilot), pp. 12, 13./ *Barrasihā-ye darbā-e ye Bīrūnī*, (ar. Faṭḥulāh Mojtābāee), p. 268./ *Eḵṭerā‘āt va eḵṭeshāfāt-e Abu Rayḥān* (Jalāl al-din Homāee), p. 32./ *al-Qanun al-Mas‘udi...* (ar. S. H. Barani), pp. VI, XV.

mechanical clocks in Europe, since Zarqālī's [disk/ plane/ spider](#) owes its reputation to Bīrūnī's apparatus.¹³⁶

On the whole, eleven works by Bīrūnī on astronomical instruments are known four of which exist (*Kārnāme*, nos. 46, 47, 122, 169) and, in addition to the fourth chapter of the book *Al-taḥḥīm* on astrolabes (pp. 285-315), his other books such as *Istī'āb al-wujūh al-mumkina fī ṣan'at al-aṣṭurlāb* (*A Comprehensive Study of the Possible Ways of Making Astrolabes*) received high reputation for their great and scientific significance and benefit. (Concerning Bīrūnī's *Al-istī'āb*, see the author's exhaustive book review under the title "Bīrūnī va abzār-e setāre shenāsī" [Bīrūnī and Astronomical Instruments], *Māhnāme-ye Jahān-e Ketāb*, 7th year, nos. 7, 8, 1381/ 2002, pp. 6-9). It should finally be added that the English scientist Donald Hill produced an astrolabe according to Bīrūnī's model as presented in *Al-istī'āb* which is preserved in the library of the British museum.¹³⁷

3. Geomorphology

Bīrūnī's astronomy in the realm of cosmology can be summarized in his statement that "the universe is in the form of a circle".¹³⁸ "The spherical shape of the earth is necessarily natural; and this is because of the properties of it the truth of which cannot be confirmed but with the spherical shape of the earth".¹³⁹ "The globular shape of [...] and the earth [...] the fact that the earth [is] situated in the center of the globe [...] are the elements of astronomy; and that weights tend, by their nature, to move from all directions towards the center, so the stability of the earth is due to the fact that the earth's center of gravity is the center of the universe".¹⁴⁰ From these quotations three fundamental ideas of Bīrūnī can be inferred: (1) sphericity of the universe and the earth, (2) the Ptolemaic theory of geocentrism, i.e. that the earth is in the center of the universe, (3) gravitation theory which can be interpreted as the theory of the gravity force. Bīrūnī says that the Greek and the Indian ideas are the same, as far as the sphericity of the earth is concerned.¹⁴¹ His argument is both experimental and deductive: "because the earth is in the center of the universal sphere, the arcs on the earth are the same

¹³⁶ *Science and Technology in Islam*, pp. 9-18./ *Islamic Science...* (S. H. Nasr), pp.112-126.

¹³⁷ WELTALL, 1919, no. 20, pp. 21-26, 131-134./ *Aufsätze zur arabischen wissenschafts Geschichte* (Windemann), 1970, b. II, pp. 516-540./ *al-Qanun al-Mas'udi* (ar. S. H. Barani), p. XV./ *Science and Technology in Islam*, pp. 9-18./ *The Commemoration Volume* (ar. L. Elwell-Sutton), pp. 113-128./ *Zendegīnāme-ye 'elmi-ye dāneshmandān-e eslāmī* (ar. M. S. Kennedy), p. 315./ *Al-taḥḥīm*, Notes by Jalāl al-Dīn Homāee, pp. 285-315.

¹³⁸ *Al-qānūn al-Mas'ūdī*, vol. 1, p. 21.

¹³⁹ *Taḥqīq mā li al-Hind*, pp. 223-224./ *India*, I, p. 269.

¹⁴⁰ *Taḥdīd nihāyāt al-amākin* (Ar.), p. 42./ (Pers.), pp. 19, 25./ *Taḥqīq mā li al-Hind*, PP. 203, 225. / *India*, I, pp. 244, 269./ *al-Biruni Commemoration Volume* (ar. S. H. Barani), p. 1-52.

¹⁴¹ *India*, I, p. 33.

as the arcs of the sphere.”¹⁴² He also reasons, in line with Ptolemy’s famous argument, that the masts of the ships in the sea are seen first from afar, etc.¹⁴³ However, in *Ifrād al-maqāl* (*The Exhaustive Treatise on Shadows*) he says that because the earth’s shadow falls on the moon during the eclipse of the moon, in such a way that the moon seems partly light and partly dark, from the circle of the earth’s shadow we understand that the earth is spherical.¹⁴⁴

Morover, his doubt in the geocentric theory can be inferred from this item too: “the theory of geocentrism is among the principles of the knowledge of astronomy, as the first article of Ptolemy’s *Almagest* entails it, though, without any investigation or correction, we agree with that theory.”¹⁴⁵ It should be said that any doubt in the geocentric theory will make the theory of the gravity of the universe shaky as well. Then, how should one justify the “movement towards the center”, or the gravity force? “The propositions of the knowledge of the astronomy are based on the movement of weights towards the earth’s center. The difference of times is one of the consequences of the earth’s circular shape and the necessity of its location in the middle of the universe, so is the declination of the weights towards the earth’s center which is the middle point of the universe”.¹⁴⁶ Undoubtedly, as we will mention later, Bīrūnī was aware of the celestial non-Ptolemaic mechanics and gravitation as well.

4. Motion of the earth

It should first be noted that, as it were, Bīrūnī regarded the geocentric theory as an axiomatic principle of Ptolemaic astronomy, and also considered the earth’s rest as one of the same axioms. However, he is personally likely to have believed differently: “because the issue is mathematically so and has nothing to do with the natural circumstance.”¹⁴⁷ “So, be the earth moving or not, I should say that it is all the same for the engineers and astronomers, since it is harmless to their job. However, the rejection of the belief in the earth’s rest and the answer to the question has to do with natural philosophers”.¹⁴⁸ It appears that Bīrūnī’s idea of the theory of the rest of the earth is the same as his famous view of astrology: though personally a disbeliever, he had to write books and treatises on the nonsensical topics, as he said that in such matters, “I simply relate without criticizing”. Therefore, there is a difference between not believing in smething and mentioning the possibility or the falsification conditions of it.

¹⁴²*Taḥdīd nihāyāt al-amākin* (Pers.), p. 184.

¹⁴³*Al-qānūn al-Mas‘ūdī*, vol. 1, p. 48.

¹⁴⁴*Ifrād al-maqāl fī amr al-ḡalāl*, p. 29./ *The exhaustive treatise on shadows* (tr.& co. Kennedy), vol. I, p. 68; vol. II, p. 25.

¹⁴⁵*Taḥqīq mā li al-Hind*, p. 224./ *India*, I, p. 269.

¹⁴⁶*Taḥdīd nihāyāt al-amākin* (Pers.), pp. 14, 19./ *Taḥqīq mā li al-Hind*, p. 225./ *India*, I, p. 269.

¹⁴⁷*Al-qānūn al-Mas‘ūdī*, vol. 1, pp. 49, 50.

¹⁴⁸*al-Qanun al-Mas‘udi*, p. XVII./*Al-istī‘āb al-wujūh al-mumkina*, (ed.) Jawādi al-Ḥussaynī, Maṣḥhad, 2001, p. 128.

Nevertheless, firstly, Bīrūnī did not take a passive stance towards the theory of the universe, and, secondly, the rejection and falsification of the theory of the rest of the earth and, as a consequence, the rejection of the geocentric theory was by no means an easy task at that time. As we have already said, even five hundred years after Bīrūnī, Copernicus, after he was faced with his pupil's insistence, announced his heliocentric celestial mechanics fearfully.¹⁴⁹ Yet, it should be noted that a long time before Copernicus, the Muslim astronomers had found out the motion of the planets.¹⁵⁰ The celebrated scholar, Otto Neugebauer, wrote a book on the issue with respect to the ancient and mediaeval astronomy.¹⁵¹ Three current philosophical hypotheses in this regard, as Ibn Sīnā discusses in his natural philosophy in *Shifā'* (technique?? 2, chapter 6) under the category "motions of the stars", are as following: (1) the celestial bodies are motionless and their motion is revolutionary, (2) the celestial bodies are moving, in the direction opposite to that of the revolution, (3) the celestial bodies just rotate. Ibn Sīnā himself believed in the earth's rotation, but he took revolution impossible and believed in the geocentric theory.¹⁵² It is obvious that the theory of the impossibility of the earth is based on the belief in the earth's centrality.

On Bīrūnī's personal idea the scholars have all come to the conclusion that he was one of the pioneering thinkers who doubted the Ptolemaic astronomy which held that the earth was motionless, the center of the universe and the pole for the sailors of the spheres. He was one of the first brave inquirers to remove the crown of uniqueness from the Earth's head.¹⁵³ A good evidence of this is the aforementioned quotation from his *Ifrād al-maqāl* (*The Exhaustive Treatise on Shadows*) about the boat-shaped astrolabe produced by Abū Sa'īd Sajzī which well shows his doubt and implies the motion of the earth as a probability, although he announces the final proof and judgment is a task of natural scholars.¹⁵⁴ It should be added that Bīrūnī explained this in full at least in two other books, both lost unfortunately: *Miftāh 'ilm al-hay'a* (*Key of Astronomy*) (*Kārnāme*, P. 31) and the book *Sukūn al-arḥ aw ḥarakatuhā* (*The Earth, at Rest or Moving?*), written for him by his scientist friend Abū Sahl Mas'ūd (Kārnāme, p.62) based on a mutually accepted ground. The evidence that the author has found can shed more light on the issue: "The followers of Āryābhata maintain that the earth is moving and heaven at rest. People have tried to refute them [...]. The rotation of the earth does not in no way impair the value of astronomy, as all appearances of an astronomic

¹⁴⁹Abū Rayḥān al-Bīrūnī, (ar. Mohammad Ons), Afghanistan Academy, 1973, pp. 60-61.

¹⁵⁰*al-Qanun al-Mas'udi* (ar. S. H. Barani), p. XVII./ *The Commemoration Volume* (ar. V. Gines), p. 222.

¹⁵¹*The transmission of planetary theories in ancient and medieval*, New York, 1956.

¹⁵²*Al-shifā'*, Al-ṭabī'iyāt, (ed.) Madkūr, Cairo, pp. 45-46, 59.

¹⁵³*Yādnāme-ye Bīrūnī*, (ar. Reza), p. 276./ *Tārīkh-e nojum-e eslāmī*, Nalino, p. 314./ *Tārīkh al-adab al-jughrāfī*, Krachkovski, p. 250./ *Payām-e Yunesko*, vol. 59, (ar. Jack Boilot), p. 16; (ar. Atashgazāi), pp. 17, 18./ *The Commemoration Volume*, (ar. L. Gardet), p. 201./ *The Scholar and the Saint*, (ar. A. Heinen), p. 60.

¹⁵⁴In his book, *Al-istī'āb*, Bīrūnī says: "some [including he himself] argue that the general regular eastern motion belong to the earth not the [celestial] sphere and I swear to my soul that the analysis of this problem is hard and its inquiry is so difficult (p. 128)". For further details, see my writing in *Jahān-e ketāb*, 7th year, nos. 7, 8, p. 7.

character can quite as well be explained according to this theory as to the other. There are, however, other reasons which make it impossible. This question is most difficult to solve. The most prominent of both modern and ancient astronomers have deeply studied the question of the moving of the earth, and tried to refute it. We, too, have composed a book on the subject called *Miftāh 'ilm al-hay'a* (*Key of Astronomy*), in which we think we have surpassed our predecessors, if not in the words, at all events in the matter (*India*, I, 276-7).¹⁵⁵

Now, taking into account all aspects of the problem, including what Bīrūnī takes as a cause of the impossibility of the earth's motion, we should accept the acute comment made by some contemporary scholars. They argue that firstly the dominance of the Aristotelian philosophy at that time, including the celestial system taking the existence of void as impossible, created a barrier against Bīrūnī's viewpoint on the existence of the oval void of the planetary spheres. Bīrūnī's view had no supportive environment but what was to happen five hundred years later with Copernicus theory of the celestial mechanics based on heliocentrism. Secondly, lack of the astronomical and observational requirements of modern times should be taken into consideration, although, in his disagreement with the Aristotelian theory of planetary motion in *Al-qānūn*, Bīrūnī gets much close to the revolutionary view of Kepler (d. 1630). Even the significance of knowing the stars' positions and their distances can be understood from the treatise *Fī kuriyyat al-samā'* (*On the Sphericity of the Sky*) by his master Abū Naṣr 'Irāq (p. 4), as he says, again in *Al-qānūn* (p. 30), that the Ptolemaic argument concerning the stability of the position of the stars in the sky does not contradict the planetary motion. Thirdly, expressing any ideas against that of Ptolemaic system was not an easy task in that age. It is clear that such ideas would cause radical changes in Aristotelian natural philosophy and would change the intellectual and religious grounds as well, in the same way that Copernicus theory did so some centuries later in Europe. Now, it is probable that Bīrūnī expressed the same ideas as his ancestors and contemporaries, because he was well aware of the extra-astronomical consequences of his own beliefs. In fact, the social and political conditions were far from desirable for rejecting and falsifying the Ptolemaic system of thought. Besides, the scientific ground, as far as mathematical astronomy is concerned, was not available. Therefore, the turning point of the history had to wait for the appropriate time (as the Arabic saying has it that 'the affairs all depend on their times'). His task was only to knock the first powerful scientific blow to the geocentric system of Ptolemy.¹⁵⁶ We should finally add that, concerning Bīrūnī's view of the moving earth, two writings are available by two contemporary scholars; one by Shlomo Pines¹⁵⁷ and the other by Verner Gines¹⁵⁸, despite the fact that their viewpoints are opposite.

¹⁵⁵*Tahqīq mā li al-Hind*, p. 232./*India*, I, pp. 276-277./ *Al-qānūn al-Mas'ūdī*, vol. 1, p. 49.

¹⁵⁶*Abū Rayḥān al-Bīrūnī*, (ar. Mohammad Ons), pp. 60-61./ *Sharḥ-e ḥāl-e nābeghe-ye shahir-e Irān Abū Rayḥān*, Dehkhodā, p. 16./ *Naẓar-e motefakkerān-e eslāmi darbāe-ye ṭabī'at*, Sayyid Hossein Nasr, p. 217./ *Andīshmand va ensān*, Najafi and Khalili, pp.107-110./ *al-Qanun al-Mas'udi* (ar. S. H. Barani), p. XXII.

¹⁵⁷*J. A.*, no. 244, 1956, pp. 301./ International congress on the history of science, VIII (1956), (ar. S. Pines), pp. 299-303.

¹⁵⁸*The Commemoration Volume*, (ar. V. Gines), pp. 219-234.

5. Astrology

Bīrūnī made a basic semantic difference between the science of astronomy and the pseudo-science of astrology.¹⁵⁹ In line with modern scientists, he humiliated the so-called occult sciences such as alchemy exercised by the Indians of his time. He even adds that no nation is free from such wizardry, since “intelligent people [...] are not to be blamed for occupying themselves with alchemy, for their motives is simply excessive eagerness for acquiring fortune and avoiding misfortune”.¹⁶⁰ Obligated to write the book *Al-taḥfīm* in response to the persistence of a certain Rayḥāna of Khwārazm, he states, at the beginning of the fifth section on astrology, that “the questioner intended to [...], though our belief in this craft is the same as that of the humblest people”¹⁶¹, “because the craft of astrology has weak roots, fragile branches and distracted scales and conjecture exceeds the certainty in it”¹⁶²: “[I]n this craft, once the astronomer goes too far from the allowed limits, he looks like a soothsayer and when he goes farther, he enters the arena of divining people’s future and deserves to be reprimanded, (then) if he passes that arena, he will make himself and his craft ridiculous, as it is the case today”.¹⁶³

Bīrūnī was used to deride, whenever necessary, the astrological statements mostly based on the belief in the impact of stars on people’s astronomical tables (Zījs). He even goes beyond criticism and writes, in full length, with a falsifying tone, his book *Al-tanbih ‘alā ṣinā‘at al-tamwīh wa hīya aḥkām al-nujūm* (Warning About the Art of Misrepresentation, i.e. Astrology)¹⁶⁴ against astrology, but it is unfortunately lost. We should say that Bīrūnī was deeply concerned about the danger of vulgarism in science and was aware of the conflict between scientific knowledge and folksy beliefs which would lead to the pressure of the common people’s religious ideas over astronomers. Accordingly, he does not hesitate to make a clear-cut distinction between the followers of astrology (ḥashwīya, or the materialist duration cult, in his own term) and knowledgeable astronomers and goes on to explain instances of equivocation and identical terms of the two domains. For example, in the treatise *Tamhīd al-mustaḥqār li taḥqīq ma‘nī wa al-mamarr* (Preparation of the Established (Mustaqar)/ Preparing the Ground for the Inquiry of the Signification of the ‘Passage’ (Mamar)) on the meaning of the term ‘mamarr’ (passage) which refers to the passage of a planet beyond another one, he deals with the spherical trigonometric theorems and makes a distinction between this usage and the astrological usage of the word. Moreover, he regards

¹⁵⁹ *Ifrād al-maqāl fī amr al-ẓilāl*, *Rasā’il al-Bīrūnī* (risāla 1), pp. 69, 194./ *The exhaustive treatise on shadows*, vol. I, pp. 111, 245./ *ISIS*, 1964, no. 55, (ar. S. Pines), pp. 343-349.

¹⁶⁰ *Taḥqīq mā li al-Hind*, p. 149./ *India*, I, p. 188./ *al-Bīrūnī Commemoration Volume*, (ar. A. Pope), p. 284.

¹⁶¹ *Al-taḥfīm li awā’il ṣinā‘at al-tanjīm*, (ed.) Jalāl al-dīn Homāee, p. 316.

¹⁶² *Taḥdīd nihāyāt al-amākin* (Ar.), p. 290.; (Pers. Tr. by Ahmad Aram), p. 253.

¹⁶³ *Al-taḥfīm*, pp. 511, 539./ *Bīrūnī Nāme*, Qorbāni, pp. 18-19.

¹⁶⁴ *Al-āthār al-bāqiya*, p. 88./ *Chronology*, p. 92./ *Kārnāme-ye Bīrūnī*, p. 53.

conjunction of the zodiac houses, known as *Ithnā ‘asharīya* (the twelve [items](#)) as nonsense fabricate of the sick minds of astrologers. However, following his method based on objective observation through which an idea is either accepted [*maqbul*] or rejected [*mardhūl*] rationally, he relates the matter indifferently.¹⁶⁵ Bīrūnī was not alone in disbelieving in astrology and alchemy; Fārābī and Ibn Sīnā too wrote treatises to falsify astrology.¹⁶⁶

¹⁶⁵*Al-qānūn al-Mas‘ūdī*, pp. 1354, 1469./ India, pp. 219-221./ *al-Qanun al-Mas‘udi* (ar. S. H. Barani), pp. LXIV-LXVIII./ *al-Biruni Commemoration Volume*, (ar. A. Pope), p. 285.

¹⁶⁶*Ekhṭerā‘āt va ekteshāfāt-e Abu Rayḥān*, Jalāl al-din Homāee, pp. 50-64./ *Payām-e Yunesko*, no. 59, pp. 24, 26./ *Zendegināme-ye Bīrūnī*, Al-shābbī, p. 49./ *Bīrūnī Nāme*, Qorbāni, pp. 15-20./ *Tārīkh al-adab al-jughrāfī*, Krachkovsky, pp. 254-255./ *Turāth al-insānīya*, Imam Ibrahim Ahmad, vol. 2, p. 420; vol. 6, p. 280./ *Biruni Symposium* (ar. G. H. Youssefi), pp. 16-17./ *al-Biruni Commemoration Volume*, (ar. J. Fillazat), pp. 101-106.

6. Geography and geodesy

1. Mathematical geography

As George Sarton considered Bīrūnī a unique man in the history of science, Vladimir Krachkovsky named, in the ninth chapter of his history of geography, the fifth/ eleventh century as Bīrūnī's century, although Bīrūnī does not seem primarily a geographer inasmuch as he is taken a scholar of mathematics and natural sciences.¹⁶⁷ It should be noted that his endeavors in geography were directed toward mathematics and astronomy, so he should be regarded as one of the greatest geographers of the times. His contribution to geography can be seen in several aspects: he developed the mathematical grounds of geography, carried out geodesy measurements, and determined the geographical coordinates of several places with great accuracy.¹⁶⁸ Famous geographers after him admired him, especially Yāqūt Ḥamavī, Amīr 'Abū al-fidā' and Maqrīzī all quoting his findings. Wholly, Bīrūnī's contribution to the history and geography of the eastern countries can be said to be really great.¹⁶⁹

Bīrūnī agreed with the tradition which divided the earth into seven climates –the Iranian idea of 'the seven countries', in the form of seven circles, one in the center and the other six tangential ones, which is wholly a picture of the seven celestial spheres.¹⁷⁰ On the climatic divisions of the earth, two (lost) works by him are known. In addition to mentioning the book *Taqasīm al-aqālīm* (*Divisions of the Climes*) (*Kārnāme*, p. 68) which is probably the very *Al-ikhṭilāf al-wāqī' fī tqāsīm al-aqālīm* (*Differences of Opinions in the Calculation of the Revolutions (of the Years)*) reported by him in the list of his works (*Kārnāme*, p. 35), Yāqūt Ḥamavī acknowledges that he quoted the idea of the seven climates, in the Iranian fashion, from Bīrūnī's hand-written script (dated 422/ 1030).¹⁷¹ On the whole, of the seventeen works by Bīrūnī on geography, twelve ones were on mathematical or astronomical geography including six (lost) ones on finding the Qibla (*Kārnāme*, no. 28-33) and six works on

¹⁶⁷ *Tārīkh al-adab al-jughrāfī*, Tr. Ṣalāh al-dīn Ūṭhmān Ḥāshim, Cairo, 1963, vol. 1, pp. 245-258.

¹⁶⁸ *Aufsätze zur Arabischen wissenschafts Geschichte*, E. Wiedemann, b. I, p. 709./ *Moqaddame bar tārīkh-e 'elm*, Tr. Sadri Afshār, vol. 1, p. 816.

¹⁶⁹ *Biruni Sbornik*, 1950, (ar. Krachkovsky), pp. 55-73./ *Tārīkh al-adab al-jughrāfī*, Kachkovsky, pp. 250, 253, 255, 257.

¹⁷⁰ *Al-qānūn al-Mas'ūdī*, vol. 2, p. 539./ *Al-taḥfīm* (Pers.), Jalāl al-dīn Homāee, p. 196./ *Al-taḥdīd*, (Ar.), (ed.) Bulgakov, p. 136; (Pers.), Tr. Aram, p. 111./ *Tārīkh al-adab al-jughrāfī*, Krachkovsky, p. 254./ *Nazar-e moteḥakkaran-e eslāmi darbāe-ye ṭabī'at*, Sayyid Hossein Nasr, pp. 236, 238./ *Die sieben klimata* (E. Honigsmann), Heidelberg, 1929, pp. 165-183.

¹⁷¹ *Mu'jam al-udabā'*, vol. 17, p. 180./ *Mu'jam al-buldān*, (ed.) Wustenfild, Leipzig, vol. 1, p. 27./ *Tārīkh al-adab al-jughrāfī*, Tr. Ṣalāh al-dīn Ūṭhmān Ḥāshim, p. 250./ *The Introductory Chapters of Yāqūt's Mu'jam al-Buldān*, W. Jwaideh, Leiden, Brill, 1959, pp. 40-43.

determining the latitudes and longitudes of places (*Kārnāme*, no. 19-23, 27) of which only one, i.e. *Taḥdīd nihāyāt al-amākin* (*Fixation of the Limits of the Places*) exists today.¹⁷²

As scientific matters emerge in response to human needs, the above mentioned book, *Taḥdīd*, was originally written for finding the Qibla¹⁷³, though it had pure scientific benefits, including astronomical and mathematical discussions -a masterpiece in determining the geographical coordinates by the application of geometry, trigonometry and algebra.¹⁷⁴ Furthermore, the second chapter of the sixth article of *Al-qānūn* involves the mathematical explanation of the rules of determining the latitudes and longitudes of places (fully discussed in *Taḥdīd*) and enjoys the tables of the longitudes and latitudes of the cities with their degrees and minutes (*Al-qānūn*, 2, 546-579) which can, in fact, be regarded as Bīrūnī's Zig.¹⁷⁵ We should add that Bīrūnī gave geography priority over history and pointed out the benefits of taking journeys and visiting cities.¹⁷⁶

2. Projection plane and cartography/ Map projection

As far as mathematical geography is concerned, Bīrūnī's works were not limited to the matter; rather, with respect to the form and idea, he presented an original method in the analysis of the content of craftsmanship plans, insomuch that contemporary experts admit that he "gathered fruitful thought and extensive knowledge together."¹⁷⁷ Five works by him are recorded on the techniques of **projection plane** (*taṣṭīḥ*) and **projecting** geometrical bodies (*mustadīr*), especially a sphere on the plane (*mustawī*) (*Kārnāme*, nos. 48, 110, 112, 139, 142), with only one writing existing under the title *Tasṭīḥ al-ṣuwar wa taṣṭīḥ al-kuwar* (*Projection plane/ Map projection of the Constellations and Regions*).¹⁷⁸ Among Bīrūnī's innovations in plane-projection is a simplified picture of **body projection** similar to that of Nicolosi di **Paterno** (printed in 1660).¹⁷⁹ The most well-known method innovated by Bīrūnī

¹⁷²*Biruni i iego raboiu po astronomii i matematicheskoy geographiyi* (K. Sadvikov), Moscow, 1953.

¹⁷³*Taḥdīd nihāyāt al-amākin*, Bulgakov, pp. 29, 35, 276.; (Pers Tr.) Ahmad Aram, pp. 8, 13, 236.

¹⁷⁴*Zendegināme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 315./ *Andīshmand va ensān*, Najafi and Khalili, p. 98./ *Tārīkh al-adab al-jughrāfī*, Krachkovsky, p. 253.

¹⁷⁵cf. *Aufsätze zur Arabischen wissenschafts Geschichte* (E. Wiedemann), b. I, pp. 776-801, 822-828./ *ISIS*, (ar. C. Schoy), 1923, no. 5, pp. 51-74./ *al-Biruni Commemoration Volume*, (ar. S. H. Barani), pp. 1-54./ *ibid.*, (ar. J. Kramers), pp. 177-194./ *al-Qanun al-Mas'udi* (ar. S. H. Barani), p. XXIX.

¹⁷⁶*Taḥdīd nihāyāt al-amākin*, (Ar.), p. 35; (Pers.), pp. 12-14./ *Majallat jughrāfīyā*, vol. 3, (ar. Ahmad Susa), Iraq, 1965, pp. 293-299.

¹⁷⁷*Tārīkh al-adab al-jughrāfī*, Krachkovsky, Tr. Ṣalāḥ al-dīn Ūṭmān Ḥāshim, p. 251.

¹⁷⁸*Abhan zur Geschichte der Naturwiss und der Medi*, (ar. H. Suter), 1922, no. 4, pp. 79-93./ *Sharḥ-e ḥāl-e nābeghe-ye shahir-e Irān Abū Rayḥān*, Dehkhodā, pp. 12, 15.

¹⁷⁹*Introduction to the history of science*, G. Sarton, vol. I, p. 709./ *Moqaddame bar tārīkh-e 'elm*, Tr. Sadri Afshār, vol. 1, p. 816.

which made him conspicuous in projecting geographical maps is the ‘cylindrical’ method which he claimed had not been not applied by anyone else before him.¹⁸⁰ Some believe that, due to Bīrūnī’s precedence, it is right to name this method ‘Bīrūnī’s [projection plane/ map projection](#)’, instead of ‘Mercator’s map’.¹⁸¹

The method of projection on astrolabe plates, today called stereographic projection, is the subject of a work by Bīrūnī under the title *Tashīl al-tashhīḥ al-usṭurlābī* (*Fascilitation of the Astrolabic Correction*) which exists (*Kārnāme*, p. 40) and has been discussed by scholars.¹⁸² Making geographical spheres too brought him great reputation, as he says: “I have produced a hemisphere with a diameter of about 5400 cm on the surface of which I can specify the longitudes and latitudes in terms of distances.”¹⁸³ The names and coordinates of each place (longitudes and latitudes) were hereby recorded on the surface of the hemisphere.¹⁸⁴

3. Geodesy

It seems right to regard Bīrūnī as the founder of the knowledge of geodesy as well.¹⁸⁵ Once the amount of the earth’s circumference or the southern circle is calculated by measuring the arch length of one degree of it, the practical benefit will be that one can make known the distances of any geographical spot by it. Bīrūnī tried, for the first time, to measure the earth’s circumference in the plain of Gurgān in 384/ 994 which was a failure, but in 408/ 1017 he succeeded to calculate the earth’s circumference (20119.5 miles) and the arch length of one southern degree (55.53 miles) by his own method, i.e. the observation of ‘the dip of the horizon’ in the castle Nandana.¹⁸⁶

The difference between the length of the earth’s radius as calculated by him above the mountain of Nandana and the present day value is just 15 km and in the case of the earth’s

¹⁸⁰ *Al-āthār al-bāqiya*, p. 451./ *Chronology*, p. 357./ *Yād-nāme-ye Bīrūnī*, (ar. Jalāl al-din Homāee), pp. 86-88.

¹⁸¹ *Barrasiḥā-ye darbāre-ye Abū Rayḥān Bīrūnī* (ar. Aqayan Chavoshi), pp. 375-376./ *Sharḥ-e ḥāl-e nābeghe-ye shahīr-e Irān Abū Rayḥān*, Dehkhoda, pp. 12, 19.

¹⁸² *Ekhterā’āt va ekteshāfāt-e Abū Rayḥān*, Jalāl al-din Homāee, pp. 15-17./ *Konjāwīhā-ye ‘elmi va adabī*, (ar. Gholāmhossein Rahnama), p. 51./ *Sharḥ-e ḥāl-e nābeghe-ye shahīr-e Irān Abū Rayḥān*, Dehkhoda, p. 19.

¹⁸³ *Tahdīd nihāyāt al-amākin*, (Ar.), p. 38; (Pers.), p. 16.

¹⁸⁴ *Yād-nāme-ye Bīrūnī*, (ar. Jalāl al-din Homāee), p. 103./ *Ekhterā’āt va ekteshāfāt-e Abū Rayḥān*, Jalāl al-din Homāee, p. 32./ *Payām-e Yunesko*, vol. 59, p. 24./ *Andīshmand va ensān*, Najafī and Khalilī, p. 102.

¹⁸⁵ *al-Bīrūnī Commemoration Volume*, (ar. S. H. Barani), p. 2./ *Naẓar-e motefakkerān-e eslāmi darbāe-ye ṭabī’at*, Sayyid Hossein Nasr, p. 204.

¹⁸⁶ *Al-qānūn al-Mas’ūdī*, vol. 1, p. 52; vol. 2, pp. 529-531./ *Tahdīd nihāyāt al-amākin*, (Ar.), pp. 214-215, 221-223; (Pers.), pp. 187, 194-195./ *Al-taḥfīm*, pp. 156-164./ cf. *S. P. M. S. E.*, 1909. No. 41, pp. 26-78./ *Aufsätze zur Arabischen wissenschafts Geschichte* (E. Wiedemann), b. I, pp. 544-596./ *al-Bīrūnī Commemoration Volume* (ar. S. H. Barani), pp. 1-52./ *Tārīkh-e nojūm-e eslāmi*, Nalino, Tr. Ahmad Aram, pp. 363-365./ *Yād-nāme-ye Bīrūnī*, Jalāl al-din Homāee, pp. 88-99./ *Ekhterā’āt va ekteshāfāt-e Abū Rayḥān*, Jalāl al-din Homāee, pp. 17-20./ *Turāth al-insāniya*, vol. 6, Imam Ibrahim Ahmad, p. 278.

circumference the difference is just 110 km. He explained his measurement method, after gathering the previous data, in his treatise *Istikhrāj qadr al-arḡ bi raṣad inḥitāt al-uḥūq ‘an qulal al-jibāl* (*Calculation of the Amount of the (Circumference) of the Earth by Observing the Dip of the Horizon from above the Mountain Peaks*) in sixty pages (*Kārname*, p.35) and the treatise, fortunately existing, is well-known by his own name (‘Bīrūnī’s method’). He points to another method of measuring the earth by an astrolabe in his above-mentioned treatise, *Tashīl al-taṣḥīḥ al-aṣṭurlābī* (*Facilitation of the Astrolabic Correction*) (*Kārname*, p.40).¹⁸⁷

4. Discoveries

Bīrūnī’s findings in geography and civilization history are by no means less important than his innovations in mathematical and natural sciences. The overall picture he presented of the habitable lands surrounded by seas is exact. His information on the northern Europe and the eastern Asia roots both in the writings prior to him and in the reports gathered from passengers and merchants. For example, he spoke of the farthest regions of the east including Sablā beyond China (perhaps Japan), Zābaj islands (Java), Qamīr (Khmer/ Vietnam), and Vaqvāq islands (Malaya). However, concerning Africa, he mentioned no more than southern areas of the equator and beyond the Qamar mountains, although some believe that he was aware of the Cape of Good Hope.¹⁸⁸

As far as northern Europe is concerned, he speaks of the white “Varang” sea (obviously the Baltic sea), the sea leading to the north of the lands of the “Ṣaqālaba” (the Slaves) from the “Muḥīt” sea (the Mediterranean Sea). Furthermore, along with information on the northern tribes, the Bulgarians, the “Atel” river (the Volga) and the Caspian Sea, he presents unique details about the tribes in the Balkans. Then, on the linkage of the seas, he introduces the channel connecting the two seas; therefore, it is strongly conjectured that he was aware of the Bering Strait between Alaska and Siberia or that he guessed the existence of the strait.¹⁸⁹

Among wonderful historical reports by Bīrūnī, we should note the report he gives of digging the canal between Clysmā (the Red Sea) and the “Muḥīt” sea (the Mediterranean Sea), in Egypt, the great project ordered by Darius I (522-486 B.C.), the information

¹⁸⁷*al-Qanun al-Mas‘udi* (ar. S. H. Barani), p. XXXII./ *Tārīkh-e nojum-e eslāmi*, Nalino, pp. 263-265./ *Payām-e Yunesko*, no. 59, (ar. Boilot), p. 16; (ar. Mohammad Salim Atashgazāi), pp. 18, 42./ *Bīrūnī Nāme*, Qorbāni, p. 57./ *Andishmand va ensān*, Najafi and Khalili, pp. 96-97.

¹⁸⁸*Al-qānūn al-Mas‘ūdī*, vol. 1, p. 47; vol. 2, p. 538./ *Tārīkh al-adab al-jughhrāfi*, Krachkovsky, p. 250./ *Payām-e Yunesko*, no. 59, (ar. Boilot), p. 16./ *Zendegināme-ye Bīrūnī*, Al-shābbī, p. 76./ *Memoires of the archaeological survey of India*, (ar. Zakī Walīdī Ṭuqān), no. 53, New Delhi, 1941./ *al-Qanun al-Mas‘udi* (ar. S. A. Barani), p. XXXI./ *al-Biruni Commemoration Volume* (ar. Minorsky), pp. 233-236.

¹⁸⁹*Taḥdīd nihāyāt al-amākin*, (Ar.) p. 142.; (Pers.) p. 116./ *Al-qānūn al-Mas‘ūdī*, vol. 2, pp. 538, 539./ *Tārīkh al-adab al-jughhrāfi*, Krachkovsky, pp. 248-250./ *Turāth al-insānīya*, vol. 6, Imam Ibrahim Ahmad, pp. 276-277./ *Payām-e Yunesko*, no. 59, p. 22./ *Zendegināme-ye Bīrūnī*, Al-shābbī, p. 77./ *al-Biruni Commemoration Volume*, (ar. Zakī Walīdī Ṭuqān: *Ṣūrat al-ma‘mūrat ‘alā al-Bīrūnī*)/ *Memoires of the archaeological survey of India*, no. 53, (ar. V. Minorsky), p. 233.

uniquely reported by him (*Taḥdīd*, Arabic version, p. 49/ Persian version, p. 23). The event had already been reported only by Herodotus (book 2, section 58; book 4, section 39) and the tablet of Darius I almost recently found in Egypt. One can, therefore, conclude that, as Krachkovsky remarked, Bīrūnī had a sort of access to new geographical information which was not possible for others.¹⁹⁰ His prediction of the existence of the new continent of America in the “Maghrib” sea (the Atlantic Ocean) is especially astonishing-the narration simply neglected by western scholars and exclusively emphasized by sayyid Hasan Barani and Jalal al-Din Homāee up to this time.¹⁹¹ It is well known that the new continent was discovered only after Columbus crossed the Atlantic Ocean for India (1492). Before Bīrūnī, all natural philosophers and geographers believed that the habitable lands on the earth were exclusively limited to the northern inhabited quarter. However, Bīrūnī conjectured, through scientific rules, sheer intuition and perspicacity, that there must be another land in the antipodal quarter, opposite to the northern habitable quarter and that the seas surrounding the other two antipodal quarters must have separated the two continents. The idea can be inferred from his hints to the antipodes or the natural symmetry of the earth and its necessary mass balance.¹⁹² Now, we present another piece of evidence here which expresses the same idea more explicitly:

“The inhabitable world [...], as lying in the northern half of the earth, and more accurately in the one half of this half -i.e. in one of the quarters of the earth [...]. This sea separates the inhabitable world from whatever continent or inhabitable islands there may be beyond it, both towards west and east, for it is not navigable on account of the darkness of the air and thickness of the water because there is no more any road to be traced, and the risk is enormous [...]. As far as our observation, based on induction, goes, the *terra firma* must be in one of the two northern quarters, and therefore we guess that the same is the case on the adjacent quarter”.¹⁹³ What supports this idea is Bīrūnī’s fourth question, of the second eight questions in his famous debate with Ibn Sīnā, where he asked why one northern quarter was habitable and the other northern quarter and the two southern ones were not. It is clear that Bīrūnī believed in the existence of another territorial quarter or continent on the other side of habitable quarter known at his time.¹⁹⁴ Krachkovsky found out only the concept of the

¹⁹⁰*The Persian Wars*, Herodotus, Tr. G. Rawlinson, New York, 1942, pp. 197, 305./ *Old Persian*, R. Kent, 2nd ed., New Heaven, 1953, 147./ *Tārīkh al-adab al-jughrāfi*, Tr. Šalāḥ al-dīn Ūṭmān Ḥāshim, pp. 249, 253./ *Turāth al-insānīya*, vol. 2, (ar. Imam Ibrahim Ahmad), p. 416; vol. 6, p. 285./ *Ekhterā’āt va ekteshāfāt-e Abu Rayḥān*, Jalāl al-dīn Homāee, p. 36.

¹⁹¹*al-Qanun al-Mas’udi* (ar. S. A. Barani), p. XXX./ *Yādnāame-ye Bīrūnī*, (ar. Jalāl al-dīn Homāee), pp. 109-112./ *Ekhterā’āt va ekteshāfāt-e Abu Rayḥān*, Jalāl al-dīn Homāee, pp. 37-42.

¹⁹²*Al-qānūn al-Mas’ūdī*, vol. 2, p. 536./ *Taḥqīq mā li al-Hind*, p. 221./ *India*, I, p. 266./ *Taḥdīd nihāyāt al-amākin*, (Ar.), pp. 55, 143; (Pers.), pp. 27-28, 33, 116./ *Andishmand va ensān*, Najafī and Khalilī, p. 134./ *Yādnāame-ye Biruni*, (ar. Jalāl al-dīn Homāee), p. 109./ *Ekhterā’āt va ekteshāfāt-e Abu Rayḥān*, Jalāl al-dīn Homāee, p. 40./ *al-Qanun al-Mas’udi* (ar. S. A. Barani), p. XXX.

¹⁹³*Taḥqīq mā li al-Hind*, pp. 156, 224./ *India*, I, pp. 196, 269.

¹⁹⁴*Al-as’alah wa al-ajwibah*, (ed.) Sayyid Hossein Nasr and Mahdi Mohaqqueq, p. ج, 41./ *Yādnāame-ye Bīrūnī*, (ar. Jalāl al-dīn Homāee), pp. 111-112./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī’at*, Sayyid Hossein Nasr, p. 238.

southern continent (antipodes) which was, of course, unparalleled in Ptolemy's works and those of his followers.¹⁹⁵ Nevertheless, Bīrūnī's theoretical discovery of the continent of America, in Homāee's words, is by no means less than the contribution of Urbain Le Verrier (1811-1877) in the discovery of Neptune.¹⁹⁶

¹⁹⁵ *Tārīkh al-adab al-jughrāfī*, Ṣalāḥ al-dīn Ūṭhmān Ḥāshim, p. 249.

¹⁹⁶ *Yādnāame-ye Biruni*, (ar. Jalāl al-din Homāee), p. 112.

7. Natural sciences

1. General physics

Bīrūnī's epistemology in the field of natural philosophy can take two forms: first, the positive form, customarily be observed in his viewpoints here and there on the knowledge of nature and general physics; second, the negative form, inferred from his doubts and criticisms against Aristotelian natural philosophy and physics. In chapter 3, we noted that a good number of scholars have recognized Bīrūnī as the pioneer of scientific methodology, prior to the modern times philosophers in Europe such as Bacon and Descartes. Now, we should briefly note that Bacon found out that Plato, Aristotle, Galen and their followers had hindered scientific advance by their explanation of the order of events in terms of the final cause outside the order. It is worth saying that, regarding the idea of 'the final cause' in nature, Aristotle's philosophy had worse effects than that of Plato. Accordingly, the natural philosophies of Democritus and other thinkers which considered the causes of specific observations without the intervention of the final cause and solely in terms of the necessity of the matter, have stronger ties with natural sciences than the philosophy of Plato and Aristotle, because of the resource of the former to the natural causes. Therefore, Democritus atomic theory, always attracting the scholars' attention, obtained scientific and theological priority and Bacon had a tendency toward that theory.¹⁹⁷

Bīrūnī too had such a declination five hundred years before Bacon. He did not believe in the final cause; rather, as we will explain in chapter 9, he regarded only 'the first cause' as necessary and agreed with his favorite philosopher and natural scientist, Rāzī, on the atomic theory (See chapter 3). His disagreement with some of the Aristotelian principles of natural philosophy can be seen in his debate with Ibn Sīnā in which eight questions, out of total eighteen ones, posed in the well-known treatise *Al-as'alah wa al-ajwibah* (*The Questions and the Responses*), are the problems concerning "water and consumption, the movement of the four elements, the downward inclination of the gravity, the reason why one sees things under water, objection to the principle of the impossibility of the existing of the void, the expansion and contraction of the heat, the reason of the lightness of the ice in comparison to water" etc.¹⁹⁸ The criticisms mainly posed in the first ten questions, are against Aristotle's book, *Al-samā' wa al-ālam* (*The Sky and the Universe*). Q 1: Why is the sphere neither light nor heavy? Q 4: Why does he [Aristotle] maintained that it is foul to believe in the atoms (indivisible particles)? Q 6: Why does a sphere not require void? Q 8: If it is true that heat moves upwards the circle, why is the sun's heat (in the form of) its rays? Q 10: Why are some things transmuted into other things? etc. And the criticisms posed in the second eight

¹⁹⁷ Francis Bacon, J. Crowther, London, 1960, p. 70./ Francis Bacon (*aqvāl va āthār, aqāyed va afkār*), Mohsen Jahāngiri, Tehran, enteshārāt-e 'elmi va farhangī, 1990, p. 44.

¹⁹⁸ *Sharḥ-e ḥāl-e nābeghe-ye shahir-e Irān Abū Rayāḥm, Dehkḥodā*, pp. 32-66./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 200./ *'Elm va tamaddon dar eslām*, Sayyid Hossein Nasr, Tr. Ahmad Aram, Tehran, nashr-e andishe, 1971, pp. 127-134.

questions are mainly as the following: Q 2: Why do fire and air tend to move from the center? Q 4: Why is the other northern quarter of the earth not inhabited? Q 6: What is contrary to the idea of non-existence of the void in the universe? etc. Then, he goes on to criticize Ibn Sīnā and expresses his own ideas: 1. Elements and objects are not in their natural places. 3. It is not true that living things move from their right sides. 4. It is impossible for an object to be perpetually indivisible. 10. Transmutation is the dispersion of the parts of one thing into the parts of another thing. And again he repeats criticism 6 above, that the impossibility of the existence of the void in the world is impossible.¹⁹⁹

Bīrūnī's heroic attack on the castle of 'Aristoteleocracy' can be viewed, for instance, in the treatise *Ifrād al-maqāl* (*The Exhaustive Treatise on Shadows*). Bīrūnī's criticisms about the Aristotelian philosophy will be discussed in chapter 9; however, his natural philosophy discussions, concerning meteorology are as the following briefly: "Those who obediently surrender to Aristotle's views in his book *Al-āthar al-ilwīya* (*Meteorology*) for instance, his view about the rays from the visible (things), attribute his views to others to pretend they never opposed Aristotle's doctrines, because they are going to keep him far from the manifest errors he committed in that book. Of such errors is his viewpoint that there are absolutely no inhabitants under the place of the summer solstice (i.e. under the equator), or in the southern hemisphere. The Aristotelian followers have gone denying the counterexamples in so far that their efforts have led to buffoonery. I had to write a treatise under the title *Al-ibāna 'an al-tarīqa al-muḥtarifa* (*In Praise of the Way of Those Gainfully Employed*) (?), so that they would not adhere to those beliefs".²⁰⁰ It is worth noting that in his natural inquiry, Bīrūnī applied mathematical branches, but he cannot be taken, like the Brethren of Purity, a Pythagorean. Nonetheless, he sometimes tries to regard the geometrical shapes and theorems congruent with natural phenomena such as the number and the shapes of the petals. On the whole, he is one of the scientists who recognized the importance of the mathematical sciences and objective experience in the study of the physical laws and can be considered, in the contemporary sense of the word, a 'scholar of mathematical physics'. Therefore, he is a pioneer of the philosophers as Bacon and Descartes, and hence, of the same status as the scientists of physics in the eighteenth and nineteenth centuries.²⁰¹

The eighth chapter of the sixth article of *Al-qānūn* deals with the amount of the apogee motion where he says: "If things are so, slowness will appear from the two aspects of the apogee and the ultimate amount of slowness is near it [the apogee]. Then, the slowness will decrease and will become fast-moving and the ultimate amount of it is at its perigee. Afterwards, the slowness will decrease and will become slow-moving, because slowness and

¹⁹⁹*Al-as'alah wa al-ajwibah*, (ed.) Sayyid Hossein Nasr and Mahdi Mohaqqueq, Tehran, 1973./ *Shahr-e ḥāl-e nābeghe-ye shahr-e Irān Abū Rayḥān*, Dehkhodā, pp. 32-66./ *'Elm va tamaddon dar eslām*, Sayyid Hossein Nasr, pp. 127-132.

²⁰⁰*Ifrād al-maqāl fī amr al-ẓalāl, rasā'il al-Bīrūnī*, p. 56./ *The exhaustive treatise on shadows*, Tr. E. S. Kennedy, pp. 32-33.

²⁰¹*Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, pp. 202, 203./ *Yādnāame-ye Bīrūnī*, (ar. Reza), p. 276.

acceleration are in terms of the decrease and increase of the difference in the adjustments”.²⁰² The experts believe that the above quotation, stated in the philosophical and scientific terms of Bīrūnī’s time, shows that he was aware of the fundamental principle of ‘acceleration’ according to the ‘differential’ six centuries before Newton and Leibniz. One of the instances of the principle is the speed of the earth’s motion. The computational calculations carried out in the United States based on the values of the eclipse of the sun and the calendars presented in Bīrūnī’s works reveal that his calculations were not far from correct.²⁰³ Furthermore, while explaining the Roman and the Syriac months, he remarks, by way of digression, several ideas concerning physics and the laws of temperature, light, velocity and motion with reference to his debates with Ibn Sīnā. Among those discussions, he stresses that nothing is speedier than light and the movement of the sound is much heavier (slower) than that of light. We should add that, in the absence of any objective observation, he seems to have arrived at these conclusions merely through speculation.²⁰⁴

We have already mentioned, in chapter 3, that Bīrūnī was a counterpart of his contemporary scientist al-Hazen (354-430/ 965-1038), in the application of the experimental method and observation in the study of the concrete matters with rational forms. The comparison roots in the fact that al-Hazen was the greatest Islamic physicist, especially in optics. Similarly, Bīrūnī’s studies on the subject, as reflected in *Ifrād al-maqāl* (*The Exhaustive Treatise on Shadows*) are in line with his findings, including the fact that the rays are not emitted from the eye. Some have added that Bīrūnī wrote the book *Al-luma‘āt* (*The Bright Lights*) on optics, which was later a source of the book *Jāmi‘-e Bahādor Khānī* (*The Exclusive Book of Bahādor Khānī*).²⁰⁵ As for the physical nature of the sun which, like other topics of the type, Bīrūnī regards more concerned with the natural science than astronomy, he takes a position against the Greek metaphysical and mythological ideas: “Heat is nothing but the rays of the sun detached from the body of the sun towards the earth or from the warm body which touches the inside of the Lunar sphere, which is called Fire”. It can be inferred that he held that the mass of the sun is the element of fire.²⁰⁶ He discussed the fourth state of the matter, i.e. plasma and vaguely described some of the qualities of the motion of the parts in the plasma. He also defended the atomic theory based on Rāzī’s ideas which will be discussed later in detail.

In sum, he considered nature subject to the physical laws of the matter according to which he rejected the interference of the metaphysical factors. He inferred the motion of the matter,

²⁰² *Al-qānūn al-Mas‘ūdī*, vol. 2, p. 666.

²⁰³ *Yādnāme-ye Bīrūnī*, (ar. Reza), pp. 268-269, 271.

²⁰⁴ *Al-āthār al-bāqiya*, p. 319; *Ta‘liqāt*, p. 693 ff./ *Chronology*, p. 247./ *Moqaddame bar tārikh-e ‘elm*, Sarton, vol. 1, p. 816./ *al-Bīrūnī Commemoration Volume*, (ar. M. Abdur Rahman), p. 172.

²⁰⁵ *The Commemoration Volume*, (ar. A. Sarba), pp. 439-478./ *The exhaustive treatise on shadows*, vol. II (co. E. S. Kennedy), p. 1./ *Zendegīnāme-ye dāneshmandān-e eslāmi*, (ar. Kennedy), pp. 315-316.

²⁰⁶ *Al-qānūn al-Mas‘ūdī*, vol. 2, p. 646./ *Al-āthār al-bāqiya*, p. 319./ *Chronolgy*, p. 247./ *al-Qanun al-Mas‘ūdi* (ar. S. H. Barani), p. XLVI.

in the general sense, as subject to natural changes. He also expressed the principle of the transformation of quantity to quality in the system of the nature in terms of “the superfluity of material beyond the due proportions of the measure of everything” which, on the whole, reveals the basic lines of his natural philosophy.²⁰⁷

2. Pycnometry

The measurement of the specific weight by Bīrūnī and, later, by Abd al-Raḥmān Khāzinī (c. 440-c. 525/ 1048-1130) was one of the outstanding results of their experimental studies of nature. Bīrūnī accomplished this with a cone-shaped instrument, as the first pycnometer and Khāzinī completed Bīrūnī’s results and methods.²⁰⁸ There exists a treatise by Bīrūnī under the title *Al-nisab allati bayn al-filizzāt wa al-jawāhir fī al-ḥajm* (*Proportions between Metals and Gems According to Volume*) (*Kārnāme*, no. 63), quoted from selectively by Khāzinī in the third volume of his book *Mīzān al-ḥikma* (*The Scale of Wisdom*).²⁰⁹ Khāzinī quoted from Bīrūnī’s book *Al-jamāhir fī al-jawāhir* (*Gems*) on the physical features of the gems.

In his treatise *Al-nisab*, Bīrūnī exactly determines the specific weight of nine metals in relation to gold, and nine gems as compared to ruby. He also mentions the same values of the relations in introducing each of the metals and gems in *Al-jamāhir*²¹⁰ and presents the information as tables too. It is believed that the findings are very close to those of present day.²¹¹ The pycnometer or the cone-shaped pairs of scales which he invented²¹² was in fact a goblet or decanter which is believed to be more exact than Archimedes pair of scales, and especially the mathematical method employed in his invention is said to be what became current in Europe after the seventeenth century.²¹³

²⁰⁷ *Histoire de la philosophie Islamique* (H. Corbin- H. Nasr-O. Yahya), vol. 1, Paris, 1964, pp. 208-210./ *The Commemoration Volume*, (ar. F. Rosenthal), p. 537./ *The Scholar and the Saint*, (ar. A. Heinen), pp. 60-61./ *Naẓar-e motefakkerān-e eslāmi darbāre-ye ṭabī‘at*, Sayyid Hossein Nasr, pp. 197-198./ *Andishmand va ensān*, Najafī and Khalilī, p. 118.

²⁰⁸ *Al-‘ilm ‘ind al-arab*, Eldu Mieli, p. 194.

²⁰⁹ *Mīzān al-ḥikma*, Khāzinī, (ed.) Dā‘irat al-ma‘ārif al-uthmānīya, Haydar Ābād al-Dakan, 1970, pp. 55-73; (Pers. Tr. 14th century A. D.), (ed.) Modarres Razavi, Tehran, Bonyad-d farhang-e Iran, 1967, pp. 47-75.

²¹⁰ *Al-jamāhir fī ma‘rifa al-jawāhir*, (ed.) in India, pp. 162, 173, 192, 195, 222, 225, 232, 266 ff., p. 3; (ed.) in Iran, pp. 266, 281, 304, 311, 364, 368, 381, 433.

²¹¹ *Andishmand va ensān*, Najafī and Khalilī, pp. 64-70./ *‘Elm va tamaddon dar eslām*, Sayyid Hossein Nasr, p. 137./ *Yādnāme-ye Birūnī*, (ar. Hossein-Ali Sha‘bānī), p. 262./ *Introduction to the History of Science*, G. Sarton, I, p. 709./ *Aufsätze zur Arabischen wissenschafts Geschichte* (E. Wiedemann), b. I, pp. 240-257; b. II, pp. 1-4, 39-44, 215-229.

²¹² *Mīzān al-ḥikma*, Khāzinī, (Ar.), pp. 58-59; (Pers.), 48-49.

²¹³ *Konj-kāvihā-ye ‘elmi va...* (ar. Gholāmhossein Rahnamā), p. 53./ *Ekhterā‘āt va ekteshāfāt-e Abu Rayḥān*, Jalāl al-din Homāee, p. 33./ *Zendegināme-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 315./ *Naẓar-e motefakkerān-e eslāmi darbāre-ye ṭabī‘at*, Sayyid Hossein Nasr, p. 209.

3. Gemology

The book *Al-jamāhir* (*Gems*) deals with the minerals. The book is said to be, like other works by the natural history scholars in the Islamic period, an inquiry and observation of ‘the divine signs’, since the supreme wisdom was believed to be manifest everywhere in nature. It is also said that, though an opponent of alchemy, Bīrūnī seems to have followed Jābir Ibn Ḥayyān (d. 200/ 815) as far as the theory of the formation of the minerals is concerned.²¹⁴ Perhaps his journey to India persuaded him to study mineralogy, as the hunger of the rulers for precious jewels made him measure the specific weight of gems.²¹⁵ The book *Al-jamāhir* was written in 2 parts and 46 chapters, the first part dealing with gems and the second part with the metals, altogether studying 300 types of minerals and stones, with the relevant Iranian and Greek opinions of the scholars. It can be viewed everywhere in the book that he explains his well-known experiments based on natural sciences, including discovering the properties and features of diamond, emerald, honey bees, etc.²¹⁶

It should be noted that Bīrūnī wrote two other works on gemology: firstly, the book *Nuzhat al-nufūs wa al-afkār* (‘*Pleasure of the Souls and Thoughts*’), the unique manuscript of which exists in Oxford library (*Kārnāme*, no. 157) and secondly, the missing book *Al-ḥijār* (*Mineralogy*) which is said to be of the same value as that by Aristotle (*Kārnāme*, no. 159). It is finally worth noting that he expressed some of his social, civil and moral opinions in the introduction of *Al-jamāhir* under subdivisions named “tarwīha”s (roughly meaning ‘refreshment’) and that Naṣīr al-Dīn Tūsī made full use of the book totally as his reference book in his mineralogical book *Tansūkh Nāme-ye Ilkhānī*.

4. Botany

Bīrūnī’s botanical inquiry, in line with his nature studies, can be found, for instance, in his description of the geometrical shape and the mathematical order of the petals. By way of digression, he says that “There exist, e.g. double formation or correlation in things opposite to each other, triple formations in many leaves of plants and in their kernels, quadruplications in the motions of the stars and in the fever days, quintuplications in the bells of the flowers and in the leaves of most of their blossoms, and in their veins; sextuplication are a natural form of cycles, and occur also in bee-hives and snow-flakes [...]”. Then he goes on to criticize some of the ideas of his tome “You scarcely ever find a flower of 7 or 9 leaves, for you cannot

²¹⁴ ‘*Elm va tamaddon dar slām*, Sayyid Hossein Nasr, p. 100./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabi‘at*, Sayyid Hossein Nasr, pp. 241-242./ *Die Quellen des steinluches des Bērūnī* (Inaugural-Dissertation) von M. J. Haschemi, Bonn, 1935.

²¹⁵ *Tārīkh al-adab al-jughrāfī*, Krachkovsky, p. 248.

²¹⁶ *Al-jamāhir*, (ed.) Tusef al-Hadi, Tehran, 1395, pp. 172-173, 273, 494./ *Ekhterā‘āt va ekteshāfāt-e Abū Rayḥān*, Jalāl al-din Homāee, p. 35.

construct them according to the laws of geometry in a circle as isolate (triangles). The number of their leaves is always 3 or 4 or 18”.²¹⁷

The great masterpiece of Bīrūnī in this subject is the book *Al-ṣaydana fī al-ṭibb* ('Pharmacy' on Medical Herbs) which is highly reputed. The number of the herbal, animal and mineral drugs presented alphabetically (the Arabic pronunciation), amounts to 1116 entries, according to the Arabic text of the editions in Iran.²¹⁸ The names of the drugs in various languages are given –Arabic, Greek, Syriac, Latin, Indian, Sindi, and Iranian languages, including Persian, Khwarazmi, Soghdian, Bakterian, Tokharian, Zabuli, and Sajzi. The pronunciation is followed by lexical evidence from mostly Arabic verses and literary fragments. But, as he asserts, he is not going to focus on the the rapeutic effects of the herbs, except for a few cases. Bīrūnī's *Al-ṣaydana* was written following Rāzī's books, *Ṣaydana* (Pharmacy) and *Abdāl* (The Substitutes), involving a summary of the natural and medicinal inquiries by the scholars of his time on the shape, scent and other qualities of the drugs with a few words on their origins. Experts have mentioned that Bīrūnī's *Al-ṣaydana* is superior to the pharmacological books by other Islamic scholars. It is worth noting that he asserts that in producing synthetic medicines natural rules should be observed, in addition to their individual and compositional proportions.

5. Geology

Bīrūnī's geological viewpoints revolve around geological transformations according to the general rules of natural evolution. When he mentions the alternation of the geological eras in the introduction of his book *Al-taḥdīd* (Fixation), he means the theory of the formation of the earth's crust, i.e. how the lands transformed into the seas and vice versa, because of the gradual changes on the surface of the earth.²¹⁹ What we said earlier about Bīrūnī's theoretical discovery of the new continent (America), based on the principle of the symmetry of the two quarters and the balance of the earth's mass, refers indeed to the geological rules of evolution.²²⁰ Similarly, his theory of the formation of the Sind valley by the sedimentary layers of the rivers is really wonderful: “One of these plains is India, limited in the south by

²¹⁷*Al-āthār al-bāqiya*, p. 396./ *Chronology*, p. 294./ *Andīshmand va ensān*, Najafī and Khalili, p. 118./ *al-Biruni Commemoration Volume* (ar. Abdor Rahman), p. 172.

²¹⁸*Kitāb al-ṣaydana fī al-ṭibb*, (ed.) ‘Abbas Zaryāb Khoe, Tehran , Markaz nashr-e dāneshgāhi, 1991./ *Ṣaydana*, (Pers. Tr.) Abūbakr Kāsānī (14th century A. D.), (ed.) Manūchehr Sotude and Iraj Afshār, Tehran, Shorā-ye ‘ālī-ye farhang va honar, 1973-1974.

²¹⁹*Taḥdīd nihāyāt al-amākin* (Ar.), pp. 41-42, 44; (Pers. Tr. Ahmad Arām), pp. 18, 20./ ‘*Elm va tamaddon dar eslām*, Sayyid Hossein Nasr, pp. 105./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabi‘at*, Sayyid Hossein Nasr, p. 231./ *Andīshmand va ensān*, Najafī and Khalili, pp. 103-104./ *Payām-e Yunesko*, no. 59, (ar. Bābājān Ghafurov), p. 5.

²²⁰*Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabi‘at*, Sayyid Hossein Nasr, p. 238./ *Taḥdīd nihāyāt al-amākin* (Ar.), pp. 27, 28, 33, 116.

the above-mentioned Indian Ocean, and on all three other sides by lofty mountains, the waters of which flow down to it”.²²¹

As for the issue of animal and plant fossils which was virtually an unsolved problem to the European scholars until the Renaissance, Bīrūnī explained the emergence of them in terms of geological evolution.²²² The discovery of the Artesian well which he calls “Al-’ābār al-fawwārāt” (the ??? fountains), is one of the other results of his dynamic knowledge of geology and he explains the natural mechanism of the eruption of the underground waters in terms of hydrostatic rules. It has been noted that Bīrūnī argued about the subject, centuries before European natural scholars, such as the French Zéle, the author of the book *The Natural Science*.²²³ It has been also mentioned that some of the earth ‘kārizes’ (man-made subterranean water canals) in Khurāsān were designed by him.²²⁴

6. The evolution theory

Referring to a verse by Ghaḍā’irī on the transmutation of ruby, saying:

Of changing, by abundant transmutations, ruby becomes free and clear.
‘Tis white, at first, and then changes into red,

Bīrūnī says: “[...] natural philosophers have taken heed of the fact about man that he has attained the ultimate position of perfection-higher than other animals. And they believe that human type and his existential substance transcended to the status of humanity in a promotion from the state of being a dog to that of a bear, then to being an ape and then to the (form of) human being [...] Whatever existing in the world, transmute partly to other things in terms of the extension of their durations [...]”.²²⁵ Since the idea of evolution can be inferred from this passage, it has always been a matter of controversy, for instance, Parvin Gonabadi asked “Did Bīrūnī believe the same as Darwin?”²²⁶, Jan Wilczynski emphasized on “Darwinian

²²¹ *Taḥqīq mā li al-Hind*, pp. 157./ *India*, I, p. 198./ *Tārīkh al-adab al-jughrāfī*, Krachkovsky, Tr. Ṣalāḥ al-dīn Uṯmān Ḥāshim, p. 250./ *Moqaddame bar tārīkh-e ‘elm*, G. Sarton, Tr. Ṣadri Afshār, vol. 1, p. 816./ *Introduction to the History of Science*, G. Sarton, vol. I, p. 709.

²²² *Taḥdīd nihāyāt al-amākin*, (Pers.), pp. 20, 21, 24./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī‘at*, Sayyid Hossein Nasr, p. 232./ *Andishmand va ensān*, Najafi and Khālilī, p. 104./ *Payām-e Yunesko*, no. 59, (ar. Mohammad Salim Ātaṣḡazāi), p. 42.

²²³ *Al-āthār al-bāqīya*, p. 327./ *Chronology*, p. 254./ *Tārīkh al-adab al-jughrāfī*, Krachkovsky, p. 250./ *Sharḥ-e ḥāl-e nābeghe-ye shahir-e Irān Abū Rayḡān*, Dehkhodā, pp. 18, 20./ *Yādnāame-ye Bīrūnī*, (ar. Jalāl al-dīn Homāee, p. 88./ *Ekhṭerā‘āt va ekteshāfāt-e Abu Rayḡān*, Jalāl al-dīn Homāee, p. 17./ *Andishmand va ensān*, Najafi and Khālilī, p. 105./ *al-Biruni Commemoration Volume*, (ar. M. Abdor Rahman), p. 172.

²²⁴ *Zendegināme-ye Bīrūnī* (Ali al-Shābbī), Tr. Parviz Azkai, p. 77.

²²⁵ *Al-jamāhir fī ma ‘rifa al-jawāhir*, (ed.) in *India*, p. 80.; (ed.) in *Iran*, p. 154.

²²⁶ *Majalle-ye Sokhan* (monthly), dore-ye 4, 1952, no. 7, p. 540.

hypothesis by Bīrūnī eight centuries before Darwin”²²⁷ and the like. It must be added that some have, on the other hand, maintained that he did not believe in evolution.²²⁸

Bīrūnī’s interpretation of transmutation, after his tenth question from Ibn Sīnā, “Does [transmutation] take place because of exceeding and interference or transformation?”, is what he had asserted, in his tenth objection against him “transmutation is the dispersion of the parts of one thing into the parts of another thing”.²²⁹ Therefore, in his view, transmutation takes place because of interference not transformation; in modern terms, it happens in a gradual way than by way of jump. He says “The single elements do not welcome it in their assembly and there will be no more transformation. But, their edges will be subject to transformation, because they are contraries and a contrary is the foe of the other and pulls it towards itself. When their edges touch and grind one another, domination and integration will result on the earth [...]. So, these movements are the causes of the generation and corruption in this world”.²³⁰ It is clear that Bīrūnī presupposes the principle of the contrasts and the struggle of the opposites, or, in the Hegelian terms, the thesis and the antithesis as the primordial cause of the “movement” in the process of evolution and in the alternation of the old to the new, or to be more exact, the synthesis of the two. It is worth noting that, following Rāzī, Bīrūnī used the term “transmutation”, in the sense of the Mu‘tazilī terms ‘concealment/ latency and manifestation’ (kamūn wa zuhūr), equal to the Aristotelian ones ‘potency/possibility’ and ‘action/actuality’.

Evolution or generation and corruption in the world, to Bīrūnī, is the gradual manifestation and carrying into effect the whole essential possibilities of a thing in its potency. Such manifestation takes place in the duration of limited time. Like most of old scholars, Bīrūnī considered all phenomena in the world of generation and corruption as mixtures of the elements and their action and reaction. In his viewpoint, the reason of the territorial and atmospheric changes should be studied in terms of the changes in the element mixtures. On the whole, apart from the Darwinian hypothesis of evolution as a product of the modern thought, many of Bīrūnī’s ideas about evolution are well-discussed and accepted today.²³¹ Based on his gradual evolution principle, he believed in the following hierarchy of existence: object→plant→animal→human²³² (as Rūmī says: “I died from mineral, and plant became; / died from the plant and took the sentient frame.”). The scholars who maintain that the general criterion of Bīrūnī’s speculation, i.e. the ‘principle of gradual evolution’, has nothing to do with the Darwinian hypothesis, have presented no argument. Do they suppose one really

²²⁷ *ISIS*, no. 50, pp. 459-466, Beyrouth, 1958.; (Pers. Tr.) Hossein Ali Haravi (in) *Maqālāt va barrasīhā-ye dāneshkade-ye elāhiyāt va ma‘āref-e eslāmī*, Tehran University, no. 7-8, 1971.

²²⁸ *Yādnāame-ye Bīrūnī*, (ar. ‘Abd al-jawād Falāṭūrī), p. 513.

²²⁹ *Al-as’ilah wa al-’ajwibah*, (ed.) Nasr and Mohaqeq, pp. ٣٤, 34, 55.

²³⁰ *Al-tafhīm li awā’il šinā’at al-tanjīm* (Pers.), (ed.) Homāee, p. 508.

²³¹ *Nazar-e motefakkerān-e eslāmī darbāre-ye ṭabi’at*, Sayyid Hossein Nasr, p. 230./ *Payām-e Yunesko*, no. 59, (ar. Sayyid Hossein Nasr), p. 40.

²³² *Yādnāame-ye Bīrūnī*, (ar. ‘Abd al-jawād Falāṭūrī), p. 516.

claims that Bīrūnī followed Darwin? So, there is no problem if Bīrūnī's theory of gradual evolution (in Dā'ī's words, "Many philosophical schools, from Plotin to Marx, emerged based on"), in common with the Darwinian hypothesis, focused on the origin of the species and the principle of the struggle for survival:

"The life of the world depends upon sowing and procreating. Both processes increase in course of time, and this increase is unlimited, whilst the world is limited. When a class of plants or animals does not increase any more in its structure, and its peculiar kind is established as a *species* of its own, when each individual of it does not simply come into existence once and perishes, but besides procreates a being like itself or several together, and not only once but several times, then this will as a single species of plants or animals occupy the earth and spread itself and its kind over as much territory as it can find. The agriculturist selects his corn, letting grow as much as he requires, and tearing out the remainder. The forester leaves those branches which he perceives to be excellent, whilst he cuts away all others. The bees kill those of their kind who only eat, but do not work in their beehives. Nature proceeds in a similar way; however, it does not distinguish, for its action is under all circumstances one and the same. It allows the leaves and fruit of the trees to perish, thus preventing them from realizing that result which they are intended to produce in the economy of nature. It removes them so as to make room for others. If thus the earth is required, or is near to be ruined, by having too many inhabitants, its ruler –for it has a ruler, and his all-embracing care is apparent in every single particle of it- sends it a message for the purpose of reducing the too great number and of cutting away all that is evil".²³³

In addition to the demographic principle by Malthus (which, indeed, anticipates a real threat to the world today), the basic categories of the evolution hypothesis, i.e. natural selection, struggle for survival, survival of the fittest and evolution blind alley, can be inferred from the passage. One can accept that, in Bīrūnī's view, "in the realm of natural affairs, the cause of evolution is nature, while, in the arena of human affairs, the cause is the intellect."²³⁴ We have already established that he induced the motion of the matter, in the general sense, in nature and announced that nature follows the physical laws of the matter, with no interference of metaphysical factors. In a long severely critical chapter, while rejecting the common astrological statement about the 'impact of the stars on births' of the genetic phenomena, he discusses, in line with the contemporary evolutionism, and presents exhaustive arguments to prove that the existence of the redundant members of the body or the instances such as the Siami twins and the like are examples of "superfluity of material beyond the due proportions of the measure of everything". He further goes on to explain the case as such: "when nature does not find the substance by which to complete the form of that (thing) in conformity with the structure of the species to which it belongs" and '*faults of nature*' is a false belief and a wrong idea²³⁵, because he argues that the laws of the nature are constant and unchangeable.²³⁶

²³³*Taḥqīq mā li al-Hind*, p. 336./*India*, I, pp. 400-401.

²³⁴*Yādnāame-ye Bīrūnī*, (ar. 'Abd al-jawād Falāṭūrī), p. 521.

²³⁵*Al-āthār al-bāqiya*, pp. 87-91./ *Chronology*, pp. 90-93.

It is worth noting that when Bīrūnī states that “nature is responsible for preserving the species”²³⁷ and that the “superfluity of material beyond the due proportions of the measure of everything” leads to a change in the ‘form’, he is consistent with the fundamental Hegelian dialectic hypothesis of “the transformation of quantity to quality.”²³⁸ Similarly, he expresses his evolutionary ideas about the natural study of the earth [geology], and also of the plants and the animals on the earth. In both cases, the dominant elements of his ideas are “gradual evolution, natural laws and the movement of the matter”²³⁹, supported by the dialectic logical categories of ‘antithesis, synthesis, and the quantitative transformation.’

7. Natural ideas

Concerning Bīrūnī’s statement “The heat of the heaven and the heat of the earth meet each other”, Sachau says, in his annotations, “On the fire as a spherical body within the lunar sphere, cf. also Qazvīnī, “kosmographie”, ii. p. 90; translated by Dr. Ethé, p. 185”. (*The Chronology*, p. 429; *Al-āthār*, p. 319, §370). It seems that Sachau deserves to be reproached here, because, concerning such a fundamental idea of Bīrūnī, he refers to the person who borrowed the idea from Bīrūnī! By the way, the fact that “the heat is nothing but the raise of the sun detached from the body of the sun” (§45) is the basis of Bīrūnī’s theoretical physics and natural philosophy. This idea has quite a long story which we will make short in the following. However, at the very beginning of *Al-qānūn* (first article, first chapter), concerning the overall shape of the universe, he remarks that “it is a circle-like mass with its middle point [around it/on the edge of it](#) [...] and we say that anything moving round in a circle can be referred to as ‘Ether’, the term commonly used by ancient philosophers [...] and for the seven stars Ether was divided into seven tangential spheres, [their top space encircling their downspace](#) [...] and the first of those spheres from down to top is the sphere of the moon. The moon is a sphere-like body with very dry mass and the light which is seen on its body comes from the sun [...]” (pp. 21-23). This theory originally entails the explanation of the fourth state of matter, i.e. ‘fire’, identified as the material element of creation in the form of ‘light’. To speak of the sphere of fire [Ether] in reference to the mass of the sun was a way to envisage the cosmic ‘plasma’, an almost current issue in modern physics (For detailed discussions, see chapter 9, section 7 of this book). But, we should add two points here. First, the foundation of this theory roots deep in the basic beliefs of the Zurvanite-Zoroastrian, especially Manichaean beliefs. Second, Bīrūnī acquired this theory and, in general, his theoretical principles of physics entirely from the natural school of Rāzī and vigorously

²³⁶*Tārīkh al-falsafa fī al-islām*, De Boer, Tr. Muḥammad ‘Abd al-Hādī abū Rayda, p. 302.

²³⁷*Al-āthār al-bāqiya*, p. 81.

²³⁸*The Philosophy of Hegel: A Systematic Exposition*, W. T. Stace, p. ???

²³⁹*Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabi‘at*, Sayyid Hossein Nasr, pp. 197-198./ *Tārīkh al-falsafa fī al-islām*, De Boer, p. 302./ *Andishmand va ensān*, Najafī and Kḥalīlī, p. 118./ *Introduction to the History of Science*, G. Sarton, Vol. I, p. 709./ *al-Biruni Commemoration Volume*, (ar. M. Abdor Rahman), p. 172.

defended the theory against the Iranian peripatetics all by himself (see *Al-āthār*, note <371>). The Persian term *athīr* (Ether), the Arabicized form of the Avestan word *ātar*, as the sphere surrounding other spheres refers to the fifth element of the Manichaean cosmology. Rāzī recognized two different types of the element ‘fire’: one, having flames, on the earth, the same as ember; the other, without flames, in the sphere of Ether, the same as ray. The celestial element of Ether is a half mixture of matter and void, with a circular movement, as Bīrūnī pointed out earlier, which justifies the circulation of the celestial bodies. The sphere of Ether is the space of the cosmic rays, referred to as ‘wāyīg ātaxš’ (the space fire) in Middle Persian (*Dēnkird*, p. 199). Basically the belief in the eternity of the element fire in the universe as first matter is a generally ‘Arian’ idea and a part of the theoretical physics of Rāzī and Bīrūnī.²⁴⁰

Concerning Bīrūnī’s wording, “Natural position [...]” (“force must of necessity have had a beginning”) (*The Chronology*, p. 247), Sachau says, again in his annotations, that Bīrūnī stated the idea elsewhere too, especially in his ‘debate’ with Ibn Sīnā. We should say it is well-known that he means the treatise *The Questions and The Responses* which was meant, in fact, to ‘reject’ Aristotelian natural ideas. Here we will point to two of his criticisms there: the problems of the natural position of the object and the eternal forced motion. It is clear that we cannot report the arguments in detail, thus we will mention the points briefly.

First, regarding the first problem, it should be noted that to believe in the movement of the elements from their natural places entails the existence of the void (Aristotle does not believe in void), and because every object has its own natural places (Aristotle says so) and the sphere is a body (Ibn Sīnā holds so), therefore, the sphere has a natural place. Now, because everything, in its natural place, is free from lightness or heaviness (Ibn Sīnā asserts so), and because fixed elements, in their natural places, are free from lightness or heaviness (whereby to start their “substantial” motion), therefore, their movement from their natural places is possible only through the forced motion (Aristotle) and returning to their natural places is of course through natural motions (Ibn Sīnā). In summary, to believe in the unnatural motion is a consequence of the rejection of the existence of the void. Therefore, Bīrūnī, who believed in the existence of void, concluded that none of the elements of the universe was in its natural place.²⁴¹

Second, about the eighth question which was again meant to reject the famous Aristotelian theory of ‘the eternity of the universe’, or the eternal motion, he remarks that, contrary to Aristotle’s idea saying that the universe has no beginning (on which Ibn Sīnā commented to the effect that Aristotle he did not mean to deny the “agent” [i. e. the creator], rather he intended to regard the agent far from any discontinuity of his action), Aristotle believes in the ‘agentive’ rather than ‘temporal’ beginning (i. e. in the last analysis, the agent is eternal and

²⁴⁰See *Hakīm Rāzī*, Parviz Azkai, chapter IV “Natural Philosophy”, section 5 “Theoretical Physics”, and chapter V “Cosmology”, section 5/j “The Whatness of Matter”.

²⁴¹See *Al-as’ilah wa ’al-ajwibah*, Bīrūnī and Ibn Sīnā, (ed.) Sayyid Hossein Nasr and Mehdi Mohaqqueq, Tehran, 1973, pp. 3-6, 51, 62.

his action can be interpreted as forced motion. Therefore, forced motion is eternal). Concerning the philosophical stance of Bīrūnī, he means here the ‘temporal beginning’ and the ‘non-eternity of the universe’. But, this is not the end of the story, because the discussion will ultimately lead to the question of ‘time’ and ‘dahr’ (eternal duration) (*The Questions and The Responses*, pp. 13, 14, 52, 66). It should be explained that, to Aristotle, the forced motion is ‘unnatural’ motion (because, to him, motion is the certain reality of nature and nature is the origin of motion) and rest is the inclination of an object to its natural place (because motion, in its general sense, is movement in place). Now, we must note that one of the strongest rejections of Aristotelian views by Rāzī was his attack on this idea to which Ibn Sīnā reacted offensively (*The Question and the Responses*, p. 13), with a consequent severe criticism of Ibn Sīnā’s master, Aristotle, and his *Physics* in response.²⁴²

Where Sachau writes “I have spoken [...] with Abu-Ali Sīnā [...]” (*The Chronology*, p. 247). He means the famous treatise *The Questions and the Responses*, just mentioned.

Concerning Bīrūnī’s words, “the stream and the rivers begin to rise” (*The Chronology*, p. 252), Sachau says, again in his annotations, “The [...] discussion on the circumstances under which water rises is of a technical nature, the due appreciation of which I must leave to physical scholars (*ibid*, p. 429). It can be seen that ten sections (pp. 58-67) are allocated to the natural causes of water eruption from the wells and springs (see upcoming commentary <376>). Bīrūnī is claimed to have stated the laws of Artesian wells centuries before the French Zele (see p. 92 f.)

“Water-thief [...] emptiness [void]”, Bīrūnī explains the operation of ‘syringes’ and pumps with respect to their creating vacuum (the same reason in the eruption of the wells through which the air in them is evacuated). First, in the treatise *The Questions and the Responses*, mentioned above, Bīrūnī directs eight physical criticisms at Aristotle and in the sixth question, he asks the reason why syringes operate. Ibn Sīnā, denying the existence of void, explained the operation in terms of forced motion, but Bīrūnī rejected, again in his tenth objection, his answer in a different way (*The Question and the Responses*, pp. 47-48, 55-56, 58). Second, the problem of the void is of the same fundamental theoretical importance in non-Aristotelian physics, i.e. the natural philosophy of Democritus, the father of atomism, and his followers, especially Rāzī and Bīrūnī, as in the modern physics and mechanics. Rāzī regarded void as the eternal “substance”, among his famous ‘five eternal entities’. Furthermore, in his well-known falsifications of Aristotle’s ideas and his doubting Galen’s views, he emphasized not only the possibility of the existence of void, also the necessity of its existence in nature. He wrote some single treatises and books on the subject and further explained his natural and philosophical viewpoints. Apart from his objective natural observations, he described the operation of the syringes, as Bīrūnī did later, through the example of the closed bottle. In response to Rāzī, Fārābī, the great philosopher of the peripatetics of the time, wrote his *Risāla fī al-khālā’* (*A Treatise on Void*), followed by Ibn

²⁴²See *Hakīm Rāzī*, Parviz Azkai, chapter IV “Natural Philosophy”, section 5/e “Motion and Rest”, and section 5/j “Appendices”./ *Barrasihā darbāre-ye Bīrūnī*, (ar. Morteza Motahhari): “Porsesh-hā-ye falsafi-ye Abu Rayḥān az Abū ‘Alī”, Tehran, 1973, pp. 54-163.

Sīnā, just in rejection of Rāzī's view.²⁴³ However, one needs to know that the experiment goes back to Aristotle and his exposition of 'the air' and his commentators presented arguments either to prove or to falsify it later, including the pupil of Rāzī, Yaḥyā Ibn 'Adī, with his restatement of his teacher's argument to prove void.²⁴⁴

²⁴³See *Hakīm Rāzī*, Parviz Azkai, chapter IV "Natural Philosophy", section 5/d "Void and Place", and section 5/j "Appendices, 15/d"

²⁴⁴*Al-ṭabī'a*, Arastū, Tr. Eshāq Ibn Ḥunayn, (ed.) 'Abd al-raḥmān Badwī, pp. 313-323, 330, 339, 343.

8. Theological ideas

1. Religious beliefs

It seems quite futile to investigate the faith of scholars such as Bīrūnī; Sunnites have been proud of attributing their beliefs to him, as Shiites have committed the same mistake. However, free from all prejudices, the scholar escapes from such vulgar traps. In sum, Bīrūnī was an original Iranian scientist observing the common laws of the Islamic society. Still, knowing his religious beliefs can be crucial in the scrutiny of his theological and philosophical views which were obviously not of the type of religious sectarianism. While philosophical stance could customarily stand in direct opposition to religion in the past, science did not. Bīrūnī was in fact a simple faithful man with a highly complicated mind. It has been commented that religion, as Bīrūnī or Galileo practiced, contrasted theology, philosophy and mysticism, but not 'faith'. As a matter of fact, he reconciled rationalism and experimentalism with religious faith.²⁴⁵

Bīrūnī's nationalistic anti-Arab feelings did not hinder him from believing in Religions and his religion studies actually helped him posit for the single truth underlying all superficial differences among religions. One can observe his spiritual tendency in finding the Qibla, lengthy inquiries about the prayer times and also his resorting to Quranic verses.²⁴⁶ He had scientific faithfulness to Quran, regarding it as the best holy book fully consistent with science. He commentated some of the Quranic verses about the creation of the world, calendar and catching sight of the new moon, the longitudes and latitudes of well-known places, the Qibla, and the importance of mines, precious stones and metals. Similarly, he referred to other holy books, viewing the phenomenon of the universe as a divine sign. As Yāqūt Ḥamavī reported his valuable book, *Lawāzim al-ḥarakatayn* (*The Necessary Consequences of the Two Motions*), dedicated to Mas'ūd Ghaznavī (*Kārnāme*, no. 145) embraces numerous Quranic verses. Another instance of his religious faith can be seen in his objections to some of blasphemies expressed by his favorite philosopher and scientist, Rāzī.²⁴⁷

Bīrūnī's contemporary philosophers and scholars, in the political-cultural dynasties of Khwārazmids, Samanians, Zīyārīds and Buyīds, such as Ibn Sīnā, were all suspected of Shiite

²⁴⁵*The Commemoration Volume* (ar. A. Bausani), pp. 483, 491./ *Naẓar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 183.

²⁴⁶*Tārīkh al-falsafa fī al-islām*, De Boer, p. 306./ *Naẓar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 179./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 63./ *Zendegināme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 321./ *The Scholar and the Saint*, (ar. E. Kennedy), p. 83 ff.

²⁴⁷*Tahqīq mā li al-Hind*, pp. 219-220. / *India*, I, p. 264./ *Mu'jam al-udabā'*, vol. 17, p. 184./ *Fihrist kutub al-Rāzī*, (ed.) Mehdi Mohaqeq, pp. 2, 46./ *Yādnāme-ye Bīrūnī*, (ar. 'Abd al-jawād Falātūrī), p. 512./ *Tārīkh al-falsafa fī al-islām*, De Boer, p. 306./ *Naẓar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 258./ *The Commemoration Volume...* (ar. Ma'sumi), pp. 557-578.

tendencies. It was Sachau, the editor of *Al-āthār al-bāqīya* (*Vestiges of the Past*), who first found out, from parts of the content of the book, that Bīrūnī had such a tendency.²⁴⁸ As it were, Yāqūt Ḥamavī reported that Bīrūnī was a pupil of ‘Abd al-Ṣamad Ḥakīm, killed on the charge of Karmatian thoughts, and that the Sultan intended to kill Bīrūnī too-the punishment waiting for the Ismaelite Ibn Sīnā as well.²⁴⁹ In addition, there is much evidence indicating that Bīrūnī’s unique philosophical conception of monotheism has much in common with the early theological Ismaelite philosophy.²⁵⁰ He wrote a book on historiography, under the title *Akḥbār al-Mubayyaḍa wa al-qarāmaṭa* (*Reports of the White-robed and Karmatians*) (*Kārnāme*, no. 162), yet he has criticized the esoteric cult of the Ismaelites, denying their sciences as well. Thus, some scholars have emphasized that undoubtedly he was not a follower of the Ismaelite or Sufism.²⁵¹ Some maintain that he was probably a Zaydite Shiite, because of a reference in his works (see *Al-āthār*, p. 422; *Al-qānūn*, p. 255).²⁵²

Bīrūnī is even believed to have been a Sunnite because he criticized Shiites here and there and even preferred Sunnite beliefs in some occasions. According to the contents of some tarwīhas in the book *Al-jamāhir* (*Gems*), he has been considered as a Sunnite.²⁵³ However, the general consensus is that he was born Shiite and had a Shiite tendency in youth (probably c. 407/ 1016), but during his long stay in the Sunnite-stricken court of Maḥmūd Ghaznavī, he seems to have adopted the Sunnite beliefs.²⁵⁴ Undoubtedly, in the Ghaznavī court, he was obliged to act as the Sunnites did, hence, he might have hidden his true beliefs. It should, furthermore, be said that his Shiite feelings manifested his political stance (his anti-Arabic feelings were so strong) which led to a kind of (cultural) Shu‘ubiite.²⁵⁵ He takes an indifferent standpoint toward cults (of course, not the religion), where he points out the properties of the

²⁴⁸*Chronologie Orientalischer Völker*, p. XXVII./ *Al-āthār al-bāqīya*, pp. 75, 420, 422./ *Chronology*, pp. 79, 326, 328.

²⁴⁹*Mu‘jam al-udabā’*, vol. 17, p. 186./ *Yādnāme-ye Bīrūnī*, (ar. Zabih Allah Safā), هشت / *Aḥvāl va āthār-e Abū Rayḥān Biruni*, Zabih Allah Safā, Tehran, Vezārat-e farhang va honar, 1973, p.....

²⁵⁰*Yādnāme-ye Bīrūnī*, (ar. Hossein Ḍiyā’ee), p. 191./ *Barrasiḥā-yi darbāre-ye Bīrūnī*, (ar. Mojtabā Minovi), p. 8.

²⁵¹*Al-āthār al-bāqīya*, pp. 233, 258, 260./ *Chronology*, pp. 177, 195-197./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 62./ *Nazar-e motefakkerān-e’eslāmi darbāre-ye ṭabī‘at*, Sayyid Hossein Nasr, p. 183, 246.

²⁵²*Bīrūnī Nāme*, Qorbāni, p. 3./ *Dā’erat al-ma‘āref-e tashayyo’*, vol. 3, (ar. Parviz Azkaei), 1992, p. 576.

²⁵³*Zendegināme-ye Bīrūnī* (Ali al-Shābbi), pp. 61-62./ *Journal of the Islamic Research Institute*, (ar. S. H. Nadvi), vol. XIII, no. 4, Pakistan, Dec. 1974, p. 263.

²⁵⁴*Tārīkh al-falsafa fī al-islām*, De Boer, pp. 299-306./ *Al-‘ilm ‘ind al-‘arab*, Aldo Mielī, pp. 188, 190./ *Tārīkh al-adab al-jughṛāfī*, Krachkovsky, p. 252./ *Nazar-e motefakkerān-e’eslāmi darbāre-ye ṭabī‘at*, Sayyid Hossein Nasr, p. 181./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 61./ *Zendegināme-ye ‘elmi-ye dānešmandān-e’eslāmi*, (ar. Kennedy), p. 321.

²⁵⁵*Chronologie Orientalischer...* (Vor. E. Sachau), p. XXVII./ *Introduction to the history of science* (G. Sarton), vol. 1, p. 707./ *Taḥdīd nihāyāt al-amākin* (Pers.), p. 21./ *Moqaddame bar tārikh-e ‘elm*, Tr. Sadri Afshār, p. 815./ *Sharḥ-eḥāl-e nābeghe-ye shahūr-e Irān Abū Rayḥān*, Dehkhodā, p. 23./ *Yādnāme-ye Bīrūnī*, (ar. Kuru Yanaki), p. 60./ *Andishmand va ensān*, Najafi and Khalili, p. 121./ *Dā’erat al-ma‘āref-e tashayyo’*, vol. 3, (ar. Parviz Azkaei), 1992, p. 576.

black and white iron ores (*khumāhan*), the black ore used by Sunnites and the white ore by Shiites in making their own signet rings, and adds that “I myself used to wear a double signet ring, black and white to represent the two cults at the same time.”²⁵⁶

Such a stance roots solely in his unprejudiced mind and liberal peace-making. Obviously, the man believing in the unity of religions, or the philosophical monism, shall never lead a life to be subject to sectarianism. He has repeatedly stressed that “he is far from prejudice and false persistence” *Maqālīd ‘ilm al-hay’a* (*Keys to Astronomy*), presenting faithful records of non-Islamic beliefs.²⁵⁷ Sachau remarks “Independent in his thoughts about religion and philosophy, he is a friend of clear, determined, and manly words. He abhors half-truth, veiled words, and wavering action. Everywhere he comes forward as a champion of his conviction with the courage of a man, as in religion and philosophy, so too in politics. There are some remarkable sentences of political philosophy in the introductions to chapters ix and Lxxi [...] he declares that “their union represents the highest development of human society, all that men can possibly desire”.²⁵⁸ In brief, Bīrūnī seems to have been in a sort of agreement with Shiites, without any opposition to the Sunnite sects of his time. With such universal worldview, he was not limited to any boundaries in religion and cults.²⁵⁹

2. Problem of creation

In the first classification, discussions on the subject can be traced back to two origins: eternity of the world versus non-eternity of the world. To Bīrūnī, non-eternity of the world means that it was created by the creator; hence, he believed in the temporal beginning of the world and rejected the *temporal eternity*.²⁶⁰ He says that “the non-eternity of the universe is true according to rational arguments and Syllogism. The limited duration created by the origination of the world has a beginning; [therefore], it is temporal and non-eternal”.²⁶¹ Accordingly, he viewed the creation of the universe *ex nihilo*, as the holy books assert.²⁶² In his debate with Ibn Sīnā and in the second question, as a criticism against Aristotle, he regards Aristotle’s words as blasphemous, because, to him, it is the same whether to believe in the eternity of the spheres or to deny the creator. He also rejects the eternity of the world

²⁵⁶ *Al-jamāhir fī ma’rifā al-jawāhir*, p. 325./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 64./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī’at*, Sayyid Hossein Nasr, p. 181.

²⁵⁷ *Bīrūnī Nāme*, Qorbāni, p. V./ *Biruni Symposium*, (ed.) E. Yarshater, p. V.

²⁵⁸ *Tahqīq mā li al-Hind*, p. 75./ *India*, I, p. XIX.

²⁵⁹ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Mojtabā Minovi), p. 8.

²⁶⁰ *Fihrist kutub al-Rāzī*, Mehdi Mohaqqueq, pp. 18, 58./ *Payām-e Yunesko*, vol. 59, (ar. Sayyid Hossein Nasr), p. 39./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī’at*, Sayyid Hossein Nasr, p. 184.

²⁶¹ *Tahdīd nihāyāt al-amākin* (Ara.), p. 39; (Pers.), p. 16.

²⁶² *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī’at*, Sayyid Hossein Nasr, pp. 184, 185./ *Tahdīd nihāyāt al-amākin* (Pers.), pp. 16-18.

and the possibility of infinite divisions of the matter, in line with the theological doctrines, since [Bīrūnī's] atomistic arguments leading to the temporality of the universe and denying its eternity, are the same as the new metaphysical theory in philosophy. By the way, believing in the holy books and 'days of creation', he is said to have begun the same critical debate through philosophy (in the western sense of the word) that Ghazālī did in his *Tahāfut al-falāsifa* (*Incoherence of the Philosophers*).²⁶³

As we will discuss fully in the next chapter, while discussing the Brahman philosophy of the Hindus, Bīrūnī mentions the necessity of the existence of the creator. He also discusses the two concepts 'eternal duration' and 'time', used by theologians. Furthermore, during his discussion of the concepts Brahm [the creator] and Prajapati [pre-eternity] used by Hindus, he mentions creation by nature, which can be understood to refer to the first cause.²⁶⁴ The earth and the heaven are created by 'time' (Kāla) and whatever exists or will exist are contained in time, including Brahman. Time is the lord of everything and the father of Prajapati. Thus, time is both the creator and the lord of the creation he has fashioned. He is the creator or the lord of the celestial bodies, determines the human destiny- 'the father of everything'. We should know that the concept of time as the supreme God roots in the Arian [Iranian] tradition, where time is the creator and the protector of the universe.²⁶⁵ However, Bīrūnī does not consider 'time' as eternal, as we will discuss in the next chapter, and this is simply a difference in terms, since he means the finite time, while, following Rāzī, he names the infinite time without beginning as 'eternal duration'.

3. Principle of monotheism

"The Hindus believe with regard to God that he is one, eternal, without beginning and end... He is height, absolute in the idea, not in *space*, for his sublime beyond all existence in any space"²⁶⁶, and says, in a quotation from the book *Patanjali* that the world is sempiternal in itself [...], divine matters have no connection with time"²⁶⁷. This is Bīrūnī's own monotheistic belief too, as we have just mentioned concerning the issue of creation and the creator. Sachau says that Bīrūnī had a manifest tendency to Indian philosophy and that he seems to have supposed that Indian and Greek philosophers, frequently distinguished by him with precision from the ignorant idol-worshipper masses, believed in the same fact as he did himself, that is, absolute monotheism. He also believed that people were in the beginning equally pure and

²⁶³ *Al-as'alah wa al-'jwibah*, Sayyid Hossein Nasr and Mehdi Mohaqqueq, pp. 11, 13, 51, 52./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 248./ *Payām-e Yunesko*, (ar. Sayyid Hossein Nasr), p. 39./ *Barrasiḥā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahari), p. 90./ *The Commemoration Volume*, (ar. L. Gardet), pp. 196-197.

²⁶⁴ *Tahqīq mā li al-Hind*, pp. 71, 270-271./ *India*, I, pp. 93-94, 319-320.

²⁶⁵ *History, Time and Deity* (S. Brandon), Manchester University, 1965, pp. 37-38, 44, 53, 98.

²⁶⁶ *India*, I, pp. 27, 28

²⁶⁷ *Tahqīq mā li al-Hind*, pp. 20, 21, 58./ *India*, I, pp. 27, 28, 77.

pious, worshipping the same sublime all-mighty God, but the dark lusts of the society began to cause the differences between that religion with philosophical and political ideas, eventually leading to idol-worshipping [...] therefore, he admitted a single truth believed by everybody as a consequence of his readings of the nations' religions.²⁶⁸

By the distinction he made between common people and the thinkers, Bīrūnī meant that only a limited number of Greeks or Indians came to achieve abstract thinking, the 'divine knowledge'.²⁶⁹ He says that the thinkers there believe in God, the One, eternal, free, almighty, wise, alive, etc, as the Muslims believe.²⁷⁰ He blames Manichaeans for diverting people with little faith from the "One and First God" to dualism.²⁷¹ Acquainted with mysticism, Bīrūnī respectfully studied the Indian idea of pantheism (Advaita Vedanta) which is compatible with the *Vedas* and the *Upanishads*. It appears, from the seventh chapter of *India*, on how to release from the world, that he believed Indian way was the most practical; the mystical way was the most spiritual, and Greek thought the most logical.²⁷²

Bīrūnī's efforts in sciences, as it were, root in the unity principle and monotheism; hence he disagreed with Aristotelian ideas. Similarly, concerning religions, as majority of the scholars have agreed, he was the first scientist to emphasize the unity of religions and regarded the monotheistic practice as the greatest precept. The idea of the unity of human civilization, or the 'perpetual wisdom', is the ideal that Bīrūnī shares with his advanced contemporary thinkers. In the next chapter, we will show how his theory of the 'original unity' is a consequence of his belief in the 'first cause'. However, it would be of great pleasure here to note a passage from *India*: "Their union is the highest development of the society, all that men can possibly desire".²⁷³

²⁶⁸*India*, pp. XVIII./ *'Elm va tamddon dar eslām*, Sayyid Hossein Nasr, p. 247./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 179.

²⁶⁹*Biruni Symposium*, (ar. B. Lawrence), p. 40.

²⁷⁰*Tahqīq mā li al-Hind*, p. 20./ *India*, I, p. 27./ *Barrasiḥā-yī darbāre-ye Bīrūnī*, (ar. Ja'far Sajjādi), p. 319.

²⁷¹*India*, I, p. 264.

²⁷²*Nazar-e motefakkerān-e eslāmi darbāre-ye Ṭabī'at*, Sayyid Hossein Nasr, p. 182./ *Tahqīq mā li al-Hind*, pp. 53-54./ *India*, I, pp. 70-71./ *Yādnāme-ye Bīrūnī*, (ar. Hossein Ziyāee), p. 189./ *al-Biruni Commemoration Volume*, (ar. H. Heras), pp. 119-124./ *The Scholar and the Saint*, (ar. B. Lawrence), p. 30.

²⁷³*Tahqīq mā li al-Hind*, p. 4, 75./ *India*, I, pp. XIX, 99./ *Payām-e Yunesko*, no. 59, (ar. Sayyid Hossein Nasr), p. 39./ *Biruni Symposium...*, (ar. F. Rosemthal), p. 10./ *al-Biruni Commemoration Volume*, (ar. A. Pope), p. 283.

9. Philosophical ideas

1. Scientific philosophy

It has been frequently quoted, as Ṣahīr al-dīn Beyhaqī (born 565/ 1169) noted first, that Bīrūnī dived and inquired not deeply enough in the sea of rationality and philosophy.²⁷⁴ Other historians of philosophy too have not named him as a philosopher, rather as a scientist only.²⁷⁵ Despite the fact that he never claimed to be a philosopher, he was by no means unaware of philosophical issues, as his famous debate with Ibn Sīnā manifests too.²⁷⁶ We should note here that people seem to be used to recognize a thinker as a philosopher, if he or she bows at Plato or Aristotle, as Fārābī said that “Plato and Aristotle are the two outstanding pioneers of philosophy” and Shahrastānī added that “The Islamic philosophers as the Iranian sages, are [all] the followers of Aristotle.”²⁷⁷ Bīrūnī was no such man; After Rāzī, he was the only thinker in Islamic philosophy to attack vigorously the Aristotelian philosophy. Now, how can one expect Iranian followers of Aristotle to recognize Bīrūnī ‘a philosopher’ in their histories of philosophy?

Nonetheless, he was a philosopher both in the ancient sense of the word, with respect to his mastery in theoretical and practical wisdom, and mathematical and experimental sciences, and also in the modern sense, just in the same way that the enlightenment scholars have been customarily considered as philosophers in the west. If he has achieved no such status in philosophy, he is still viewed worldwidely as a wonder for his theoretical thoughts and inquiries, today known more as science than philosophy. However, he owes his scientific exactness to his philosophical ideas which can more or less be inferred from his well-known refutations and objections against Aristotle.²⁷⁸ The first point is that he did not follow any of the philosophical schools of his time, although he had an overall knowledge of all.²⁷⁹ He is

²⁷⁴*Tatimmat ṣiṭwān al-ḥikmat*, p. 63./ *Nuzhat al-arwāḥ*, Shahrzūrī, Haydar Abad al-Dakan, vol. 2, 1396, p. 86./ *Tārīkh al-falsafa fī al-islām*, De Boer, p. 297./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), p. 62./ *Yādnāame-ye Bīrūnī*, (ar. ‘Abd al-jawād Falāṭūrī), p. 512.

²⁷⁵*Tārīkh-e ‘olum-e ‘aqli dar tamaddon-e eslāmi*, Zabih allah Safa, Tehran University, 1957, p. 286./ *Payām-e Yunesko*, no. 59, (ar. Sayyid Hossein Nasr), p. 38./ *Abu Ryhan al-Biruni*, Mohammad Isma‘il Moballegh, Kabul, 1973, p. 71./ *The Commemoration Volume*, (ar. L. Gardet) p. 193./ *ibid.*, (F. Rosenthal), p. 537.

²⁷⁶*Biruni Symposium*, (ed. E. Yarshater), p. V./ *The Commemoration Volume*, (ar. L. Gardet) p. 194./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), p. 65./ *Tārīkh-e ‘olum-e ‘aqli...*, Zabih allah Safa, p. 283.

²⁷⁷*Al-jam‘ bayn ra’y al-ḥakīmāyn*, Fārābī, p. 2./ *Al-mīlāl wa al-niḥāl*, Shahrastānī, vol. 2, p. 64./ *Abu Ryhan al-Biruni*, Mohammad Isma‘il Moballegh, pp. 71, 79./ *Barrasīhā-yī darbāre-ye Biruni*, (ar. Morteza Motahhari), p. 62.

²⁷⁸*Abu Ryhan al-Biruni*, Mohammad Isma‘il Moballegh, p. 71./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), p. 65./ *Tārīkh-e ‘olum-e ‘aqli dar tamaddon-e eslāmi*, Zabih allah Safa, p. 282./ *al-Qanun al-Mas‘udi* (ar. S. H. Barani), p. XII./ *The Commemoration Volume*, (ar. I. Gardet), p. 194.

²⁷⁹*Payām-e Yunesko*, no. 59, Sayyid Hossein Nasr, pp. 27, 38./ *Barrasīhā...*, (ar. Sayyid Ja‘far Sajjādi), p. 317./ *Yādnāame-ye Bīrūnī*, (ar. ‘Abd al-jawād Falāṭūrī), p. 512.

indeed ‘an unknown philosopher’ independently founding a free-thinking philosophical school, especially on the general grounds of the history of rational sciences.²⁸⁰

Bīrūnī’s definition of philosophy appears especially scientific, as if he aims to explain the scientific philosophy: “[...] hence Galen produced a book on why a learned physician has to be a philosopher as well, namely a lover of wisdom. To them, philosophy is restricted to the knowledge of the entities via their real beings. And as man scrutinizes, he can say that anyone involved in a branch of science, has to be a philosopher who has studied the principles of all sciences, although his short life will never give him the chance to study the minor parts of them.”²⁸¹ Accordingly, in line with the Greek view, philosophy was to him the knowledge about the world’s entities as they are and a philosopher is, therefore, a person knowledgeable in all aspects. Bīrūnī, as an example of this type, does possess a system of thought, with an ever-dynamic selection of materials and subjects, whose products and consequences continue to extend to the present time.²⁸² Another fundamental characteristic of his thought is that he tried to interpret the reality in terms of philosophy as much as possible. As it were, we should bear in mind that his philosophy, unlike most philosophers, did not contradict religion. Philosophers, such as Averroes (520-595/ 1126-1198), attempted to reveal the concepts behind the religious categories. Bīrūnī, however, believed that religious categories are revealed linguistically, so we should first see what the terms mean.²⁸³

Even if not a methodic philosopher, Bīrūnī was a scholarly scientist with advanced philosophical competence, though not in agreement with the Aristotelian philosophy of his time. Whatever his own philosophy could have been, it was different from that of Ibn Sīnā, because it was based on rather a modern experimental and inductive foundation.²⁸⁴ The conflict of the two philosophers was indeed the disagreement between scientific philosophy and Aristotelian or peripatetic philosophy, and, to the present writer, between Iranian and Greek philosophy. As a matter of fact, no single independent philosophical work, in the narrow sense, has been found among Bīrūnī’s existing or lost writings and, apart from the

²⁸⁰It seems right here to express my own opinion as a result of long exhaustive studies which can implicitly respond questions as why Bīrūnī has seemed to have been a follower of no certain school of philosophy and has remained an unknown philosopher. What was his concealed and yet independent mode of philosophy? To respond negatively in a few words, we should say that in the philosophy followed by Bīrūnī, whatever called, metaphysical and idealist foundations were thoroughly rejected. His philosophy, in accordance with that of Rāzī (see *Rāzī, the Sage*, chapter 5), was a result of positive sciences and natural philosophy based on material atomism.

²⁸¹*Tahdīd nihāyāt al-amākin* (Ar.), p. 292.; (Pers.), p. 255.

²⁸²*The Commemoration Volume*, (ar. F. Rosenthal), pp. 542-549./ *al-Qanun al-Mas’udi* (ar. S. H. Barani), p. XI.

²⁸³*The Commemoration Volume*, (ar. A. Bausani), pp. 479-483./ *Tahqīq mā li al-Hind*, pp. 4, 19./ *India*, pp. 5, 25.

²⁸⁴*Tārīkh al-falsafa fī al-islām*, De Boer, p. 297./ *Ekhterā’āt va ekteshāfāt-e Abū Rayhān*, Jalāl al-din Homāee, p. 45./ *Kitāb al-mihrijān li Ibn Sīnā*, Mohammad Reza Al-shaybi, Tehran, 1956, p. 124./ *Tārīkh-e ‘olum-e ‘aqli...*, Zabih allah Safa, p. 283./ *Zendegināme-ye Bīrūnī* (Alī al-Shābbi), pp. 83, 86./ *Barrasīhā...*, (ar. Sayyid Ja’far Sajjādi), pp. 302, 342./ *Biruni Symposium*, (ar. G. H. Youssefi), p. 18.

treatise, *Al-as'alah wa al-jwibah* (*The Questions and the Responses*), his philosophical ideas mostly spread here and there in his books and treatises, particularly the book *India* which is indeed a history of the Brahmin philosophy. Bīrūnī has a high status in the general history of philosophy both for his philosophical viewpoints toward the world and his history of philosophy and science. He viewed philosophy as a civilized phenomenon necessitated for human beings by the requirements of his life, so as to help him with the management of his life and also the distinction of good or evil.²⁸⁵

Concerning his philosophical ideas, as it were in the previous chapter, we should note that, since he was a pupil of the Ismaelite sage ‘Abd al-ṣamad, it seems quite natural that he was acquainted with the philosophical basis of that school. In addition, according to certain evidence, his philosophical monotheism has something in common with the former Ismaelite treatises.²⁸⁶ Some scholars have also claimed that he had a tendency toward mystical philosophy, since pieces of Platonistic philosophy, also quoted in the works of Suhrawardī, the philosopher of illumination, can be found in his writings, as other mathematicians and astronomers too show such tendencies.²⁸⁷ Undoubtedly, Bīrūnī was influenced by the Iranian philosophical schools and, in the realm of pure science, like Rāzī, he was generally the representative of Iranian philosophy. Concerning the view which holds that he had to accept the overall truth of Greek philosophy because of the cultural and educational circumstances of his time,²⁸⁸ Sachau says that he learned that philosophy through the current Arabic translations from a translated Syriac origin, and also translated by his scholar friend Abu al-khayr Khammār, who knew Greek and translated Theophrastus from Syriac texts.²⁸⁹ It should, however, be noted that Bīrūnī did know Greek, in addition to Syriac, as it can be inferred from his book *Al-ṣaydana* (*Pharmacy*, p. 15). As Dr. Zaryab Khoei mentioned, Sachau’s opinion belonged to the time before *Al-ṣaydana* was found.

Bīrūnī admired Greek philosophy greatly and preferred the Greeks, ‘the pillars of wisdom’ in his terms, to the Indians on the account of their philosophy. He argued that the Greeks achieved the truth of what they study from the shortest path. His frequent citations and quotations from Greek philosophers and the comparisons he makes between their philosophy and that of the Indians and others may indicate his mastery of Greek philosophy and the schools of it. His doubts and objections against the principles of Aristotelian philosophy in his debate with Ibn Sīnā is another example. But, we should immediately add that, stimulated by his truth-seeking nature, he strongly defended Aristotle elsewhere, especially his logic and

²⁸⁵ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), pp. 61-62./ *Naẓar-e motefakkerān-e eslāmi darbāre-ye ṭabī‘at*, Sayyid Hossein Nasr, pp. 173, 246./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 83./ *The Commemoration Volume*, (ar. L. Gardet), pp. 196-203./ *al-Biruni Commemoration Volume*, (ar. A. Pope), p. 289./ *The Scholar and the Saint*, (ar. F. E. Peters), p. 26.

²⁸⁶ *Yādnāme-ye Bīrūnī*, (ar. Zabih Allah Safa), p. 8./ *Yādnāme-ye Bīrūnī*, (ar. Hossein Ziaee), p. 191./ *Barrasihā-yee darbāre-ye Bīrūnī*, (ar. Mojtaba Minovi), p. 8./ *Zendegināme*, p. 21.

²⁸⁷ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Sayyid Ja‘far Sajjadi), pp. 302, 304, 319.

²⁸⁸ *Biruni Symposium* (ar. F. Rosenthal), p. 6./ *Tārīkh al-falsafa fī al-islām*, De Boer, p. 270.

²⁸⁹ *India*, II, notes, p. 256.

categories widely spread in the Islamic countries.²⁹⁰ One does not need to emphasize that, as some scholars have noted, Bīrūnī reveals a clear tendency toward the Brahmin philosophy, as he himself frequently asserts that their writings bear some identity with those of the Greeks. However, he seeks the truth more among the Greeks, because he felt he did not have much in common with the blindly obedient Indians.²⁹¹ Bīrūnī was inspired particularly by *Bhagavadgita* which will be discussed later. In sum, his intellectual product was a mixture of the knowledge from India, Iran, Greece and other nations of the past which reveals his strong inclination to intellectual philosophical conversion.²⁹²

2. Critical philosophy

Bīrūnī's reputation in philosophy roots specifically in his strongly critical stance against the peripatetic, or, to be more precise, the Aristotelian philosophy. The critical school of philosophy is, at the present time, an important school of epistemology, parallel with experimentalism and rationalism. Bīrūnī, as a combiner of empiricism and rationalism, is regarded as one of the founders of the critical school of philosophy.²⁹³ It is quite meaningful to find statements such as "Withstanding against the worldwide philosophy of Aristotle was by no means an easier task than resisting against the invasion of Alexander".²⁹⁴ In the same line, I seem to be justified in holding that in the debate between Bīrūnī and the outstanding follower of Aristotle, the ancient cultural conflict between Iran and Greece manifestly reoccurs. "Aristotle was the one who ruled over the world's thought for about twenty centuries. He was the absolute master and idol of the people who respected thinking. He was, prior to anything else, the writer of *Organon*, the great "instrument" ever produced to make humans captive and obedient".²⁹⁵ Thus, Bīrūnī seems quite right in his exceptionally brave objections against Aristotle.²⁹⁶

By the way, his criticisms are mainly concentrated in his famous treatise *Al-as'alah wa al-ajwibah* (*The Questions and the Responses*), involving ten questions from Ibn Sīnā about

²⁹⁰ *Taḥqīq mā li al-Hind*, pp. 18, 24./ *India*, I, PP. 24, 33./ *Taḥdīd nihāyāt al-amākin* (Pers.), pp. 7-8, 110./ *The Commemoration Volume*, (ar. A. Badawī), p. 154.

²⁹¹ *Taḥqīq mā li al-Hind*, pp. 17-19, 24./ *India*, I, XVIII, 23-25, 33./ *Biruni Symposium*, (ar. F. Rosenthal), p. 6./ *'Elm va tamaddon dar eslām*, Sayyid Hossein Nasr, p. 247.

²⁹² *Tārīkh al-falsafat fī al-islām*, De Boer, p. 297./ *Yādnāame-ye Bīrūnī*, (ar. Reza), p. 276./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 177./ *India*, II, notes, p. 265.

²⁹³ *Abu Ryhan al-Biruni*, Mohammad Isma'īl Moballegh, p. 85./ *The Commemoration Volume*, (ar. L. Gardet), p. 205.

²⁹⁴ *Yādnāame-ye Bīrūnī*, (ar. Reza), p. 281.

²⁹⁵ *L'idee de la method des science*, (A. M. Badi), Lausanne, t. 1, 1953, pp. 15-16.

²⁹⁶ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahari), p. 62.

some principal topics in Aristotle's important book *The Sky and the Universe*, with eight other questions posed by Bīrūnī himself.²⁹⁷ The first question by Bīrūnī also reported in *Al-āthār* (p. 319) concerns one of the most important issues in ancient natural philosophy about the heaviness or lightness and the place of the objects: Why does Aristotle believe that the sphere is free from lightness or heaviness? Is it on the ground that one cannot envisage motion from the center and motion towards the center for the sphere? We should explain that Bīrūnī denies here the two basic Aristotelian categories of 'natural place', and "forced motion" of the bodies. It can be also said that he did not probably object the results obtained by Aristotle, rather the argumentation posed by him. However, another view holds that since Bīrūnī attributed the gravitational force to the earth, the masterpiece of his scientific thinking lies in the very question which has remained valuable to the present day.²⁹⁸ The other objections by him against Aristotelian ideas were mentioned in the section of his natural ideas, and will be discussed more in due place.

As a matter of fact, Bīrūnī criticized Aristotle more in the way an 'iconoclast' does, since, despite his deep respect for the great philosopher, he meant to warn that the master was by no means free from errors. Concerning the Aristotelian account of the rays of the sun and the moon, he comments: "the miserable point with those who exaggeratedly defend Aristotelian ideas is that they take him absolutely free from any possibility of making errors or mistakes, whilst it is right against his own idea as one of the deep-thinkers of his time. Such exaggerations with the intension of *escaping* from the hazard of errors root in the fact that they have inherited easy agreement and effortless acceptance as their ancestors' manners and habits. They have undertaken an obedient surrender to the relevant Aristotle's ideas in the book *Meteorology*. In order not to be found as opposing his beliefs, they even attribute his ideas to others to pretend that he is far from any errors in that book [...] . Aristotle's proponents have gone so far in denying counterexamples that their effort has turned into a ridiculous task. Therefore, I wrote a treatise [to divulge such distortions ...]".²⁹⁹ In this way, with his scholarly criticisms of the old philosophy, Bīrūnī has been admitted by almost all historians to be prior to Bacon and Descartes for centuries.³⁰⁰

Now, how much of his criticisms were directed to Ibn Sīnā? The answers vary from similarities to oppositions between the two philosophers. Some have maintained that Ibn

²⁹⁷ *Sharḥ-e ḥāl-e nābeghe-ye shahir-e Irān Abū Rayḥān*, Dehkhoda, pp. 32-66./ *Abu Rayhan Bīrūnī va Ibn Sina (Al-as'alah wa al-ajwibah)*, Nasr and Mohaqeq, Tehran, 1973./ *Barrasīhā-yī darbāre-ye Bīrūnī*, Morteza Motahari, pp. 54-163./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, ←pp.246-257./ *'Elm va tamaddon dar eslām*, Sayyid Hossein Nasr, pp. 126-134./ *Tārikh-e 'olum-e 'aqli dar tamaddon-e eslāmi*, Zabih Allah Safa, pp. 283-286./ *Avicenna Commemoration Volume*, (ar. S. H. Barani), pp. 3-14./ TIVAN UzSSR, (ar. Yu), 1953 (1), pp. 46-56; 1956, (ar. Zavadovskiy).

²⁹⁸ *Al-as'alah wa al-ajwibah*, pp. ب, ج, 2./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 250./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), pp. 70, 75, 76./ *Andishmand va ensān*, Najafi and Khalili, p. 113.

²⁹⁹ *Ifrād al-maqāl, Rasā'il al-Bīrūnī*, p. 56./ *The exhaustive treatise on shadows*, pp. 32-33.

³⁰⁰ *Abu Ryhan al-Biruni*, Mohammad Isma'il Moballegh, p. 81./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 248.

Sīnā's responses were mostly in defense of Aristotle, not as the final investigation of the reality. Others hold that anyone acquainted with philosophy knows that Ibn Sīnā, introduced some of his own ideas in Aristotelian beliefs and was not a slave of that philosophy, or perhaps, aware of Bīrūnī's tendency to Rāzī's doctrines, he meant to attack Rāzī for Bīrūnī's attacks against Aristotle. Yet, a remarkable stance is that Bīrūnī criticized the speculative methodology of the philosophers abiding in their ivory towers, saying "From the depth of the dark earth to the apogee of Saturn-/ universal problems of all kinds I solved" and, without objective observations, wrote books on natural sciences.³⁰¹ This seems to be the right explanation and therefore, Bīrūnī's criticisms must be, therefore, inferred as directed to Ibn Sīnā himself more than anybody else.

Since Bīrūnī's critical thinking has been taken as a clear sign of his advanced scientific thinking, some scholars have objected that objecting Aristotle, by itself, is no good reason for intellectual advancement. They have added that one should examine the validity of the objections, for instance, whether they are basic enough or compatible with the later higher achievements in philosophy. And then, objections against Aristotle are not bound to Bīrūnī at all; the followers of Ibn Sīnā, and a good number of Iranian sages such as Suhrawardī (his philosophy basically founded upon his criticisms against Aristotle), Fakhr Rāzī and Ghazālī are among the greatest critics of the peripatetic philosophy. We should also add that western researchers unanimously agree that, as a 'great independent inquirer', Bīrūnī was prior to Ghazālī, the author of the book *Tahāfut al-falāsiafat (Incoherence the Philosophers)*, as far as the critical arguments of the two are concerned. This confirms Bīrūnī's priority for his critical debates, in the western sense of the word, almost a century before Ghazālī. He was the pioneer of 'critical philosophy'.³⁰² We should furthermore add that Rāzī was the former pioneering figure a century before him (see. chapter 2, section 4) whose philosophy provided him with what the true follower needed.

3. Natural philosophy

We have already mentioned, in chapter 7, that Bīrūnī's thought is established upon the gradual evolution theory, the agent of which in the realm of natural affairs is nature itself. As a matter of fact, the theory of evolution, giving rise to several philosophical schools, from Plotin to Marx, is the principle on which Bīrūnī's natural philosophy is founded.³⁰³ Therefore, since he was a man of natural philosophy and his inquiries were founded on material and

³⁰¹ *Avicenna Commemoration Volume*, (ar. S. H. Barani), p. 13./ *Tārīkh-e 'olum-e 'aqli dar tamaddon-e eslāmi*, Zabih Allah Safa, p. 285./ *Barrasīhā-yee darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), p. 64./ *Kitāb al-mihrjān li Ibn Sīnā*, Mohammad Reza Al-shaybi, Tehran, 1956, p. 129./ *Abu Ryhan al-Bīrūnī*, Mohammad Isma'il Moballegħ, p. 75.

³⁰² *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), pp. 62, 63./ *Tārīkh al-falsafat fī al-islām*, De Boer, (ed.) Mohammad 'Abd al-Hadi Abu Rayda, p. 305./ *The Commemoration Volume*, (ar. L. Gardet), pp. 197-205.

³⁰³ *Yādnāame-ye Bīrūnī*, (ar. 'Abd al-jawād Falāṭūrī), pp. 511-514./ *Naẓar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 230.

mathematical sciences, his natural studies do not require metaphysical justifications.³⁰⁴ In his general natural philosophy, he was deeply concerned with the issues of motion, time and matter and, unlike theologians, he admitted no personification in nature, nor did he justify the evolution of the world with resource to the final cause. In brief, he believed that natural sciences were needless of ‘philosophical’ viewpoints.³⁰⁵ In his natural philosophy, he was a follower of Rāzī (251-313/ 865-925), hence one can maintain that, apart from direct inheritance of the natural schools of Iranian philosophy, the two thinkers were inherited by the school of the first Greek natural philosophers, especially Thales (624-546 B.C.), Pythagoras (571-495 B.C.), Anaxagoras (500-428 B.C.), Democritus (460-370 B.C.) and Plato (429-347 B.C.), all inspired by the wisdom of the ancient Iranian magi in the last analysis.

However, like Rāzī, Bīrūnī was inclined to the natural philosophy of pre-Socrates thinkers. We should note that Rāzī too separated from Aristotelian natural philosophy and showed a clear interest to Plato. He wrote a commentary on Plato’s book of natural science, *Timaeus*, compiled, as an entry to natural science, his own book *Sam’ al-kayān (Natural Philosophy)*, on evolution and transformation, and also wrote a book under the title *Al-ārā’ al-ṭabī’iyya (Natural Opinions)*.³⁰⁶ The natural science principles, followed by Rāzī and Bīrūnī, are the same as those developed in the sixteenth and seventeenth centuries in Europe during the scientific revolution in the form of the book *Principia* by Isaac Newton (1642-1727) which can be outlined as the following: (1) Atomism and the possibility of the existence of void, (2) Absolute time independent and prior to motion, (3) Mechanical motion as the movement of the atoms in the space, (4) Science based on observation and experience, (5) The necessity of employing mathematics in natural studies, (6) “Infinitesimals” [atoms] as actually continuous quantities in the totality of the parts.³⁰⁷ It is known that these principles were by no means new in that age, because even before the atomistic theories by figures such as Bīrūnī and Rāzī, the Greek atomism was based on the existence of void. The Pythagorean mathematics too was in line with the transformation of continuous quantities into discontinuous qualities i.e. numbers, insomuch that Plato’s cosmology in *Timaeus* has been considered as an attempt to synthesize atomism and mathematics. Of the six principles mentioned above, three were studied in previous chapters. Now, we will turn, in the following, to the exposition of the first three principles in brief.

³⁰⁴ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Sayyid Ja‘far Sajjādi), p. 343./ *Histoire de la Philosophie Islamique*, H. Corbin-H. Nasr-O Yahya, vol. 1, Paris, 1964, pp. 208-210.

³⁰⁵ *Payām-e Yunesko*, no. 59, (ar. Sayyid Hossein Nasr), p. 40./ *The Commemoration Volume*, (ar. L. Gardet), pp. 199, 200, 201.

³⁰⁶ *Fīlsūf-e Rey*, Mehdi Mohaqeq, Tehran, Anjoman-e āthār-e melli, 1970, pp. 99, 102, 103, 149, 159-161, 175, 224, 248, 256, 267, 298, 319./ *Al-sīra al-falsafiya*, Rāzī, (ed.) Mehdi Mohaqeq, p. 101.

³⁰⁷ “Miyān-e falsafe va kalām”, Hossein Ma‘sumi Hamedani, (in) *Majalle-ye Ma‘āref*, Nashr-e dāneshgāhi, دوره 3, no. 1, 1986, p. 208./ *The Commemoration Volume*, (ar. L. Gardet), pp. 202-203./ *The Scholar and the Saint*, (ar. A. Heinen), pp. 49-66.

a. The natural categories. Bīrūnī asserts: “When one intends to discriminate truth from falsehood, his inquiry will inevitably lead to the investigation of the tale of the world: whether it was ever-existing [i.e. eternal] or originated [i.e. non-eternal]”.³⁰⁸ We have already mentioned, in our account of his theological ideas in chapter 8, that he believed in the origination of the universe, as Rāzī argued that the world is non-eternal and that it has an eternal director with whom were absolute soul, and place, i.e. void and absolute time. In his book *Al-shukūk* (*The Doubts*), Rāzī criticizes the fourth article of Galen’s *book of Deduction* which had it that the world was not corruptible, and adds that here Galen contradicts himself. Scholars have remarked that Galen was dubious about taking the cosmos either eternal or non-eternal; however, Plato believed that the world was undoubtedly originated. We should also mention that, as Fakhr Rāzī demonstrated in his book *Al-arbaʿīn* (*The Forty Responses/Questions*), the majus [zoroastrians], Jewish and Muslims mostly believe in the non-eternity of the objects in essence and in attributes; some philosophers believe in non-eternity of the essence and attributes; and philosophers prior to Aristotle mostly believe in the eternity of the essence and non-eternity of the attributes. (Here by essence is meant ‘matter’, and by attributes is meant ‘form’). Galen was doubtful about the problem, probably in contradiction to his opinion in his youth.³⁰⁹

Nevertheless, it has been argued that Galen (130-200 A. D.) had always believed in the eternity of cosmos firmly and that Rāzī’s inference of Galen’s doubt was merely based on his misinterpretation of Galen’s words. Thus, the source of Rāzī’s opinion was not Galen; rather, as we will briefly point out, this idea of him and Bīrūnī’s rooted deeply in the Iranian thought. Another point to add is that to believe in the eternity of the universe implies that the first matter was neither of the nature of generation nor corruption, and this, in turn, means that the first matter might not have been subject to transformations or transmutations; motion is also free from generation and corruption i.e. the evolutionary process; therefore, whatever has anything to do with transformation, is necessarily impossible. The theory of the eternity of cosmos is hence static, anti-evolutionary and reactionary, because it admits neither the origination nor the dynamicity of the cosmos, nor ‘evolution’- gradual or by way of jump. However, the idea of the origination of the universe from the ‘pre-existing eternal matter’, called ‘non-being’ (*tomeun*) in *Timaeus*, is the same as Rāzī’s view and that of the Iranian Muʿtazilites, because the uncreated non-being is eternal and infinite. That is why theologians argued that existence emerged from non-being and, according to what we have mentioned about the issue of creation in chapter 8, section 2, Bīrūnī too shared this idea. This is again why Rāzī and Bīrūnī refused to agree with Aristotle, since, in his books *Physics* and *Generation and Corruption*, he argued that it was impossible for a thing to emerge from absolute non-being and that matter is the origin of everything. Platonistic pre-existing eternal

³⁰⁸ *Taḥdīd nihāyāt al-amākin* (Ar.), p. 24; (Pers.), p. 3.

³⁰⁹ *Fīlsūf-e Rey*, Mehdi Mohaqeq, pp. 113, 268, 324-328./ *Aʿlām al-nubuwwa*, Abu Ḥātam Rāzī, (ed.) Ṣalāḥ al-Ṣāwī and Gholamreza Aʿvāni, Tehran, ʿAnjoman-e falsafe-ye Iran, 1977, pp. 20-21./ *Al-shukūk ʿalā Jānūs*, Zakarīyā Rāzī, (ed.) Mehdi Mohaqeq, Jāmiʿt Tehrān, 1993, p. 4.

matter is, therefore, different from Aristotelian matter or 'eternal matter', yet it is emanated matter.³¹⁰

We will later note that pre-existing eternal matter or non-being, admitted by Plato, Rāzī and Bīrūnī, is the same as the atom. Now that the cosmos is non-eternal, we should see what things were considered eternal by Rāzī. The famous response is the 'five eternal entities' which is the most important problem in Rāzī's philosophy. In his explanation of duration and absolute time and also creation of the world and its annihilation, Bīrūnī says that Rāzī quoted from early Greek philosophers that there were five eternal entities: (1) the glorious Creator, then (2) absolute Soul, then (3) first Matter, next (4) absolute Space, and then (5) absolute Time, upon which he founded his doctrine.³¹¹ Bīrūnī's philosophy too was founded upon the same principle. It has been noted that Rāzī's five eternal entities is based on the ideas of the early Greek natural philosophers the most outstanding of whom was Democritus (5th century B. C.), who took a journey to Babylon and Iran at the time of the Achaemenides. The result of the journeys by the atomist philosopher includes *The Chaldaean Treatise*, *The Sacred Scripts of the Babylonians* and *Magicus* and his thoughts is said to have had an important impact on Plato's philosophy.³¹² The perfect influence of the magian school on the philosophers of the Pythagorean and Stoic schools, such as Empedocles (490-430), and also on Plato, Heraclitus and Hippocrates is known for sure in the history of science and philosophy.

Therefore, if Bīrūnī regarded Rāzī's theory of the eternal entities as taken from the early Greek philosophers, especially Democritus, the fact can be justified on the account that the theory had been originally borrowed from the ancient magi. Bīrūnī also compared the eternity of the Indian Mahābhūta, the sum of the five elements, with the Iranian five eternal entities and mentioned the creation as believed by the Indians as analogous to Plato's doctrine in *Timaeus*.³¹³ In his debate with Abū Ḥātam Rāzī (*A'lām al-nubuwwa*, pp. 16, 19; *Philosophical Treatises*, pp. 306, 307), Rāzī confirmed that he proposed the issue of the five eternal entities after Plato and opposed Aristotle over the absolute eternity of the universe.³¹⁴ Now, one can easily understand why the great Ismaelite theoreticians such as Abū Ḥātam Rāzī, Nāṣir Khusraw and the like, as well as the peripatetic philosophers with Ismaelite tendencies such as Ibn Sīnā unanimously attacked Rāzī so severely. As far as the eternal entities and other anti-Aristotelian ideas were concerned, he had dangerously brought the

³¹⁰*Falsafe-ye 'elm-e kalām*, H. Wolfson, Tr. Ahmad Aram, Tehran, Enteshārāt-e al-Hudā, 1989, pp. 390-392./ *The Philosophy of the Kalam*, H. Wolfson, Harvard, 1976.

³¹¹*Tahqīq mā li al-Hind*, pp. 270-271./ *India*, I, 319, 320. / *A'lām al-nubuwwa*, 'Abū Ḥātam Rāzī, pp. 10, 20./ *Filsūf-e Rey*, Mehdi Mohaqeq, pp. 275-289./ *Yādnāme-ye Bīrūnī*, Mehdi Mohaqeq, p. 204.

³¹²*History of the Persian Empire*, Olmstead, pp. 200, 202, 332-333, 453-454./ *Filsuf-e Rey*, Mehdi Mohaqeq, pp. 282-283.

³¹³*Tahqīq mā li al-Hind*, pp. 31, 272-273./ *India*, I, PP. 41, 321, 322./ *Yādnāme-ye Tahqīq*, Mehdi Mohaqeq, pp. 205-206.

³¹⁴*Filsuf-e Rey*, Mehdi Mohaqeq, p. 298./ *A'lām al-nubuwwa*, pp. 20-21.

principles of their creed under question. Again, one clearly see why they did not consider Bīrūnī a philosopher: To them, philosophers had to obey Aristotle. Although Rāzī and Bīrūnī had greatest reverence for Greek philosophy, they chose to remain true liberal-thinking philosophers of Iranian tradition.

The originality of natural ideas of Rāzī and Bīrūnī, particularly about the five eternal entities, can be inferred from the fact that Abu al-ḥassan Mas‘ūdī (b. 346/ 957) pointed to the five eternal entities among the miracles and signs of Zoroaster, the prophet of the Iranians: the eternals, as reported by him, are Urmazd, namely the great God, Ahriman, who is the wrecked devil, Gāh which is time, Jāy which is space and Haum which is the same as ‘clay’. This is why they glorify ‘the two brilliant ones’ [the Sun and the Moon] and other Lights, distinct from Fire.³¹⁵ The belief has been attributed to other Iranian religions such as Sabiabs, Dahrīya, etc as well. However, let us make clear here, for the first time, that Rāzī took the idea of the five eternal entities not from Zoroastrian texts, rather directly from Manichaeon works. We must bear in mind that concerning Rāzī’s list of works, Bīrūnī mentions that he was inclined toward Mānī’s and his followers’ books and texts; and in his own book *‘Ilm al-ilāhī* (*The Divine Science*), he referred to Mānī’s books, especially to *The Book of Secrets* and wrote “I was excessively longing for this book for about forty years”.³¹⁶ We should add that Manichaeon tendencies was by no means a dominant feature of Rāzī’s thought only; most of the Iranian scholars, especially those with strong nationalistic feelings had such tendencies right from the early Islamic era to the fifth century, from Ibn al-Muqaffa‘ to Ibn al-Nadīm.

The dualism of Rāzī’s thought, with a Manichaeon (Zurvanite) nature, has long been attacked severely on the account that the two books *‘Ilm al-ilāhī* (*The Divine Science*) and *Al-ṭibb al-ruḥānī* (*The Spiritual Medicine*) showed his tendency to Iranian dualistic creeds and Indian Brahman ideas, all in line with the Pythagorean natural philosophy and in opposition to Aristotle.³¹⁷ No one has ever been, as Rāzī was, subject to taunts and refutations by the heads of Ismaelite thoughts including Abū Ḥātam Rāzī and Nāṣir Khosraw, because the Ismaelite had clear anti-Manichaeon Zoroastrian and Mazdakite tendencies. As a matter of fact, the old ideological Zoroastrian and Manichaeon (Zurvanic) controversies in the Islamic age occurred later in the forms such as the debates between the Aristotelian Ismaelites, on the one hand, and Ibn Rāvandī and especially the Platonistic Zurvanite Rāzī, on the other. Like the cosmic garment of Ahura Mazda, the divine Zoroastrian-Ismaelite philosophy is ‘white’, while, like Ahriman’s garment, i. e. the world, the natural Manichaeon-Zurvanic philosophy of Rāzī, is ‘black’. Of the five eternal entities, after the glorious Creator (Ahura Mazda), the second one is the Soul, i. e. Ahriman with the attributes of demon-like, self-worshiper, sinner and cruel,

³¹⁵ *Al-tanbīh wa al-ishrāf*, (ed.) De Goje, Leiden, 1967, p. 93./ *Fīlūf-e Rey*, Mehdi Mohaqeq, pp. 285-286./ *Yādnāme-ye Bīrūnī*, Mehdi Mohaqeq, p. 206.

³¹⁶ *Fihrist kutub al-Rāzī*, (ed.) Mahdi Mohaqeq, pp. 2, 3./ *Fīlsūf-e Rey*, Mehdi Mohaqeq, P. 266.

³¹⁷ *Ṭabaqāt al-umam*, Qāḍī Šā‘id Āndulusī, Tr. Sayyid Jalāl al-din Ṭehrānī, *Gāhnāme*, 1931, pp. 187, 209./ *Fīlsūf-e Rey*, Mehdi Mohaqeq, p. 160.

as the Arabic term *hawā'* (longing) used by Rāzī, equivalent to the middle Persian word *āz* (craving) with *varanīg* (sensuous) sense, in the Manichaean texts.³¹⁸

In *The Spiritual Medicine*, Rāzī regards passion or self as opposed to reason or Mazda. As almost all philosophers have agreed, passion is the same as Iblis (Lucifer) or Ahriman who, in Nāṣir Khosraw's words 'has fallen in love with the matter out of ignorance'. Rāzī also taunts this-worldly pleasures and prefers science pleasures which can be another sign of his Manichaean tendencies. In this respect, Ibn Maymūn points, among other ravings by Rāzī, to his fancy that evil is more common in the world than good, and that pains, difficulties and grieves are much more abundant. In one word, human existence, in itself, is the great evil which has befallen him.³¹⁹ Such is a brief account of Rāzī's ethical Manichaeism in which both the rational virtues of the soul and the sensuous vileness are founded upon good and evil or, in other words, light and darkness. This is completely consistent with the gist of the middle Persian texts, Zoroastrian, Zurvanite, or Manichaean, especially in the books *Dēnkird*, *Bundahišn* and *Mēnōg i Xrad*. We should add that the adjective *rūḥānī* in the name of the book *Al-ḥibb al-ruḥānī* is exactly the translation of the middle Persian word *mēnōg* which could otherwise be translated as *nafsānī* (pertaining to soul).

It is true that the number five yields to the five Zoroastrian "gāh"s, or the prayers times, and also to the number of the old Indian Mahābhūta elements, yet it has a high frequency in reference to the Manichaean pentaple ones in the dualism of matter and idea. Generally speaking, God and matter are the two basic elements in the Manichaeism, both eternal and simultaneous. Matter is also called Prince of Darkness, the same as Ahriman or Iblis al-qadīm (the eternal Lucifer). These two are, according to a cosmological interpretation, created by an eternal divinity, i.e. Zurvan, later identified with the Space-Time Lord. The kingdom of Light is composed of five aspects of Greatness with Zurvan as the father of all. The twelve eternals (aeons) are also in the living space, or the Lord of Light. The four aspects of Zurvan are time, light, force and wisdom; and the five elements of Light are air, wind, light, water and fire; the supreme eternal essence of paradise, or the paradise of light is composed of the five elements ether, air, water and fire over which the Father of Greatness rules and is inhabited by numerous eternals. The five modes of the twelve astrological mansions in Manichaean astrology are smoke, fire, air, water and darkness. Mānī also considered five substratums for the embodiment of god: sense, intellect, thought, will and intension. The hell consists of five dark elements and the earth and the five planets are made of the masses of the darkness demons. Finally, the Living Spirit (the Soul) has five children. There are such five-part

³¹⁸See *Zurvan, a Zoroastrian dilemma*, R. Zaehner, 1955, New York, p. 122./ *Mani and Manichaeism*, Geo Widengren, London, 1965, p. 59.

³¹⁹*Fīṣṭūf -e Rey*, Mehdi Mohaqeq, pp. 187, 194-198, 200, 218, 273-274, 279, 282./ *Al-aqwāl al-dhahabiya*, Hamid al-din Kermani, (ed.) Ṣalāḥ al-Ṣāwī, Tehran, 'Anjoman-e falsafe-ye Iran, 1977, pp. 21-33, 49, 68, 87 ff./ *A'lām al-nubuwwa*, Abū Ḥātam Rāzī, pp. 21-23./ *Arabic writings of Maimonides*, (ed.) I. Friedlaender, Leiden, Brill, 1951, pp. 24-25.

elements of Zurvanism and especially Manichaeism, and one should always bear in mind that the historical connection of the two is an established fact.³²⁰

Accordingly, the five eternal entities, as sought for by the scholars, are of the same category as the *khusravānī* wisdom, also called the *Fahlavī* wisdom, adopted in principle by the illumination philosopher Suhrawardī (587/ 1191).³²¹ We may now claim that the philosophy of Rāzī and Bīrūnī had, as its history, the philosophies of light and illumination. Apart from Mānī's *The Book of Secrets* (*Sifr al-asrār* in Arabic), the Manichaean texts to which Rāzī referred, as Walter Henning remarked in his writing on a cosmological Sogdian book, the major items of the creation of the world can be found in a treatise of the type of "bundahišn" (the middle Persian word for 'genesis'). It was the text by Theodore bar Khoni from which Ibn Nadīm took his exposition of the Manichaean beliefs in his book *Al-fihrist* (*The Catalogue*). In addition, the five elements were mentioned in Mānī's book *Kavān* (*The Monsters*), or *Sifr al-jabābara* (*The Book of the Monsters*).³²² It should be added that in the (middle) Persian terms of the five eternal entities, as narrated by Mas'ūdī (*Al-tanbīh*, 93) and Ibn Ḥazm (*Al-Fiṣal*, 1/ 35), there were some editing mistakes in the text which were corrected by Stern as the following: "kāṃ" must be "gām" (time). "jām" must be "jāy", as used by Rāzī in the sense of 'space'. The term "ṭibat" is ṭīnat (clay) in the sense of matter. "Būm" must have been synonymous with the term ṭīnat, probably used in the sense of 'matter' in opposition to 'form'. Thus, the five eternal entities by Rāzī would be as following: God, Soul, būm/ ṭīnat (Matter), gām (Time), jāy (Space).³²³

The middle Persian word būm was the matter of the creation; accordingly, the believers in the precedence of its existence were called 'materialists'. In his account of the five eternal entities, Bīrūnī says "These exist in the world of existence by way of necessity. Among them, matter is concrete in its combination with form and must occupy space. Its differing states are bound to time, either "before or afterwards".³²⁴ It is clear in this definition that space and time are the aspects of matter (Due to the philosophical significance of this issue, a section will be devoted to the discussion of the category of 'time'). Now, from the viewpoint of 'continuity', in relation to matter, space is a substratum of the form, because, according to the doctrine of Aristotle and the majority of (peripatetic) philosophers, a thing consists of matter (substance/eternal) and form (accident/non-eternal). However, from 'discontinuity'

³²⁰ *Mani and Manichaeism*, Geo Widengren, pp. 43, 44, 46, 47, 50, 70-71./ *Mesopotamian elements in Manichaeism*, Geo Widengren, p. 41./ *ACTA IRANICA*, 15 (W. B. Henning Selected Papers, II), Leiden, Brill, 1977, pp. 126-127, 303./ *A reader in Manichaeism Middle Persian and Parthian texts*, M. Boyce, *ACTA IRANICA*, vol. II, 1975, pp. 4-5.

³²¹ *Al-tanbīh wa al-ishrāf*, Mas'ūdī, p. 93./ *Ṭabaqāt al-umam*, Qādī Šā'id, Gāhnāme, p. 171, 178./ *Al-fiṣal*, Ibn Ḥazm, vol. 1, p. 35./ *Tārīkh-e 'olum-e va dabiyyāt-e irāni*, Zabih allāh Safa, p. 47./ *Fīlsūf-e Rey*, Mehdi Mohaqeq, pp. 270, 285./ *Goftār darbāre-ye Dinkird*, Mohammad Javad Mashkur, p. 61.

³²² *ACTA IRANICA*, 15 (W. B. Henning), pp. 126-127, 301.

³²³ *W. Henning Memorial Volume*, 1970, (ar. S. M. Stern), pp. 413-415./ *Fīlsūf-e Rey*, Mehdi Mohaqeq, pp. 329-330.

³²⁴ *Tahqīq mā li al-Hind*, p. 271./ *India*, I, p. 320./ *Yād-nāme-ye Bīrūnī*, (ar. Mehdi Mohaqeq), p. 204.

viewpoint, space is the same as void, because, according to the teachings of certain philosophers especially Democritus and the Islamic theologians (with whom Rāzī and Bīrūnī agree only over this issue) a thing is composed of pre-existing eternal matter, or non-being, i.e. the atoms in the space.³²⁵

We should see now what primal matter, or emanated matter in the Iranian cosmological viewpoint was like. It is known that, due to their religious legends of creation, each of the ancient nations regarded one of the four elements in nature as the basic element or the *urstoff* in the generation of the universe. The *urstoff*, to the Semitic and Indian nations, was water (as in the Quranic fragment “and from water everything is living”); however, to the Arian nations, it was fire. In the Iranian *Bundahišn* (chapter 2, section 18; chapter 3, section 8), it is stated, on the creation of the (material) world by ‘time’, that Ahura Mazda created the element ‘fire’ from the boundless light through the glimpse of a spark (as the *urstoff*). Then, “from the Endless light he fashioned fire in material form, from fire wind, from wind water, from water the all-solid earth [...] and scattered fire in all creation, just like a landlord entering his own house”.³²⁶ We should firstly explain that the scatter of the elemental parts (i.e. fire) into things was carried out according to the principle of generation and transformation and, as we have already mentioned, concerning Bīrūnī’s definition of transmutation, it is the dispersion of the parts of one thing into the parts of another thing. Secondly, this idea is according to the atomistic rule of the change from division of density and thickness toward rarefaction and discontinuity, because the space spots, i.e. void, are the place of the atoms, just like “a landlord entering his own house”.

It is also worth noting that since the origin of fire is the boundless light, there is logically and naturally, no difference between ‘light and ‘fire’. Contrary to what Mas‘ūdī reckoned, as we have pointed out in the section of the general physics, Bīrūnī had a different idea from the Greek metaphysical beliefs: He maintained that the mass of the sun is the element of fire. He seems to have explained the fourth state of matter, i.e. plasma, and some qualities of the motion of its parts.³²⁷ Such is the scientific theory of Bīrūnī, based on the illumination wisdom about primal matter in his natural philosophy which is said to have several similarities with the modern theory. To sum up, according to the ancient Iranian viewpoint (*Dēnkird*, M. 120; *Bundahišn*, chapter 1), fire was first created from the boundless light; matter (‘*mādag*’ in middle Persian) was what had with it the earthly creation seeds (‘*zahagān*’ in middle Persian), i.e. the elements, and also the becoming motion (*bawīšn rawīšnīh*). Then, the organic life emerged through motion for the sake of perfection. Such a view is considered as compatible with the Greek natural philosophy, especially that of Heraclitus and Aristotle: In this view, the cosmic *formulations* of matter organs and the transformations of the organic

³²⁵See *Falsafe-ye ‘elm-e kalām*, H. Wolfson, pp. 390-392./ *Mīyān-e falsafe va kalām*, (ar. Hossein Ma‘sumi Hamedani), *Ma‘āref*, 3 دور، no. 1, p. 218./ *Fīlsūf-e Rey*, Mehdi Mohaqeq, p. 280.

³²⁶*Bundahišn*, Farnbagh Dādagi, (ed.) Mehrdad Bahar, Tehran, 1990, pp. 39, 48./ *Zurvan*, Zaehner, p. 141; part II, pp. 283, 318, 322, 334, 373, 374.

³²⁷*Al-qānūn al-Mas‘ūdī*, vol. 2, p. 646./ *Andishmand va ensān*, Najafi and Khalili, p. 117./ *al-Qanun al-Mas‘udi* (ar. S. H. Barani), p. XLVI.

life have been found compatible with the ancient Indian philosophy, on the one hand, and with the natural philosophy of, for example, Empedocles and Hippocrates, on the other.³²⁸

Bīrūnī's sixth question from Ibn Sīnā on the rejection of the Aristotelian idea of the 'impossibility of the void' is well-known enough: "Why does a sphere not require void?" "Why does he [Aristotle] believe in the impossibility of the void?" And finally, as he asserts, the "impossibility of the void is impossible in the world?"³²⁹ As it were, according to the viewpoint of Aristotle and majority of (peripatetic) philosophers, because an object consists of matter (substance) and form (accident), due to the continuity of the two, its space will be the substratum of the form; therefore, there will be no emptiness or void. Again, as it were, the original idea of 'possibility of the void', as posed by Newton dates back to the atomistic theory. Absolute space, among the five eternal entities, was the same as void- the idea said to be borrowed from Irānshahrī (3rd / 9th century). The dualist Rāzī belived that space was of two types: absolute space and partial space. The former belongs not to objects; it is emptiness; it embraces void and plenum, and finite bodies are located in that space. However, absolute space is infinite, and as we know, whatever is infinite, shall be eternal; hence absolute space is eternal.³³⁰ The thinkers believing in void took it the same as non-being, because to agree with the existence of the void was in some way an indispensable part of the idea of 'the existence of non-being'. Non-being is essentially non-existing, thus it cannot exist. But, the matter or the (primal) matter which is accidentally non-existing shall mean 'existing'. The atomist Democritus believed in the existence of void, as well as, plenum. He called void, in this sense, 'non-being'. We should finally add that in theological controversies, the term non-being refers to the Platonic 'ideas'.³³¹

The theory of void in the natural philosophy of Rāzī and Bīrūnī is in accordance with the Iranian Zurvanite-Zoroastrian cosmologies: 'vāy' (space) is the emptiness between the unlimited light and the unlimited darkness; it is the compound category of Zurvan (time) and 'sepehr' (sphere), and also the originator of the limited time from the unlimited time.³³² No theological-philosophical expressions in the pre-Islamic texts had ever expressed such a complicated idea as it was stated in the Iranian *Bundahišn* (chapter 1, sections 4, 5): "(4) Between them [the Endless Darkness and the Endless Light] was the Void: some call it Vāy in which the two Spirits mingle. (5) Concerning the finite and infinite: the lights which are

³²⁸ *Zurvan*, Zaehner, pp. 141, 142, 143, 145./ *Zoroastrian Problems*, H. Bailey, Oxford, 1943, pp. 82-84.

³²⁹ *Al-asalah wa al-ajwibah*, pp. "ب", 27, 47, 58./ *Sharḥ-e ḥāl-e nābeghe-ye shahūr-e Irān Abū Rayḥān*, pp. 48, 66.

³³⁰ *Miyān-e falsafe va kalām*, (ar. Hossein Ma'sumi Hamedani), *Ma'āref*, دور 3, no. 1, p. 239./ *A'lām al-nubuwwa*, Abū Ḥātam Rāzī, pp. 18-19./ *Madhhab al-dharrā 'ind al-muslimin wa 'alāqatuh bi madhāhib al-yūnān wa al-hunūd*, S. Pines, Tr. Mohammad 'Abd al-Hādī Abū Rayda, Cairo, 1946, pp. 45-46./ *Beitrag zur Islamischen Atomenlehr*, S. Pines, Berlin, 1936.

³³¹ *Falsafe-ye 'elm-e kalām*, H. Wolfson, Tr. Ahmad Aram, pp. 387, 388, 395-396./ *Miyān-e falsafe va kalām*, (ar. Hossein Ma'sumi Hamedani), *Ma'āref*, دور 3, no. 1, p. 237.

³³² *Zurvan*, Zaehner, pp. 126-127.

called the Endless Light (since they have no end) and the depths which are the Endless Darkness, these are infinite. On the border they are both finite since between them is Void, and there is no contact between the two. Again both Spirits in themselves are finite”.³³³ Apart from the atomistic problem of discontinuity of the mass in void (stated by the terms ‘discontinuity of the light atoms’, in *Bundahišn*), the above idea is furthermore mentioned in the middle Persian treatise *Šikand Gumānīk Wizār* (lit. *The Doubt-breaking Treatise*) (chapter 16, sections 53-55): “Now I shall first discuss the impossibility of any existent thing being infinite except only the Void and Time, which I call infinite. All entities which are within locality and temporality are seen to be finite”.³³⁴

The same was true with Greek philosophy in which place was considered as an essentially empty three-dimensional space. The idea had a relevance to the atomistic theory and the same opinion is attributed to Rāzī, defended strongly by Bīrūnī later. We do not have to repeat here that the unlimited space or void was, to Bīrūnī, the same as non-being which is eternal. Therefore, Bīrūnī, in line with that of theologians, regarded void as the ‘unreal dimension’ or ‘pure dimension void of matter’ as the origin of creation and hence as a pure non-existing thing. As Maimonides remarked, theologically this means that the universe is created and that the glorious God is the only eternal one who created it from absolute nothingness.³³⁵ It is while Rāzī believed in four other eternal entities as well. We should here briefly conclude that, in the final analysis, the five eternal entities maintained by Rāzī are, according to their philosophical conception, indeed the five modes of a single truth: the monotheism of Rāzī and Bīrūnī can be said to be ‘acquired’ and not ‘numerical’, as that of the theologians.

b. The atomistic theory. In the third and fourth questions from Ibn Sīnā, Bīrūnī attacks Aristotle who believed that there were six ‘directions’ and went in so far as to denounce the idea of the indivisible parts (atoms), believed by Rāzī too. Aristotle argues that it is impossible for a thing to be permanently divisible.³³⁶ The idea of the indivisible parts, reported by some of the followers of Plato, originally rooted in Democritus and Leucippus (460-370), the pioneers of atomism. The two philosophers held that the real world is different from what is perceived through our senses; thus, one has to perceive the world through the atomic motions in the space, and he/ she should explain the transformations of the phenomena in terms of the continuity and discontinuity of their compound parts. As a posteriori view, this theory gave rise to the scientific method by which observable changes in the organic elements were studied.³³⁷ In his book under the title *The Ideas of the Predecessors About Principles and Qualities*, Rāzī says that Galen, in his book *The Elements*

³³³ *Bundahišn*, (ed.) Mehdad Bahar, p. 33./ *Zurvan*, Zaehner, Part II texts, pp. 278, 313.

³³⁴ *Zurvan*, Zaehner, Part II texts, pp. 394.

³³⁵ *Madhhab al-dharrā*, Pines, pp. 46-47./ *Miyān-e falsafe va kalām*, (ar. Hossein Ma’sumi Hamedani), *Ma’āref*, 3 دور، no. 1, p. 327./ *Arabic Writings of Maimonides*, p. 10.

³³⁶ *Al-as’alah wa al-ajwibah*, pp. “ب”, 14, 17, 53./ *Sharḥ-e ḥāl-e nābeghe-ye shahir-e Irān Abū Rayḥān*, Dehkhoda, pp. 40, 42, 63.

³³⁷ *A Historical Introduction to the Philosophy of Science*, J. Losee, Oxford, 1977, p. 27.

According to Hippocrates, shows no disagreement with the belief that the matters of the elements fire, air, water and earth are micro indivisible masses.³³⁸ This implies that perhaps Galen and, less probably, Hippocrates believed that the matter of each of the four elements was composed of such indivisible parts. By the way, Bīrūnī made use of this view of Rāzī against the peripatetic belief in ‘continuity in the parts of nature’.³³⁹ Bīrūnī’s criticism against Aristotle’s ‘directions’ was indeed a reference to the description of the atoms of Democritus which are limited to those directions, according to his belief in the finiteness of the bodies. Concerning the continuity and discontinuity of the parts (atoms), we should say that, quoting from Rāzī’s book *The Divine Science*, Nāṣir Khosraw explained the quality of the “closeness” and “openness” of the elements and remarked about fire that “the substance of matter is mixed with the substance of void, but there is in it more void than matter... etc”.³⁴⁰ Such a phenomenon can be explained through the spectrum of the elemental parts from the state of thickness (plenum) to the state of rarefaction (void), or in other words, through the motion of gathering of the atoms (continuity) to their scattering (discontinuity). The phenomenon, as it were, has a long history in Iranian thought: it has been expressed, especially with respect to the element fire, in terms of ‘tuhīgīh’ (void) and the blending of the two forces in ‘wāy’ (space). Basically, the idea of the indivisible part presupposes the idea of void. In his attack on the atomists, Pythagorians, and on natural philosophers, Aristotle rejected the idea of bodies as composed of the indivisible parts, denied void, considered a body as essentially continuous, and finally denied any actual ‘limitlessness’. However, modern science was to follow non-Aristotelian concepts. We should add that mathematical naturalists do not agree with the matter formed, in Aristotle’s view, by the potential motion. Bīrūnī’s tendency, as announced by Massignon (1883-1962), was compatible with the modern mathematicians, inclined to accidental, quantitative, discontinuous atomism, as it can be observed in algebra. The mythical Pythagorean opinion, especially in its abstract form, for example, expressed in their emanation of numbers from the ‘oneness’, which dominates Bīrūnī’s mathematical theory, can justify his atomic theory as well.³⁴¹

We should note that if Bīrūnī expressed a totally conditioned agreement with theologians in his support of the atomic theory of Rāzī, the reason lies in the fact that there is a difference between a natural philosopher and a theologian with respect to the problem of the indivisible parts. The philosopher observes the body from the viewpoint of motion and rest, while the theologian speculates about the way it signifies the agent. The aim of the philosopher is to establish a science about the bodies; the theologian intends to prove that the world requires a creator. However, there is a sort of similarity between the theological atomistic view and

³³⁸*Fīlsūf-e Rey*, Mehdi Mohaqqueq, p. 322./ *Madhhab al-dharra*, Pines, p. 46.

³³⁹*Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabi‘at*, Sayyid Hossein Nasr, p. 253./ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), pp. 101-106./ *The Commemoration Volume*, (ar. L. Gardet), p. 195.

³⁴⁰*Zād al-musāfirin*, pp. 52-53./ *Filsuf-e Rey*, Mehdi Mohaqqueq, pp. 271-272.

³⁴¹*Ma‘āref*, 3, 1, (ar. Hossein Ma‘sumi Hamedani), p.209./ *al-Biruni Commemoration Volume* (ar. L. Massignon), p. 220./ *The Commemoration Volume* (ar. L. Gardet), pp. 202-203./ *The Scholar and the Saint* (ar. A. Heinen), pp. 52-54.

natural inquiries as done by Plato in *Timaeus* and also by the Greek atomist philosophers. Some contemporary scholars have concluded that any resemblance between the ideas of the atomists in the Islamic world and those of the Greek atomist philosophers is not but a similarity in the vocabularies, although they take the Islamic atomism closer to Epicurian version than that of Democritus. On the other hand, the doctrine of the indivisible part (jawhar i fard) by the Iranian Mu‘tazilite theological sect has been taken by some scholars as a kind of return to the Greek natural philosophy, with the possibility of the impact of the Indian atomistic school, especially their dimensionless atoms.³⁴² By the way, nothing seems to be wrong with Rāzī’s approaching the numerical atomism of the Islamic theologians. It is interesting that this aspect of his natural philosophy was not criticized by the Iranian Ismaelite theoreticians, i. e. the very foes fighting his five eternal entities so severely. The reason can be that, from a mathematical viewpoint, the space-time to which Bīrūnī inclined as well, shows some signs in other doctrines of Rāzī’s and Bīrūnī’s too. Altogether, the real mathematics or physics, to Bīrūnī, was in harmony with philosophical epistemology here and everywhere in his works.³⁴³

4. The problem of time

a. Duration and time. Bīrūnī started chapter 32 of the book *India* on explaining duration, time and furthermore the creation and annihilation of the cosmos, with a discussion of the five eternal entities, the fifth of which being ‘absolute time’, saying “On these things Alrāzī has founded that theory of his, which is at the bottom of his whole philosophy. Further, he distinguishes between *time* and *duration* in so far as *number* applies to the former, not to the latter; for a thing which can be numbered is finite, whilst duration is infinite. Similarly, philosophers have explained *time* as duration with a beginning and an end, and eternity [eternal duration] as duration without beginning and end.

According to Alrāzī, those five things are *necessary postulates* of the actually existing world. For that which the senses perceive in it is the matter acquiring shape by means of combination. Besides, the matter occupies some place and therefore we must admit the existence of *space*. The changes apparent in the world of sense compel us to assume the existence of time, for some of them are earlier, others later, and the *before* and the *afterwards*, the earlier and the later, and the simultaneous can only be perceived by means of the notion of time, which is a necessary postulate of the existing world.

Further, there are *living beings* in the existing world. Therefore, we must assume the existence of *the soul*. Among these living beings there are *intelligent* ones, capable of

³⁴²*Madhhab al-dharra ‘ind al-muslimin*, Pines, pp. 94-95./ *Tārīkh al-falsafa fī al-islām*, De Boer, p. 119./ *Falsafē-ye ‘elm-e kalām*, H. Wolfson, p. 507./ *Miyān-e falsafē va kalām*, (ar. Hossein Ma’sumi Hamedani), *Ma’āref*, 3 دوره، no. 1, p. 210.

³⁴³*The Commemoration Volume*, (ar. L. Gardet), p. 203.

carrying the arts to the highest perfection; and this compels us to assume the existence of a Creator, who is wise and intelligent [...].

On the other hand, some sophists consider eternity [eternal duration] and time as one and the same thing, and declare the motion which serves to measure time alone to be finite.

Another one declares eternity [eternal duration] to be the circular motion. No doubt this motion is indissolubly connected with that being which *moves* by it, and which is of the most sublime nature, since it lasts for ever. Thereupon, he rises in his argumentation from the moving being to its mover and from the moving mover to the first mover who is motionless.

This kind of research is very subtle and obscure. [...] some people declare that there is no time at all, while others declare that time is an independent substance”.³⁴⁴

This single quotation precisely illustrates Bīrūnī’s philosophical layout, implying that he regarded ‘absolute time’ prior to the other eternal entities. If this is true, it will then be extremely important in understanding Bīrūnī’s epistemology and thought system. Furthermore, in discussing the ‘universal soul’, again he regarded it prior to the ‘universal intellect’ indirectly. As a matter of fact, through his tactful rhetoric, he means to allude to the principle of the contraries.

The basic point about time is that, following Rāzī, Bīrūnī called the limited time ‘time’ and the unlimited time ‘duration’, apparently the same as the middle Persian term ‘gāh’ (time). By the way, according to Irānshahrī, ‘dahr’ (eternal duration), and ‘mudda’ (duration) are names with meanings of the same substance...”.³⁴⁵ The term ‘duration’ is Platonic and Rāzī remarks that he intends to follow Plato in the problem of the five eternal entities, as he did with respect to the categories of space and time. Fakhr al-dīn Rāzī, in his commentary on ‘*Uyūn al-ḥikma (Springs of Wisdom)*’ (151 b- 152 a), notes “this is the idea of the Leader Plato who argues that ‘duration’, if (during which) no motion and change occurs (in anything), will show but endurance and continuity. Accordingly, it is called eternal duration or sempiternity. But, if any motion or change occurs, the accident resulted will not be in the essence of duration and time, rather it is due to the change in the thing”.³⁴⁶ Finally, we can infer directly from Bīrūnī (he used to write, for the probable fear of hostile inquisitions, some of his basic ideas briefly here and there where one may not expect) that “Duration, or time in general, only applies to the Creator as being *his* age, and not determinable by a beginning and an end. In fact, it is his eternity. But as regards common time, which is determinable by motion, the single parts of it apply to beings behind the Creator”.³⁴⁷

³⁴⁴ *Taḥqīq mā li al-Hind*, pp. 270-271./ *India*, I, pp. 319-320.

³⁴⁵ *A’lām al-nubuwwa*, Abu Ḥātam Rāzī, pp. 14-16./ *Madḥhab al-dharrā ‘ind al-muslimin*, Pines, 46, 50./ *Yādnāame-ye Bīrūnī*, (ar. Mohaqeq), pp. 204-205.

³⁴⁶ *Fīlsūf-e Rey*, Mehdi Mohaqeq, p. 298./ *Mīyān-e falsafe va kalām*, (ar. Hossein Ma’sumi Hamedani), *Ma’āref*, 3, no. 1, pp. 247, 274.

³⁴⁷ *Taḥqīq mā li al-Hind*, p. 441./ *India*, II, p. 118.

This valuable evidence reveals that he identified the ‘creator’ with ‘eternal duration’, both synonymous to ‘absolute duration’ and it suffices here for our discussion to lead to its logical conclusions. However, we should first explain an important point. Before Rāzī used the Arabic word ‘mudda’ (*lit.* ‘duration’) in this specific sense, the translators of Plato from Greek or Syriac to Arabic had done the same and had apparently used the term as an equivalent to the Greek word ‘aion’ (eternity), synonymous to kronos (eternity) and the middle Persian term ‘Zurvān akarānag’ (the unlimited Zurvan).³⁴⁸ The misunderstanding of this sense of the word ‘duration’ in the philosophical writings of Rāzī, Bīrūnī and others has misled a number of great scholars. Indeed, the two terms ‘duration’ and ‘zamān’ (time) have long been interchangeably misused. Now, it is no longer necessary to assert that Bīrūnī disagreed with the eternal time.³⁴⁹ In the explanation of his well-known theory about ‘the periods of time’ in *Taḥḍid* (*Fixation*) or elsewhere, he wrote “the eternal time is impossible, because fractions of time (i.e. periods) are numerable and increasing and whatever numerable starts with one and ends with another number; therefore, time is originated”.³⁵⁰ Here by the word ‘time’ he means the limited time, and he does not regard as impossible the unlimited ‘duration’ or absolute time. In brief, wherever he writes ‘zamān’ he means the limited originated time and wherever, without adjectives, he uses “mudda” he means the unlimited eternity.

Now, we can say that, to Bīrūnī, the universe was originated, therefore it would be necessary for it to have an eternal creator, or, in his terms, the ‘eternal duration’ (absolute time). Furthermore, he believed that the transformation or the generation and corruption in the world were the gradual manifestations and actualizations of all essential inseparable possibilities of everything that occur in a certain period of time. Accordingly, any discussion of time has a close relation to generation and corruption. However, the circular feature of time, as he believed, did not mean that the phenomenon would return to the starting point. It means the qualitative changes and the concurrence of times within a certain period. Believing in time periods, Bīrūnī regarded them as results of the motion of spheres, and the appearance of time as an effect of the motion of the sun in Zodiac. That is why he went on to hold that the numerable time can be measured by the spherical motion, as it has been defined as ‘the amount of the spherical motion’.³⁵¹ He distinguished two types of space, i.e. the absolute or the infinite space (void or the space of non-being) and the partial or the finite space (place), similarly, he divided time in two types: absolute time (‘duration’ and ‘eternal duration’) and the limited time (zamān). Bīrūnī’s dualistic Zoroastrian-Manichaean tendency can be inferred from such ideas expressed here and there: the essence of the void (the unlimited space) is

³⁴⁸ *History, Time and Deity*, S. Brandon, Manchester University, 1965, pp. 44, 55, 56, 60, 61.

³⁴⁹ *Nazar-e motefakkerān-e eslāmī darbāre-ye ṭabī‘at*, Sayyid Hossein Nasr, pp. 189-190./ *Payām-e Yunesko*, no. 59, (ar. Nasr), p. 39.

³⁵⁰ *Taḥḍid nihāyāt al-amākin* (Ar.), pp. 39-40; (Pers.), pp. 16-17.

³⁵¹ *Nazar-e motefakkerān-e eslāmī darbāre-ye ṭabī‘at*, Sayyid Hossein Nasr, pp. 189-190./ *Tamhīd al-mustaqarr*, (Rasā’il al- Bīrūnī), p. 38./ *Fīlsūf-e Rey*, Mehdi Mohaqeq, pp. 81-82./ *The Commemoration Volume*, (ar. L. Gardet), p. 198.

logically identified with the essence of ‘duration’ (the unlimited time), the identity which he refers to as ‘the creator’. This is the ‘acquired monotheism’ of the great genius.

b. The unlimited Zurvan. We have so far talked enough about the five eternal entities of Rāzī as reported by Bīrūnī and Mas‘ūdī, and also of the various theological and cosmological tetramorphs, some of which are different aspects of the same category which has taken place either through some sort of identification or blending. However, the two well-known foundations upon which Iranian dualism is based, can be represented, for the time being, in the same order of the five aforementioned eternal entities (the two are blended into the eternity category or Zurvan): (1) God/ light/ truth, (2) Ahriman/ darkness/ falsehood, ... (5) Zurvan.³⁵² Now, we should assert once forever that these theological-philosophical categories and cosmological ideas, as their advocates such as Rāzī and Fakhr al-dīn Rāzī claimed, were by no means borrowed from Plato or Democritus, and that Plato and Aristotle surely borrowed the categories from the ancient Iranian sages. The evidence for this comes from the reports by the Greek historian, Theopompus of Khi’os (ca. 380-305 B. C.), in the eighth part of his book about the ‘magian creed’, quoted later by Plutarch in the treatise of *Isis and Osiris*, and also from what Eudemus of Rhodes (ca. 320 B. C.), the first historian of science and a disciple of Aristotle, wrote in *Magokos*, and later quoted by Damascius: “Both the Magi and the whole Aryan race... call by the name “Space” (τόπον) or Time (χρόνον) that which forms an intelligible and integrated whole, and from which a good god (θεὸν ἀγαθὸν) and an evil daemon (δαίμονα κακὸν) were separated out [...], or, as some say, light and darkness before these. Both parties, however, postulate, after the differentiation of undifferentiated nature, a duality of the superior elements [...], the one being governed by Oromasdes and the other by Areimanius”.³⁵³

Undoubtedly, due to his truly exceptional knowledge of religions and cults of his time, Bīrūnī knew the sources and the origins of the above-mentioned categories much better than Mas‘ūdī, because he was the only one well aware of the ancient Iranian Magians. Among other things, in his account of the feasts of the magi, he says: “The ancient Magians existed already before the time of Zoroaster, but now there is no pure, unmixed portion of them who do not practice the religion of Zoroaster”.³⁵⁴ By the way, it can be understood from the Greek report of the Iranian creation myth that the concepts of time and space were homonym categories, i.e. the two aspects of the true single essence which is eternal. As it were, Bīrūnī maintained that the ‘eternal duration’ or ‘duration’, identifiable with void or non-being, was a clue to the Iranian acquired monotheism, the detailed interpretations of which can be found in

³⁵² *Tahqīq mā li al-Hind*, p. 271./ *India*, I, p. 320./ *Al-tanbīh wa al-ishrāf*, p. 93./ *Mani and Manichaeism*, G. Widengren, pp. 43-45.

³⁵³ *Zurvan*, Zaehner, pp. 447-448./ *History, Time and Deity*, S. Brandon, pp. 38, 144./ *Din-e Irani*, Emile Benveniste, Tr. Bahman Sarkarati, Tabriz University, 1971, pp. 62-63./ *Dīnhā-ye Iran-e bāstān*, Samuel Nyberg, Tr. Seyf al-din Najm Abadi, Tehran, 1980, pp. 392-394./ *Mazdāparastī dar Iran-e qadīm*, Arthur Christensen, Tr. Zabih Allah Safa, Tehran University, 1966, p. 141.

³⁵⁴ *Al-āthār al-bāqiya*, p. 407./ *Chronology*, p. 314.

the contents of the Avestan Zands (i.e. the Avestan exegeses in Pahlavi writings) and the middle Persian theological religious texts.

The idea of the sempiternal time by the Iranian magi with the cosmic parts and celestial bodies as its representatives, had a long history in the concept of Zurvan as the sublime god in Iran since the twelfth century B.C.³⁵⁵ *Dēnkird* (Madan, p. 290; Sanjana, 3, 322) presents the Zoroastrian viewpoint of the eternity: “This that which was before creation was Infinite Time: that which coincided with the very act of the Creator’s creation was Finite Time: that which was after creation was action (continuing) till the rehabilitation”.³⁵⁶ It can be wholly understood that “Zurvan the limited, the unlimited time and infinite space, is neither light, nor darkness; neither good, nor bad. He was not originated; free from accident, he is existence-giving. He is the creator. The limited time was originated by him with the creation: from eternal limitlessness emerged limitedness. The foundation of all good and evil is him; he is the source of light and darkness. He is great, called the Father of Greatness in Manichaeism and entitled Abhā d^eRabbūthā in the Syriac texts. The other names or attributes of him are gyāg [space/ place], gāh [place/ time], ǝwāša [atmosphere/ space], andarwāy [space/ air], wāy [air/ wind], asar roshnīh [the limitless light], gēhān xwadāy [the god of universe], gēhān/ gētīg [universe/ this-world], kaywān [Saturn], asmān xwadāy [the god of the sky], xšaēriya [kingdom], arta/dād [truth], bakhtāwar [fortune-bringer], etc. In the Islamic age, he was entitled as “dahr, mudda, sarmad, azal, [all roughly meaning ‘eternity’], ruzgār, zamāne, ayyām [all roughly meaning ‘times’], falak, gardūn, charkh, sepehr [all roughly meaning ‘sphere’] and also the primal matter and the supreme being”.³⁵⁷ The four aspects of Zurvan are, according to different narrations, ‘time, space, wisdom, force’ and this is in correspondence with the four elements. He is the four-faced god, i.e. ašōgar [righteous], frashōgar [renewer], zarōgar [old-maker], Zarvan [old age (d)/destroyer]. These attributes are interpretable as creation, innovation, alteration and destruction, respectively. His name is given to the days of the month four times: day/dātar [*lit.* creator], gāh [*lit.* space/ time], Hormozd [Ahura Mazda], dēn [religion], all the attributes of the unlimited times.³⁵⁸

The limited time or duration in the limited sense, as we have already discussed, is called ‘Zurvan karānag’, i.e. the originated time or the time of creation, emerged from absolute infinite time. It is duration with a beginning, as an origin of dating, which has been called ‘Zurvan drang xwadāy’ (Zurvan of the long dominion) in the middle Persian texts. He is

³⁵⁵See *Resāle-ye zurvān-ye ‘olamā-ye eslām*, Prviz Azkaei, *Majalle-ye Chistā*, no. 73, 1990, pp. 341-342./ *History, Time and Deity*, Brandon, p. 38.

³⁵⁶*Zurvan*, Zaehner, Part II texts, p. 391.

³⁵⁷*Bundahišn*, Mehrdad Bahar, p. 35./ *Minoo-ye kherad*, Tr. Ahmad Tafazolli, pp. 22, 107./ *Resāle-ye zurvān-ye ‘olamā-ye eslām*, Prviz Azkaei, *Majalle-ye Chistā*, no. 73, p. 346./ *History, Time and Deity*, Brandon, p. 40./ *Zurvan*, Zaehner, pp. 60, 64-65, 106-107, 183; Part II texts, pp. 322, 391-2./ *The Cambridge History of Iran*, vol. 3 (ed.) E. Yarshater, 1, XLVI./ *A Reader in Manichaesim...*, Mary Boyce, p. 101./ *Manichaean Literature*, J. Asmussen, New York, 1975, p. 113 f.

³⁵⁸*Zurvan*, Zaehner, pp. 196, 214, 219-224; Part II texts, 278, 312, 322-323, 333-334./ *Mani and Manichaeism*, G. Widengren, p. 46-47.

compared and contrasted with light and darkness: in Zoroastrianism, he is a peer of Ohrmazd, but in Mithraism and Manichaeism, he stands close to Ahriman. Sphere is the body of the duration god Zurvan, i.e. the limited time is always present in the celestial bodies and this is the same as the definition ‘the amount of the spherical motion’ above-mentioned. The limitedness of the god may be interpreted as the process of transformation and evolution, immanence and manifestation. Space, limited to the material world, can be then analogous to the limited time. Altogether, any fixation of Zurvan will lead to separation of the compound parts of the universe, resulting in the distinct entities of mēnōg [force], gētīg [this-world], kāmīg [disposition/ temper], čīhrīg [nature].³⁵⁹

The general consensus of remarkable studies on Zurvan as the supreme god in ancient Iran is that the Iranian concept of the god of time is the same as the supreme Varuna of the Arian tribes represented in the *Rig Vedas*. Yet, they agree that Zurvan has exerted the greatest and deepest impact on human thought so far- in the form of the Platonic unlimited time (eternal duration) or the Greek Chronos, on the religious worldviews of the Jewish, Christian, and especially Islamic theology and philosophy, and finally on the profound mystical concepts.³⁶⁰

c. Kala-Kronos. As it were, Bīrūnī’s philosophical worldview, in addition to its Iranian roots, was influenced by the Indian and Greek philosophies. An evidence of his unique comparative studies in *Mā li al-Hind (India)*, found by the present writer, is what the European scholars of our time succeeded, independently of Bīrūnī, to discover thematically. Now, the evidence, once considered with contemplation, shall prove to be sufficient and clear enough: “Prājapati (eternity) is the god Saturn, the same as the Greek concept Kronos whose son is Zeus (the same as the Iranian Ahura Mazda). But the non-human aspect of Zeus is that he is Jupiter, the son of Saturn (the same as the Babylonian Kayvan, the Iranian Zurvan and the Vedic Prajapati); that is why, as Galen says in his book *Al-burhān (Book of Deduction)*, in the viewpoint of the stoic philosophers, Saturn is the only eternal ones everlasting and unborn. Plato too considers, in the book *Al-nawāmīs (Laws)*, Zeus (Ahura Mazda) the same as Jupiter...who is the son of Kronos (Zurvan), namely Saturn. The Indian beliefs in čaturyuga are almost the same”.³⁶¹

We have already mentioned that the supreme Arian god was realized as the concept of time which is probably the same as the Arian Varuna, identified with Rata or the cosmic order for the tribes invading to India in the second millennium B. C. The concept of time or Varuna has been realized in the four celebrated supreme Vedic-Brahman gods, i.e. Prajapati, Brahma, Kala, Vishno, each made known and discussed by Bīrūnī in his book. Prajapati, the concept of absolute time is the same as Zurvan and Kronos. The three ancient nations of Indians,

³⁵⁹*History, Time and Deity*, S. Brandon, pp. 39, 40, 43-45./ *Zurvan*, Zaehner, pp. 56-57, 233, 235; Part II texts, pp. 322, 333./ *The Cambridge History of Iran*, vol. 2, p. 678.

³⁶⁰*Hochgottglaube im Alten Iran*, (eine religionsphänomenologische untersuchung), von Geo Widengren, Uppsala, 1938./ *Zurvan*, Zaehner./ *History, Time and Deity*, S. Brandon, pp. 37, 38, 60, 61, 146, 147.

³⁶¹*Taḥqīq mā li al-Hind*, pp. 72-74, 181, 318./ *India*, I, pp. 95, 97, 222, 379./ *Loghāt-e Sanskrit dar Mā li al-Hind*, Jalali Na’ini and Shokla, Tehran, Shorāye ‘āli-ye farhang va honar, 1974./ *Gozide-ye Rig Veda*, Tr. Jalali Na’ini, Tehran, Naṣhr-e noqre, 1988, p. 537.

Iranian and Greeks identified the deities with the biggest, farthest, slowest and heaviest spherical body, namely the awesome and mysterious Saturn, located at the edge of the cosmos. Prajapati as the god of the creatures, having the golden egg of creation and the supreme creator (the *Rig Vedas*, 10, sections 81, 82) was a tetramorph deity like Zurvan. He was the creator of the devil, identified with the symbol of time, i.e. ‘year’, and also called the god ‘kā’, almost the same as the concept of ‘hū’ in the Islamic mysticism to come.

Brahma, the same as Prajapati and the second of him in the Brahman age, was the supreme creator and, as Bīrūnī says, “the Brahma Purana (the prime eternal essence) is the nature responsible for the universe”. In the continuation of the concept of Prajapati, Brahma changed into an absolute abstract character: self-existing, unseen, unborn, unchangeable, immortal, without beginning and end, the source of everything and finally the whole universe being a materialization of him. The basic existence of the world depends on Brahma who paved the path for the development of the monistic philosophy of the *Upanishads*, especially in the late *Maitreyi-Upanishads* and the way it presents the philosophical concept of Brahman: there are, due to the impersonal principle of the reality, two types of Brahman, i.e. time and non-time, equivalent to the limited and the unlimited Zurvan. In the two creeds, the year as the symbol of the limited time or the temporal periods was the place of Prajapati, Zurvan and Brahma. Kala means time, time-unit, the lord of the epoch Kaliyuga, with the compound ‘kalpa’, meaning the creator god and also a full day and night, and finally the compound ‘kala Brahman’, meaning the renewer/ rehabilitator of the universe, equivalent to aforementioned ‘frashōgar Zurvan’. Kala is the god who created the whole universe and will pull and swallow it at the end of the times and periods, right in the same way that the Greek Kronos devours his children to make them attracted in their birth again (i.e. the idea of ‘return’) and to keep only one sage who will have known the origin of the things, their non-presence (i.e. the idea of ‘absence’), and the possibility of the absolute unity with him.

In summary, ‘time’ (kala) contains and gives life to all that does or will exist, including Brahman, because time is the lord of everything. He is the father of the Prajapats. In the process of the deification of time, according to the Indian epic *Bhagvadgita*, the supreme god Vishno showed himself as the ‘time’. Then, the high-ranked Shiva, identified with Mahakala (the great kala), can be seen as the god of time. Generally, as it were, the concept of time as the supreme god roots in the Arian traditions that introduced the god as the creator and protector of the universe. From the viewpoint of comparative religion studies, the general descriptions and aspects of Prajapati, Brahma, Kala and Shiva can be observed in the Iranian god of the whole time, Zurvan. The Avestan word vāya meaning ‘amad’ (extremity, eternity) can be said to be identical with the Indian wāyas and the Sogdian vāy (‘epoch/ time’), and has the same title as the Iranian Zurvan drang xwadāy (Zurvan of the long dominion). Altogether, the religions of Brahma and Zurvan are not dualistic or polytheistic at the level of theology. So, as Bīrūnī discusses in his explanation of their monotheism, the Indian thinkers’ belief in

“the eternal, one, free, potent, wise, living God’ is the same as the Muslims’ perfect monotheism”.³⁶²

Kronos, as mentioned by Bīrūnī in reference to Plato’s and Galen’s ideas and in comparison with Prajapati, must have been borrowed from the Iranian Zurvanic religion. The scholar S. Brandon reinforced the fact. The evidence for the borrowing comes from the aforementioned idea of the Iranian Magian creation narrated by Aristotle and his followers. However, Brandon explained that the Iranian concept of the unlimited time was discussed as part of the Platonic and stoic ideas under the name and in the form of ‘aion’, although I suppose that it was the concept of the limited time, and that the unlimited time or the unlimited Zurvan was the same as Kronos. By the way, Kronos, in the Greek and Roman cultures, was admired as the supreme god, worshipped in the cities Byblos and Britos, and was identical with the Egyptian Osiris. Kronos was the single symbol of the first cause in the creation of the cosmos which, as the Greek poet Pindaros (cr. 522- cr. 443 B. C.) said, was “the father of everything” swallowing his children (creatures) and was hence the same as Prajapati and Zurvan. It is known that the proper name Kronos is a cognate of the current prefix chron- (time). As a matter of fact, the identity of Kronos with aion (i.e. the eternal duration) in Greek and Roman cultures came to obtain an occult mystical sense as well which could only have been borrowed from the sublime Iranian concept of Zurvan: in the Iranian theology, the fortune-bringer creator as the lord of the celestial bodies determining men’s fate too.

The celebrated scholar Nyberg argued that in the Avestan theology dragu xwadāta (Zurvan of the long dominion) meant the time which begins with the beginning of the world and ends with its end, namely the limited time in a small world. Therefore, the Greek idea of ‘aion’ rooted in the Iranian concept of Zurvan.³⁶³

5. The idea of the first cause

According to some Greek philosophers, as Bīrūnī reports, human beings have no priority over minerals except for their approximation to the first cause. Other philosophers consider the real existence exclusively emerging from the first cause, because it is essentially needless of existence and whatever save it is in need of it (as Nizāmī said “Given not even the smallest portion of existence,/ existence-giver how could have been the Essence?”. This means that the existence of everything but the Truth is merely fantastic. The same was believed by great mystists as the sages of their own times. Now, the matter can be said to be the mediation between it and whatever beyond it, including the spiritual concepts of soul and God. “In the

³⁶²Religion and Philosophy of the Veda and Upanishads, A. Keith, vol. I, pp. 139-140, 142-153 ff./ Indian Mythology, A. Keith, New York, 1964, pp. 38-39, 50-52, 74-78, 81-82, 93, 107-117-121./ History, Time and Deity, S. Brandon, pp. 31, 34, 35, 37-38, 97, 98./ A locust’s leg..., London, 1962, (ar. de Menasce), pp. 184-185./ Taḥqīq mā li al-Hind, pp. 20, 24, 69, 71, 101, 123, 137, 272, 283, 321, 334, 342. / Loghāt-e Sanskrit dar Mā li al-Hind, Jalali Na’ini and Shokla, pp. 56, 222, 223.

³⁶³History, Time and Deity, S. Brandon, pp. 44-45, 53, 59-61./ Zurvan, Zaehner, pp. 113, 144./ Dīnhā-ye Iran-e bāstān, Samuel Nyberg, Tr. Seyf ’al-din Najm Abadi, Tehran, p. 383.

matter the first three potencies flow, as if the matter descends from top to down on a bridge. Thus, what (i.e. the dynamicity) in which the first potency (i.e. the first cause) flows is called purely as Brahma and Prajapat. Such a concept refers to **nature** in the beginning of its action, namely creation, such that the creation of the universe is attributed by them to Brahma. Therefore, Brahma (the creator) and Prajapati (the eternity) are not the names of species, but of individuals. And indeed Prajapati is the very Brahma, the first father and Brahma is the absolute essence and the sublime god. The Brahma-Purāna (the first eternal essence) is the nature responsible for the [preservation] of the cosmos.³⁶⁴

According to what we have already said about Bīrūnī's philosophical ideas and their sources, we can add that he expressed the gist of his message through the above-mentioned quotation quite clearly. It is evident that, concerning the first cause, he almost combined the Indian wisdom of Vedanta with the Greek ideas. The Vedanta system and the Indian Samkhya were presented in the book *Bhagavadgita* and the books *Mahabhrata* and the coalescence of the two in the form of the Yogic wisdom and it was this practice that came to stand in contrast to the Buddhist wisdom. Bīrūnī was enchanted by the Brahmin worldview especially by what he referred to as *Bhagavadgita* in so much that he embarked on his translation of Samkhya and Yogic Patanjali from Sanskrit to Arabic (*Kārname*, no. 98, 174). But, it should be noted that Bīrūnī's belief in the Brahmin concept of the eternal time or the Indian Prajapati does not amount to saying that he believed in the idea of the 'egg-like' cosmos ('the egg of the Brahmand' in his words) or the precedence of the element water as the primal matter or urstoff of the creation and the like, because he has refuted and mocked such beliefs. We need not repeat that he had his own delicate independent thoughts in the scientific-philosophical fields.³⁶⁵

It can be inferred from the Iranian *Bundahišn* (chapters 1 and 2 on creation) that the motion of the existence during the time was due to the conflict of the contraries in the universe, hence the concept of 'motion' from the very beginning of the unmoving creator, Zurvan. According to *Dēnkird* (Madan, 350/ Sanjana, 8, 388) the movement was produced by the seeds (elements) as the basic seeds of the worldly creation.³⁶⁶ Concerning the first mover, the same as the first cause, Bīrūnī says that philosophers believe that "the existing world is only *one* thing; that the First Cause appears in it under various shapes; that the power of the First Cause is inherent in the parts of the world under different circumstances, which causes a certain difference of the things of the world notwithstanding their original unity; however,

³⁶⁴*Tahqīq mā li al-Hind*, pp. 24, 69, 71, 100-101, 123./ *India*, I, pp. 33, 92, 93-94, 130, 159.

³⁶⁵*India*, II, notes, p. 265. / *The Commemoration Volume*, (ar. F. Rosenthal), pp. 546, 554./ *al-Biruni Commemoration Volume*, (ar. H. Heras), pp. 116-123./ *al-Biruni Commemoration Volume*, (ar. M. Moreno), pp. 162-163./ *Biruni Symposium*, (ar. B. B. Lawrence), pp. 37-38./ *Introduction to the History of Science*, G. Sarton, vol. I, p. 708./ *Moqaddame bar tārikh-e 'elm*, Sarton, Tr. Sadri Afshar, vol. 1, p. 816./ *Tahdīd nihāyāt al-amākin*, p. 22./ *Nazar-e motefakkerān-e eslāmī darbāre-ye tabī'at*, Sayyid Hossein Nasr, p. 173./ *Yādnāme-ye Bīrūnī*, (ar. 'Abd al-jawād Falāṭūrī), p. 512./ *Abu Rayhān al-Bīrūnī*, Mohammad Esma'il Moballegh, p. ???./ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Fathullah Mojtabae), pp. 257, 288./ *Zendegināme-ye Bīrūnī* (Alī al-Shābbi), pp. 83, 97-98.

³⁶⁶*Zurvan*, Zaehner, texts, 281, 315, 372, 374, 433.

sometimes they do not make a distinction between this *middle force* and the *first cause*".³⁶⁷ However, *Dēnkird* (Madan, 207/ Sanjana, 5, 232) maintains "this that Time itself is eternal, and its essence is duration. Through it matter has the Potentiality of being actualized. *Qua* potency it is eternal. Its limitation consists in the movement of matter in Space (Vāy) by means of the Firmament (Spāš), as, for example, the course of the luminaries, the blowing of the wind, the running of water, the growth of plants, and all actualization of potency in space (Vāy)". Elsewhere (Madan, 282-283/ Sanjana, 6, 313), we read "from action *in potentia*, original seed [...] first (arose), [...] the performance of action with which coincided the entry of Time into action. From the performance of action (arose) the completion of action [...]. The limit of finite Time merges into Infinite Time [...]. Time was originally infinite [...]. The law of Time is (to proceed) from original infinity through limitation involving action, motion, and passage [...]. Contingent on this is the rising up of the Aggressor, against the will (of God), to destroy the essence and properties (of Wisdom) by false speech".³⁶⁸

It appears that the Iranian viewpoint, in line with that of Bīrūnī, is identical with the Aristotelian definition and the account of the nature (but not the types) of 'motion', in that a thing is composed of matter and form; matter being the pure potency and form as the source of actuality. So, nature is essential to the things and the reason of the changing of the possibility to actuality. Any motion is immediately an effect of the nature of the thing inside it, hence, an effect of the first mover, God.³⁶⁹ Bīrūnī reports the idea of the theologians on the problem of time: "Another one declares eternity to be the circular motion. No doubt this motion is indissolubly connected with that being which *moves* by it, and which is of the most sublime nature, since it lasts for ever. Thereupon he [Rāzī] rises in his argumentation from the moving being to its mover, and from the moving mover to the first mover who is motionless. This kind of research is very subtle and obscure. But for this, the opinions would not differ to such an extent that some people declare that there is no time at all, while others declare that time is an independent substance. According to Alexander of Aphrodisias, Aristotle gives in his *φυσικὴ ἀκρόασις* the following argumentation: 'Everything moving is moved by a mover'; and Galenus says on the same subject that he could not understand the notion of time, much less prove it".³⁷⁰ It was on this complicated problem that his scholar friend, Abū Sahl Masīhī, wrote the book *Al-tawassuṭ bayn Arasṭūṭālīs and Jālīnūs fī al-muḥarrik al-awwal* (*Mediation Between Aristotle and Galen Concerning the First Cause*) dedicated to him.³⁷¹

³⁶⁷*Tahqīq mā li al-Hind*, pp. 25, 72, 332./ *India*, I, pp. 34, 94, 395.

³⁶⁸*Zurvan*, Zaehner, Part II texts, pp. 383-384, 389-391.

³⁶⁹*Falsafe-ye 'elm-e kalām*, H. Wolfson, Tr. Ahmad Aram, p. 535./ *Tārīkh al-falsafa fī al-islām*, De Boer, p. 120./ *The Commemoration Volume*, (ar. L. Gardet), p. 199.

³⁷⁰*Tahqīq mā li al-Hind*, pp. 271-272./ *India*, I, pp. 319-320.

³⁷¹*The Commemoration Volume* (ar. A. Badawi), p. 154./ *Al-mashāṭa li risāla al-fihrist*, (ed.) Mehdi Mohaqqueq, p. 188./ *Fīlsūf-e Rey*, Mehdi Mohaqqueq, p. 362./ *Kārnāme-ye Bīrūnī*, P. Azkai, p. 62.

Bīrūnī's idea, must have been the same as that of Rāzī who wrote a book on the same subject, i.e. 'a body has essential motion in itself', in addition to his lost book *Al-'ārā' al-ṭabī'īya* (*Natural Opinions*) (the Christian bishop Ilija of Nisibin (d. 1049 B.C.) wrote in his treatise, *the Unity of the Creator and the Trinity of His Hypostases*, on the fact that God is the self-existent 'substance', the same as the Syriac k^eyānā (φύσις), quoted from Rāzī's book *The Divine Science*, that the first mover is absolutely the first: God is the cause of all beings, the substance as the cause of the existence of all accidents, etc.). Rāzī also wrote in his *Philosophical Conduct* on motion that "a body moves essentially and the motion is known".³⁷² By the way, the Aristotelian argument for the existence of God introduced him as the first cause or the first mover, a substance eternal, unmovable, far from the concrete things, dimensionless and rather indivisible. This is what Ibn Sīnā called as the 'cause of motion' too. One of the arguments on the existence of God is that the chain of causes must have a sempiternal beginning. However, atomists, one of whom is Bīrūnī seemingly, have denied the causality principle, though some have taken an intermediate position. In fact, the doctrine quoted from the Greek philosophers by Bīrūnī, belongs to the stoic and neo-Platonic thinkers and even the contents and the places of citations in *India* can reveal that the idea of the first cause is completely Platonic.³⁷³

It is known that the first cause has no cause itself, or, in Ibn Sīnā's terms, the cause of the whole being and the cause of the truth of the whole being is in the being (*Ishārāt*). This is called the 'essential cause' and, in Spinoza's terms, the cause which cannot be envisaged not to exist. It is, therefore, referred to as God, because God is the cause of the existence of all beings and the cause of the existence of himself. To Kant, it was logically the same as the antecedent in the conditions of the existence of the consequent. That is why he believed that causal relations were rational and analytical, not experimental and synthetic. By the way, Bīrūnī says about the first cause that some maintain that whoever returns to the first cause wholeheartedly, will assimilate it and will possibly unite with it if the mediations and interests are abandoned. Such is the mystical views in this regard... etc. It has been said that Bīrūnī's natural and mathematical investigations led him to his knowledge of God's wisdom and creation, thus directing him toward the first cause.³⁷⁴

³⁷²*Fīlsūf -e Rey*, Mehdi Mohaqeq, pp. 83-84, 224, 265./ *Al-sīra al-falsafiya*, Razi, (ed.) Mehdi Mohaqeq, p. 101.

³⁷³*Tārīkh-e falsafe-ye gharb*, Bertrand Russell, Tr. Najaf Daryabandari, Tehran, Entesharat-e Sokhan, 1961, vol. 1, p. 355; 1966, vol. 2, pp. 846-847./ *Farhang-e falsafi*, Jamīl Ṣalībā, Tr. Manuchehr Sane'i, Tehran, Enteshārāt-e Hekmat, 1987, p. 583./ *Falsafe-ye 'elm-e kalām*, H. Wolfson, Tr. Ahmad Aram, pp. 501, 556./ *Taḥqīq mā li al-Hind*, p. 26. / *India*, I, p. 36./ *The Commemoration Volume*, (ar. A. Badawi), p. 156.

³⁷⁴*Farhang-e falsafī*, Jamīl Ṣalībā, p. 478./ *Taḥqīq mā li al-Hind*, p. 25./ *India*, I, p. 35./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, p. 183.

6. The Zurvanic philosophy

a. Origins. As it were, the scholars' ignorance of Bīrūnī's philosophy has given rise to the question of what his philosophical school looked like, if he is to be considered a philosopher. We have said that if philosophers such as the peripatetic Ṣāḥib al-dīn Beyhaqī believed that Bīrūnī was not a philosopher, it was due to the fact that customarily the followers of Aristotle were bestowed the title 'philosopher', and that Bīrūnī and his pioneer Rāzī took an opposite road. But, it seems that in Greece, too, natural philosophers and physicians were not habitually entitled philosophers: Galen asked the ruler of the time to entitle him as a philosopher³⁷⁵, the same as what Rāzī demanded his own time. Bīrūnī says that Galen wrote a book and proposed that a scholarly physician had to be a philosopher... etc, yet, the response Rāzī received from his time was, despite all his important philosophical works, the same as what Beyhaqī declared about Bīrūnī later. Rāzī wrote the treatise *Philosophical Conduct*, and called himself a philosopher. Bīrūnī, however, never claimed as such and added, after his awakening references, that "philosophy means the wisdom bound to knowing the beings as they really are. Thus, as man inquires meticulously and acquires the principles of all sciences, he will inevitably be a philosopher".³⁷⁶ We should add that keeping silent has always been a familiar foul trick against true scholars, the warfare used against Rāzīs and Bīrūnī's in Iran too.

It was Sachau, the editor of *Mā li al-Hind (India)*, who first proclaimed that Bīrūnī had a manifest tendency toward Indian philosophy and that his source book, *Bhagvadgita* or God's voice, involved the doctrine of pantheism with the "Time" as the supreme ancient Arian god. Bīrūnī learned much from the Indian men of wisdom and their books. His translations of the books *Samkhya* and *Patanjali* should be taken not merely as renderings of the philosophical texts, because his curious mind was deeply influenced by the subject and absorbed it in his own thinking. The editor of *Patanjali*, Helmut Ritter (1892-1971), too believed that the great translator of the book had found the contents of it close to his own thoughts.³⁷⁷ Concerning the Greek philosophy, we need no longer repeat that Bīrūnī attacked the natural philosophy issues in the peripatetic philosophy, especially the problem of the eternity of cosmos which has been regarded as his major objection, believed to be proved by the findings of the modern science. However, it has been argued that he accepted a good number of peripatetic ideas and attacked only the argumentation method by Aristotle and his followers. By the way, Bīrūnī admired the Greek philosophers prior to Socrates and was influenced most of all by the

³⁷⁵ *Tāriḫ-e 'olum-e 'aqli dar tamaddon-e eslāmi*, Zabih-allah Safa, p. 286./ *Abū Rayḥān al-Bīrūnī* (ar. Mohammad Esma'il Moballegh), p. 71./ *Fīlsūf-e Rey*, Mehdi Mohaqeq, P. 328.

³⁷⁶ *Tahdīd nihāyāt al-amākin*, Tr. Ahmad Aram, p. 255./ *Al-sīra al-falsafiya*, Rāzī, pp. 101-102./ *Fīlsūf -e Rey*, Mehdi Mohaqeq, pp. 213, 224-226, 306./ *Tāriḫ-e 'olum-e 'aqli dar tamaddon-e eslāmi*, Zabih-allah Safa, pp. 286-287./ *Abū Rayḥān al- Bīrūnī*, (ar. Mohammad Esma'il Moballegh), pp. 71, 79.

³⁷⁷ *India*, I, p. XVIII; II, P. 265./ *al-Biruni Commemoration Volume*, (ar. H. Heras), pp. 116-123./ *al-Biruni Commemoration Volume*, (ar. M. Moreno), pp. 209-216./ *Biruni Symposium*, (ar. B. Lawrence), pp. 37-38./ *The Commemoration Volume*, (ar. F. Rosenthal), pp. 546, 554./ *History, Time and Deity*, Brandon, pp. 2, 31, 37-38./ *Introduction to the History of Science*, Sarton, p. 708./ *Nāẓar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, pp. 173, 247./ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Mjtabaee), pp. 257, 288.

atomism of Democritus and the stoic school, particularly by Plato's concept of 'aions'. Like Rāzī, he was inclined to the philosophy of Plato or, to be exact, that of the Iranian magi, because Plato inherited the originally Iranian Zoroastrian philosophy.

Bīrūnī descended from the celebrated Avestan branch of the Arians of Khwārazm, in his own words, "a branch of the big Iranian tree" (*Al-āthār*, p. 56). It is natural if the golden culture of Iran played a constructive role in the development of his scientific and philosophical character. Scholars have pointed out the two major principles of the ancient Arian thinking, always present in the history of Iran, as the following: (1) 'order and law' are inherent in the nature, and (2) 'conflict' is also inherent in the nature, both the foundations of the Iranian philosophical thought too. Another point to note is that religion and philosophy have always been one and the same thing in Iran, as 'Iqbāl Lāhūrī says "the Iranian philosophical thinking is highly mixed with religion".³⁷⁸ Olmstead concludes, concerning the separation of the two in Greece, that Greek philosophy, if not completely disbelieving in God, did not truly believe in God".³⁷⁹ And still, regarding Iranian dualism as a masterpiece of thinking in human civilization, we have to emphasize that it was not actually a matter of religion, but more a matter of philosophical nature. Iranians have always been religiously monotheist and philosophically dualist. This can serve as a good description of Rāzī and, at the same time, reveals what non-Iranian dogmatic zealots accused him of. Bīrūnī agreed with Rāzī both in his experimental-inductive methodology and in his philosophical viewpoints, based on the same grounds. He objected Ibn Sīnā both methodologically and foundationally, since Ibn Sīnā's philosophy was bound to scholastic logical syllogisms.³⁸⁰

In the realm of science and thought, Bīrūnī and Rāzī are the members of the same family: they are similarly fond of truth through scientific inquiry. They undertook establishing a critical school of evaluating the Greek natural philosophy: Rāzī wrote down his doubts on Galen's ideas and Bīrūnī compiled his criticisms against a number of Aristotelian principles.³⁸¹ As a matter of fact, Bīrūnī had access, in some way, to Mani's books possibly through Rāzī's works and became inclined to Manichaean and Zurvanic wisdom. He reported his inclination as "becoming fascinated by Mani's books through Rāzī's book *Al-ilm al-ilāhiya (The Divine Science)*", and then, for understandable reasons, he pretended to deny his inclination to that philosophy 'lest others should suspect that he was a follower of Rāzī'. And, for the sake of convenience, he finally cursed Rāzī for his blasphemous ideas, seemingly a necessary precaution in that circumstance.³⁸² Almost all great scholars share the same idea that Bīrūnī tried to conceal for the fear that his prejudiced opponents would make him

³⁷⁸ *Seyr-e falsafe dar Iran*, Amir Hossein Arianpur, Tehran, 1968, p. 2.

³⁷⁹ *History of Persian Empire*, p. 211.

³⁸⁰ *Yādnāme-ye Bīrūnī* (ar. Sayyid Ja'far Sajjadi), pp. 229-244.

³⁸¹ *Filūf-e Rey*, Mehdi Mohaqeq, pp. 225, 297-, 302-, 309./ *Al-sīra al-falsafīya*, Rāzī, (ed.) Mehdi Mohaqeq, p. 103./ *Al-shukūk 'alā Jālīnūs*, (ed.) Mehdi Mohaqeq, Tehran, 1993.

³⁸² *Fihrist kutub al-Rāzī*, (ed.) Mehdi Mohaqeq, Tehran University, 1987, pp. 2, 3, 46./ *Tārīkh-e 'olum-e 'aqī dar tamaddon-e eslāmī*, Zabih-allah Safa, p. 283./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), pp. 84, 86.

annihilated in the Sunnite-stricken court of the philosopher-killing Sultan (Bīrūnī was once about to be thrown down from the top of the Sultan's palace, as he did the same to 'Abd al-ṣamad Ḥakīm, Ibn Fūrak, Abū Naṣr 'Irāq, the Moslem jurist Abū 'Abdullāh Ma'ṣūmī, and also to thousands of invaluable books of science and wisdom in Ray (420/ 1029).³⁸³ Therefore, Bīrūnī had to keep as a secret much of his scientific- philosophical ideas and to express them through dubious words, even tactful tricks of rejection and curse. He did so in the list he presented from Rāzī's books. We should note that his objection to Ibn Sīnā was in some way directed towards his scientific conservatism. In-so-much as they could, Rāzī and Bīrūnī tried to put an end to the static mentality which had overshadowed a large number of philosophical and epistemological issues throughout the Islamic period.³⁸⁴

It should also be made clear that it is far from fair to refer to Rāzī and especially Bīrūnī as believing in the Dahrīya materialistic 'duration' or 'matter'. In fact, they both agree with the Iranian Mu'tazilite theologians over the subject of monotheism. Believing in the creator and the creation of the cosmos, separately developed in some of his books, Rāzī produced a work under the title *Kitāb fī 'anna al-munāqaḍat ... (The Book on the Debate between the Dahrian and the Monotheist over the Cause of the Originations in the World)* and it seems correct if the subject of the causes of actions is reduced partly in terms of the extension of the action and partly of the doctrine of the eternity of the universe. It is clear that Rāzī attempted to unite the Dahriya materialistic and the monotheistic doctrines, and that he believed it was permissible to do so. The Isma'īlite Nāṣir Khosrow, however, distinguished those who believed in the Dahriya materialistic 'duration', and those who believe in 'matter' on the account that the former denied both the 'creation from nothing' and 'creation from the matter' and maintained that the world was eternal, not created. Yet, the latter argued that the universe and the matter were originally eternal with its form as 'created from nothing' and its composition 'originated'.³⁸⁵

Concerning the nature of the matter, we must say that Bīrūnī argued the same as the Islamic theologians did: the matter of the world is the same as the indivisible atoms. Thus, like Democritus, he considered the unchangeable quantities (atoms) as the substance (osia) and the existence of void (space) as possible, even necessary- the latter being the same as the theological 'non-being'. Therefore, he may be considered as an atomist philosopher or scientist. His atomic theory lies in the fact that a thing is composed of atoms, infinite in number and existing pre-eternally (i.e. duration). This means that they existed before they were arranged in the things (i.e. the pre-eternal matter prior to the existence), with their

³⁸³ *Chronologie Orientalischer Völker* (vor. E. Sachau), pp. XI, XXX./ *Biruni Symposium*, (ar. G. H. Youssefi), p. 21./ *Vaḥy va 'ql dar eslām*, A. Arberry, p. 39./ *Tārīkh-e 'olum-e 'aqlī*, Zabih-allah Safa, p. 282./ *Aḥvāl va āthār-e Abū Reyhān*, Zabih-allah Safa, p. 148./ *Nāẓar-e motefakkerān-e eslāmī darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, pp. 173, 246./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), pp. 63, 84, 85./ *Andīshmand va ensān*, Najafi and Khalili, p. 119.

³⁸⁴ *Tārīkh-e 'olum-e 'aqlī dar tamaddon-e eslāmī*, Zabih-allah Safa, p. 282./ *Vaḥy va 'ql dar eslām*, A. Arberry, p. 39./ *Andīshmand va ensān*, Najafi and Khalili, pp. 119, 126./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 63.

³⁸⁵ *Fīlsūf-e Rey*, Mehdi Mohaqqueq, pp. 79, 112-114, 146./ *Zād al-musāfirin*, Nāṣer Khosrow, p. 73./ *Tārīkh al-falsafa fī al-islām*, De Boer, p. 99.

arrangements and formations taking place accidentally. Such an atomistic viewpoint involves the principle of causality, hence Bīrūnī's belief in 'the first cause' or God.³⁸⁶ That is why he rejected the eternity of the universe maintained by the Aristotelian peripatetics and confirmed the bodily nature of the light and the elemental nature of fire in the formation of the world. Therefore, it appears that to him the matter or the atoms substantiating the world were the 'light' particles. As a result, he could definitely be regarded as a great sage among the illumination philosophers of the Khusrawānī or Ishrāq school. Concerning his belief in the eternity of the Platonic concept of aion/ duration, the same as the infinite magian Zurvan, Bīrūnī will surely be among the followers of the Zurvanic philosophy in Iran.

b. The Iranian view. In the beginning of its systematic generation, Zurvanism was a product of the Mesopotamian civilization and the Indo-European nations in Iran. At the time of Mani, it was strongly supported especially by the Median magi existing ever since the Achaemenian period. When the Fathers of the Christian church began to attack the 'magian doctrines', they meant to oppose Zurvanism as the blasphemous creed. Among the doctrines of *Dēnkird* and other Sassanian teachings, today believed to have been borrowed from the Greek and Indian thoughts, the cosmological Zurvanic doctrines have been often considered as inspired by the Indian ideas, though associated with the Greek opinions as well.³⁸⁷ We have already quoted from Bīrūnī in full that the Iranian concept of Zurvan was analogous to the Indian Brahma, as it can be observed in the same sense in the Buddhist Sogdian texts in the eastern Iran, the cultural heritage of which, written or verbal, was received and used exhaustively by Bīrūnī. The Manichaean thought of which he became aware through the writings of Rāzī, were more or less alive in the regions of Sogdiana, Balkh and Badakhshān. In the Manichaean texts, as it were, Zurvan was called Father of Greatness, The Ruler of Paradise, Father of Light, and The Primeval Father. He was the same as the Greek aion, the celestial symbol of which was the awesome far Saturn. The philosopher Majrīṭī of Andalusia (d. 398/ 1007) reported some prayer to Jupiter (the same as the star of Hormozd) from Rāzī's *Ilm al-ilāhiya (The Divine Science)* in his book *Ghāya al-Ḥakīm (The Goal of the Philosopher)* (chapter 7).³⁸⁸ According to the evidence there, Rāzī must as well have had a prayer to Saturn (Zurvan) in that book which can show his Zurvanite tendency.

There is a good deal of evidence for Zurvan being worshipped in the Sassanian dynasty which show that Time had been for long identified with Zurvan -an established feature of Iranian religions. According to the evidence, the universe emerged from a 'seed', i.e. the time-bed, the time-space being the origin of that seed. The limited world is the offspring of the unlimited universe at a certain time. In this limited world the Zurvan-space, as the major

³⁸⁶ *Falsafe-ye 'elm-e kalām*, H. Wolfson, Tr. Ahmad Aram, pp. 388, 425, 500, 785./ *Tārīkh al-falsafa fī al-islām*, De Boer, p. 120./ *Payām-e Yunesko*, no. 59, (ar. Nasr), p. 40./ *The Scholar and the Saint*, (ar. A. Heinen), pp. 49-59.

³⁸⁷ *Mani and Manicheism*, Widengren, p. 44./ *Zurvan*, Zaehner, p. 143.

³⁸⁸ *Opera Minora*, Richard N. Frye, vol. 1, Shiraz University, 1976, p. 52./ *A Reader in Manichaean...*, M. Boyce, p. 8./ *The Birth of Astronomy*, Van der Waerden, 1974, pp. 167, 171./ *Fīlsūf-e Rey*, Mehdi Mohaqeq, p. 264.

world and the origin of human descent, reveals itself as the law of the nature and the destiny. The universe (Zurvan) can never be measured with spiritual criterion since he is not only the god of nature, but the nature itself; he is the first cause of all natural phenomena, rather the absolute idea of the origin of the primal matter. Once we combine this purely physical concept of the universe with the Zoroastrian ethical principle, we can see that Time and Fortune are only the directors of the natural world; they are not involved in the moral struggle between good and evil. Firdawsī's *Shāh Nāme* is a good insightful testimony about man's world under the reign of Time and Fortune. Such a theory views the whole universe as emerged from the unlimited time, denying any spiritual punishment or reward. This idea is close to that of the Zandīqs who believed in the eternity of matter. We may explain that the Zurvanic materialism was what Kartir, the eminently influential high-priest of the Sassanian period, referred to as the fundamental blasphemy. In line with Dēnkird (*Madan*, p. 120, sections 349-350), this Zurvanite concept of matter is consistent with that of Aristotle, as some scholars hold so: Zurvan the unlimited appears as the Father (of Greatness) and the mother of cosmos. The form of the matter, influenced by the Aristotelian idea, was in its turn effective in the development of the Iranian neo-Platonism and mysticism.³⁸⁹

R. C. Zaehner and S. Brandon, as just cited, remarked that this is the materialistic philosophy of duration (the Dahriya philosophy) in the Islamic period. Nonetheless, as we have previously discussed, Bīrūnī's Zurvanic philosophy is not exactly the same as the Aristotelian materialistic philosophy in that age. Firstly, the matter of the universe in the Aristotelian philosophy was an eternal substance, while Rāzī and Bīrūnī believed in the creation of the universe. Secondly, to turn into the 'form', the Aristotelian matter had an unlimited continuous character, while the two philosophers believed in the discontinuous motion through the space of 'void' (the middle Persian 'tuhīgān') space, i. e. through the indivisible atoms. The followers of the Dahriya materialistic duration did not believe in the necessity of the creator for the universe, while Rāzī and Bīrūnī believed in the origination as creation in which the agent was the same as the first cause, the first mover, God, the unlimited time or Zurvan: it is possible only in too broad a sense to call that creator as Dahr or the materialistic 'duration'. It is in this case that the absolute time concept of Kāla/Brahma, Zurvan, Kronos, the Quranic Dahr (duration) and the Arabic 'awḍ will be identical to the sublime Allah.³⁹⁰ This is the difficulty of explaining Bīrūnī's philosophy and faith, the unique scholar whose belief in the creator of the world and the One God has been elaborated in this book. Therefore, the materialistic belief in 'duration' (the idea of the Azaliya sect) which was held by some eclectic Aristotelian philosophers of pre-Islamic Harran and Gundishapur³⁹¹ was far from the original Zurvanism followed by Rāzī and Bīrūnī.

³⁸⁹Zurvan, Zaehner, pp. 266-267./ *History, Time and Deity*, Brandon, p. 40.

³⁹⁰cf. *Opera Minora*, Richard N. Frye, p. 56./ *History, Time and Deity*, Brandon, pp. 54-55./ *Zurvan*, Zaehner, p. 266./ *Al-jāmi' al-ṣaghīr*, Siyūṭī, Cairo, 1946, vol. 2, p. 634/ *Falsafe-ye 'elm-e kalām*, H. Wolfson, p. 543./ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Sajjadi), p. 326.

³⁹¹*Al-farq bayn al-firaq*, Bghdādī, Beirut, 1973, pp. 297, 280, 282, 284./ *Falsafe-ye 'elm-e kalām*, H. Wolfson, p. 547.

M. Motahhari and S. H. Nasr achieved understanding the highly complex issue of Bīrūnī's conception of the creator and monotheism in their brilliant investigations, barely improvable, yet stopped by their own perplexity at the dilemma of religion and philosophy. Now, the present writer seems to be honorable to express the last word here, so that there may be no need for any other alternative. I suppose that once the theological problem of Rāzī's and Bīrūnī's ideas on origination and eternity is solved³⁹², as we have done here, one of the most important philosophical topics of the Iranian sages in the Islamic period will be possibly close to definite solution. The unlimited time or Zurvan is not only God, but the creator, as it is proclaimed in the Zurvanic treatise of *The Islamic Scholars* (sections 6, 7, 8): "(6) First I will speak of the world and discuss whether it has (always) existed or it was created. If it should be said that it has (always) existed, this opinion is untenable: for ever anew do things wax in the world and then again wane [and wax], decrease and then again increase. Further, whatever susceptible of coming to be and passing away and it is far from God to be the effect of a cause. We can, therefore, take it as axiomatic that the world has not (always) existed and that it has been created. Moreover, a created thing necessarily implies a Creator. (7) Now it must be known that according to the Pahlavi religion to which the Zoroastrians adhere, the world is said to have been created. After positing that the world has been created, we must add who created it and when, how, and why he created it. (8) In the religion of Zoroaster it is thus revealed. Expect Time all other things are created. Time is the creator, and Time has no limit, neither top nor bottom. It has always existed and shall exist for evermore. No sensible person will say whence Time has come".³⁹³

These words are almost exactly the same as those remarked by Bīrūnī in the previous sections. It is clear that we mean to emphasize his intellectual harmony with the Zurvanic philosophy and the framework of its 'system'. It seems that it is only in the Zurvanic school of thought that religion and philosophy really become identical, with no boundary between their concepts: the creator, God, the first cause and the first mover are all the same. This is the remarkable characteristic of the organic unity of religion, philosophy and science in Iran. One will be shocked over the sorrowful fact that the Iranian investigators of Bīrūnī have all followed their European counterparts and have announced whatever non-Iranian philosophical schools -Pythagorean, Platonic, Aristotelian, Hermetic, and Indian, as influencing Bīrūnī's philosophy, while none has ever pointed out to the Iranian school of philosophy even as a plausible source of effect. This reminds us of the meaningful verse by Hafiz saying: "what it (my heart) possessed itself from aliens it begged". This is why Rāzī and Bīrūnī and later, Suhrawardī are undisputedly the greatest representatives of the Iranian school of philosophy in the Islamic period. Rāzī's five eternal entities and Bīrūnī's time categories were later scrutinized by Mullā Ṣadrā (cr. 979?-1045?/ 1571-1635), Mīr Dāmād (d.

³⁹² *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), pp. 90-92, 95./ *Naẓar-e motefakkerān-e eslāmī darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, pp. 182, 246, 257./ *Payām-e Yunesko*, no. 59, (ar. Sayyid Hossein Nasr), p. 40.

³⁹³ *Resāle-ye zorvānī-e 'olamā-ye eslām*, (ed.) Parviz Azkai, Chistā, no. 73, 1990, pp. 346-347./ *Hochgottglaube im alten Iran*, G. Widengren, p. 274./ *Zurvan*, Zaehner, p. 409-410./ *History, Time and Deity*, Brandon, p. 41.

1040/ 1630), Mīr Fendereskī (970?-1050?/ 1562-1640), and Sabzevārī (1212-1289/ 1797-1872) in their discussions on the ‘origination of duration versus its eternity’.³⁹⁴ In Iran, the belief in a single (non-numerical) God as the creator was possible in the ancient times and in the mediaeval ages only by resorting to the methodology of the Zurvanic philosophy. This Iranian philosophy, as we have stressed frequently, exerted great impact on the Greek ideas of aion-Kronos and the Jewish-Christian beliefs, and later in the sixth century A. D. on the theological monotheistic beliefs of Arabia which was under the Iranian domination.³⁹⁵ We may take the Quranic ḥanīf (extensionally, ‘the True’) religion and the ḥunafā’ (later, the true believers) as an interpretation of the Iranian Zurvanism.

c. Religion of the philosophers. The only point to add here is the category of the contraries in Zurvanism and due to the reasons already presented for the acquired/ inferred not numerical monotheism, the point need not to be explained much more. We need not also repeat that the dualism in the Iranian philosophical worldview and the religious monotheism are by no means mutually exclusive, because the origins and the realizations of good and evil are well-known in all religions and if this characteristic has been attributed especially to Iranian religions, it does not mean that it is exclusively a feature of these religions. The contraries in Zurvanism are the origins of ‘light’ and ‘darkness’, hence it is called the ‘light philosophy’ (illumination) from a philosophical viewpoint, and the ‘sublime philosophy’ from the viewpoint of the existence of the Sublime, i.e. the supreme god, Zurvan. Bīrūnī’s references to the opposites in nature are of importance, and yet, in addition to supernatural entities such as paradise and hell, angels and beasts, reason and soul, knowledge and ignorance, he reveals, according to the Zurvanite-Manichaean texts, the dualism by the distinction he makes between the two groups of society: the elite (the learned ones) and the common people (the ignorant ones). He reports, regarding the mystical union, whereby it is said that there are one thousand stations of light and darkness between the servant and God and the servants all endeavor to move away from darkness to light and when they reach the light stations, they can return no longer.³⁹⁶ Wholly, the Manichaean mythology, based on the fundamental Zurvanism, clearly indicates the birth of the two heavenly twins, as Geo Widengren says, and, like all mystical religions, this involves a presentation of the Hegelian triad of thesis, antithesis and synthesis, that is, light, darkness and life as the synthesis of the two.³⁹⁷

In Hegel’s philosophy, when we face “‘the portentous power of the negative,’ we have to consider that for him negation is the very process of creation. For the *positive* nature of an object consists in its determinations. The nature of a stone is to be white, heavy, hard, etc. And since all determination is negation, it follows that the positive nature of a thing consists in its negations. Negation, therefore, is of the very essence of positive being. And for the

³⁹⁴ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Sayyid Ja‘far Sajjadi), 326.

³⁹⁵ *History, Time and Deity*, Brandon, p. 55.

³⁹⁶ *Taḥqīq mā li al-Hind*, pp. 29-31, 67./ *India*, I, pp. 39-40, 88.

³⁹⁷ *Mani and Manicheism*, Widengren, p. 44./ *Mesopotamian Elements*, Widengren, p. 14.

world to come into being what is above all necessary is the force of negation, ‘the portentous power of the negative’. The genus only becomes the species by means of the differentia, and the differentia is precisely that which carves out a particular class from the general class by excluding, i.e. negating, the other species. And the species again only become the individual in the same way, by negating other individuals. These thoughts are no casual reflections of Hegel. They underline his entire system. We must get to understand that these three ideas, determination, limitation, and negation, all involve each other”.³⁹⁸ The dialectical philosophy of Hegel can, hence, be said to represent the idea of the entire human history. Be it so, the ancient Zurvanic philosophy of the Iranian magi, prior to Hegel, was definitely an attempt to represent such an idea according to the definite well known evidence. It is known that the negative concept, or the Hegelian antithesis, is the very philosophical darkness and the religious Ahriman (devil) in Zurvanism, Zoroastrianism or Manichaeism. We do not intend to elaborate on this here, but we should only point out that Bīrūnī discussed the problem of non-being (void) as the counter example of existence in the time-bed and, in line with the Iranian viewpoint of the opposites, he expressed some of his best philosophical ideas about the negative category of the eternals and also about the topic of the cosmic void. Moreover, the necessity of the negative force for the process of Being, already cited according to the rational and narrative arguments from the Zurvanite-Zoroastrian texts, as Hegel argued, lies in the domination of darkness and Ahriman in comparison with light and Ahuramazda in the Manichaean ideas. Rāzī’s inclination to such an idea is obvious enough, whereas it cannot be observed directly in the lay-out of Bīrūnī’s thought. In summary, it has been said that Bīrūnī’s wording of the ‘principle of contrast’ at the end of his treatise *Al-as’alah wa al-ajwibah* (*The Questions and the Responses*) in which he announces the principle as a principle of the scientific knowledge, is in accordance with the dialectical epistemology and one of the scientific-philosophical characteristics of the contemporary thoughts.³⁹⁹

It is true that Zurvanism has been considered as a religion or used to be the religion of the magi in ancient Iran, but historians of religion and philosophy commonly held that it was more a philosophical tendency distinct from Zoroastrianism and its church and rites: it was an intellectual religion with mystical attractions for the scholarly elite mostly the elect from the upper classes and noblemen in Sassanian period. The philosophical nature of Zurvanism has made men of philosophy astonished, since it encouraged philosophical and scientific investigation, hence its being the religion of philosophers and the creed of the sages.⁴⁰⁰ However, we should note again that if some of the historians of the philosophy have identified Zurvanism with Dahriya or the materialistic duration creed, it is obviously wrong, because, as far as Bīrūnī is concerned, he severely refuted the materialistic duration.⁴⁰¹ By the

³⁹⁸*The Philosophy of Hegel: A Systematic Exposition*, W. T. Stace, Dover Publications, New York, 1955, p. ????.

³⁹⁹*Andīshmand va ensān*, Najafī and Khalili, p. 113.

⁴⁰⁰*Tārīkh al-falsafa fī al-islām*, De Boer, p. 15./ Dīn-e Irānī, Emile Benveniste, p. 9./ *Opera Minora*, R. N. Frye, pp. 49, 52, 55, 56./ *The Cambridge History of Iran*, vol. 3, (ed.) E. Yarshater, vol. 1, p. XLVI.

⁴⁰¹*Al-āthār al-bāqiya*, p. 87./ *Chronology*, p. 90./ *Tārīkh al-falsafa fī al-islām*, De Boer, pp. 14, 15, 135, 152.

way, we have attempted, in the previous section, to present Bīrūnī's Zurvanite tendency through a priori demonstrations; now, it is appropriate to add, through a posteriori demonstrations, that almost all great thinkers, including mathematicians, especially those involved in astronomy, are all inclined to the philosophical school of Zurvanism, identifiable with its prominent space-time doctrine. In addition to Khayyām, Sohravardī and Ṭūsī, Bīrūnī was a member of the same school.

Bīrūnī has sometimes been thought of as following Kendī (cr. 800-870/ 1397-1465) or Mas'ūdī (895-957/ 1489-1550) which is false, unless one immediately adds that the two thinkers were also more or less inclined to the Zurvanite doctrines. Bīrūnī has also been considered as being influenced by Pythagorean, Platonic, and Indian philosophies which can be true only if one admits that the philosophies all reflect different faces of the Zurvanic prism. Sayyid Murteḍā of Ray said "And you should know that no creed is closer to the philosophers' creed than that of the Magi" (*Tabṣira al-'awām*, p. 16). But, in Rāzī's terms, philosophy "is assimilation to God glorious in-as-much as man can endure" (*Philosophical Conduct*, p. 100) and, based on Bīrūnī's interpretation, the assimilation is the unity tendency or the union with the first cause. Now, was the highly knowledgeable Bīrūnī lucky enough to present a philosophical system of his own? The scholarly Bīrūnī-experts as L. Gardet, B. Lawrence and F. Rosenthal agree that philosophical data-gathering and topic selection rushes abruptly only to a learned mind and in the case of Bīrūnī, the output will be in the shape of a thought system, because he endeavors to watch the whole view of the truth from past to present from an overall outlook. Therefore, the epistemological aspects of his knowledge are all driven by a synthetic philosophical system, especially concerning the problem of the non-eternity of the universe and the problem of origination and the creator in which Bīrūnī can be said to have achieved a sublime philosophy. The philosophy, generally in accordance with the independent and coherent metaphysics of the modern ages, was, of course, evolving along with what his contemporary Ibn Sīnā was doing. However, the structure of Ibn Sīnā's synthetic metaphysics never attained its due organization and perfection. The sheer fact that Bīrūnī managed to manifest his philosophical maturity and observe the objects in the world from a profound extensive philosophical viewpoint suffices to bring him his deserved high status in the general history of science and philosophy.⁴⁰²

It is stimulating that among Islamic philosophers Abū al-'alā' Ma'arrī (937-1057 AH) was acquainted with Bīrūnī's thoughts and works. He quoted fragments of his ideas which is quite meaningful. And if Bīrūnī has been compared and identified with the famous philosopher Gottfried Leibniz (1644-1716), the reason lies in the fact that their prominent works in different realms of science were distinct from those of their counterparts, and that the impacts of the two scholars have continued to last for several generations. We should further add that the characteristics Leibniz and Bīrūnī have in common are particularly due to their atomistic viewpoint: to Leibniz, the monads (indivisible spiritual atoms) were the building blocks of the universe; The categories of Time and Space were not experimental realities, rather

⁴⁰²*Biruni Symposium*, (ar. B. Lawrence), p. 38./ *The Commemoration Volume*, (ar. L. Gardet), pp. 196, 204-205./ *The Commemoration Volume*, (ar. F. Rosenthal), p. 549./ *Tārīkh al-falsafa fī al-islām*, De Boer, pp. 269-270./ *Tabṣira al-'awām*, Sayyid Rāzī, p. 16./ *Tahqīq mā li al-Hind*, p. 25./ *India*, I, p. 35.

appearances; the Space was the sequence of the signs with the same possibility and the Time was the sequence of the possible and distinct beings. Therefore, the world is no more than temporal and spatial sequences. Like Bīrūnī, Leibniz can be considered a pantheist from a certain point of view, because he believed that the creation of the world was done according to unchangeable eternal laws, so that ‘these laws of nature necessitate the world in which we live’. The pantheistic philosophy of Baruch Spinoza (1632-1677) too shares something with that of Bīrūnī. God is similarly believed to be emanating from everything; Everything is in him; The intelligent and the intelligible are unified in him. The visible world is his body and the force moving it is his soul, yet the spirit and the body are the same, as are the force and the matter. God is the infinite, substance and thought of the world. Accordingly, the idea of the original unity of the whole civilization, i.e. the ‘eternal wisdom’, is what Bīrūnī shares with the thinkers of his time and the later times.⁴⁰³

7. Bīrūnī’s Overall worldview

As we have already noted, Bīrūnī argued that the world was created from the pre-existing eternal matter or the emanation matter (8, 2/ 9, 3 and 4), also called the ‘non-being’. The creator is identified with absolute time in the sense of the eternal duration (dahr/ mudda) and the unlimited Zurvan; the creator is the same as God. Bīrūnī considered the creation process as the action of the nature the agent of which is the first cause or the first mover who is the eternal being or God (8, 2/ *India*, p. 270). He believed that absolute space is also eternal, and that it is the space of the non-being or void, as the negative aspect of the eternal being, logically identifiable with the unlimited time or Zurvan (9, 3). Therefore, the origin of creation from nothing was a single moment of eternity from which matter was emanated in the space of the void, vāy, originated in the ‘form’ of indivisible atoms discontinuously (9, 3). The material element of the creation was ‘fire’, identified through light, the non-being or the negative aspect of which is darkness, again in the space of the void. Thus, this world, or the material corporeal world, is composed of the chains of the material indivisible atoms, i.e. unchangeable quantities with discontinuous qualities in the masses. Then, these fundamental particles came to have their places in the entire parts of nature, creating the whole universe (9, 3, 6). The generation and evolution of the world are due to the quantitative changes of the atoms and their dispersions. The changes in nature too are because of the superfluity of material beyond the due proportions of the measure of everything. Transmutation and perfection of the natural phenomena are the results of dispersion of the parts of one thing into the parts of another thing (7, 6).

The shape of the universe, to Bīrūnī, was circle-like (oval) and spherical. The spheres and the celestial globes have external reality the physical properties of which were always a source of investigation for him. His belief in the fire sphere refers to the sun’s mass, an

⁴⁰³*Tārīkh al-falsafa fī al-islām*, De Boer, p. 305./ *Mabāni va tārikh-e falsafe-ye gharb*, Haling Dale, Tr. ‘Abdulhossein Azarang, Tehran, Keyhan, 1985, pp. 149-150./ *Bozorgān-e falsafe*, Henry Thomas, Tr. Fereydon Badre’ee, Tehran, Keyhan, 1986, pp. 232, 356./ *The Commemoration Volume*, (ar. H. Roemer), p. 190./ *The Commemoration Volume*, (ar. L. Gardet), p. 200./ *Biruni Symposium*, (ar. F. Rosenthal), p. 10.

obscure conception of the cosmic ‘plasma’, and in the realm of physics of light, he came to discover the cosmic lights and their ‘acceleration’ (7, 1). He referred to the sphere of ether which is one of the five creation elements in the Manichaean worldview and it should be added that it is the same as the world of the “fravahar”s (roughly, ‘the spiritual Zoroastrian forces’), and of the Platonic ideas. He believed that the world was globular, situated in the center of the world in line with Ptolemaic cosmology, though he showed general doubts about that theory and considered non-Ptolemaic celestial mechanics seriously possible (5, 3). Thus, he expressed his idea about the revolution and the rotation, in favor of the possibility of non-geocentricity (5, 4). The theory of the movement toward the center, in his terms, viz. the gravity force referred to the gravitational center, or the equilibrium point of the center of gravity (5, 3). In line with the possibility of void and the atomistic view which is a Newtonian principle, his mechanical conception of the motion involved the movement of the particles in the space (9, 3). Therefore, having denied the ḥayyiz, or natural place of the bodies, he refuted the belief in the Aristotelian eternal forced motion (9, 2). He also rejected the final cause in the evolution and the alterations of nature (9, 3/ 7, 1). He viewed natural phenomena as divine signs (8, 1), but in his nature studies, no metaphysical justification or theological concerns were involved (9, 3). As a result, Bīrūnī’s view about the beginning and the end of the world was not mystical or religious, rather natural and scientific: he wrote a book on cosmology under the title *Takmil Hikāyā ‘Abd al-malik al-ṭabīb al-bustī fī mabda’ al-‘ālam wa intihā’ihī* (*The Accomplishment of the Anecdotes Related by Abd al-Malik al-Tabib al-Bosti on the Origin and the End of the World*) (*Kārnāme*, p. 42).⁴⁰⁴

The two basic principles of the ancient Arian thinking, always followed by Bīrūnī, are as following: first, ‘order and law’ are essential in nature, and second, ‘conflict’ is inherent in nature. Thus, the nature follows the physical laws of matter (7, 1). Contrast or the struggle of the opposites, is the immanence inside matter (i.e. the potentiality), the procedure of the manifestation of which is motion in the form of transformation of the quantity to quality (7, 1). Transmutation or evolution is a gradual procedure due to the discontinuity of the indivisible atoms of the elements of nature, because, according to Aristotle, the leap in the evolution, i.e. generation and corruption, entails the existence of infinitely divisible things. As a result, Bīrūnī’s natural philosophy was founded upon the gradual evolution theory (7, 6/9, 3). The principles of evolution are natural selection, struggle for life, survival of the fittest and finally, the evolution blind alley which is likely to happen in the nature of plants or animals (7, 6). Natural laws cannot be deviated and natural phenomena can be explicable through mathematics (7). Bīrūnī viewed the whole world as a living everchanging machine in accordance with the law of becoming and expressed this principle in terms of mathematics. Once the abstract mathematical quantities come to be dynamic, they inevitably become temporal. The Greek scholars, thinking in terms of geometry, viewed the whole universe as a regular geometrical projection designed by the primal engineer, God. However, Iranian

⁴⁰⁴ *Al-tafhīm*, p. 56./ *Al-qānūn al-Mas’ūdī*, pp. 21, 626./ *Naẓar-e motefakkerān-e eslāmi darbāre-ye ṭabī‘at*, Sayyid Hossein Nasr, p. 212./ *Yādnāme-ye Bīrūnī*, (ar. ‘Abd al-jawād Falāṭūrī), pp. 514-515./ *Barrasiḥā-yī → darbāre-ye Bīrūnī*, (ar. Morteza Motahhari), pp. 55-56./ *Majalle-ye Ma‘āref*, دور 3, no. 1, (ar. Ma’sumi), pp. 223-224./ *al-Qanun al-Mas’udi* (ar. S. H. Barani), p. XII./ *A Reader in Manichaeism...*, M. Boyce, p. 9.

scientists, thinking in terms of algebra, especially Bīrūnī paid particular attention to the permanent motion giving rise to that geometrical design.⁴⁰⁵

Bīrūnī received the idea of the major and the minor worlds from the ancient sources of Iranian wisdom and presented the viewpoint in his works especially in *Al-tafhīm (Instruction)* and particularly with respect to astrology. His idea of space-time and void-space, in terms of their finiteness and infinity, along with his ideas of the nature of light and its speed, the distance of the celestial bodies, the temporal periods of the spheres and the motions, and the apogees of the stars all reveal a vague and primitive conception of the relativity hypothesis. Here, we should quote from S. H. Barani that Bīrūnī's stance about the universe is so close to Einstein's theory, in that both look at the world as a whole, and that, as Bīrūnī says, "the world as a whole is a circle-like mass with its center situated on its outermost surface (*Al-qānūn*, p. 21). He also rejects, like Einstein, the idea of the universal gravitation as the force operating on the earth. Bīrūnī gets so close to the relativity theory when he discusses the motion of the mass on a curved trajectory: "[...] when a part of a mass at rest moves from one part to the other, it moves in a straight line, but on the other hand its movement round another body at rest is of a circular nature and represents a movement round a fixed point like the Earth's centre" (*loc.cit.*). Yet, compared with contemporary physicists, Bīrūnī had a more static conception of the world. As the last word, it is worth quoting a meaningful remark by some of the scholarly Bīrūnī -experts: "He substituted the dynamic Islamic worldview for the static Greek view".⁴⁰⁶

⁴⁰⁵ *Andīshmand va ensān*, Najafī and Khalili, p. 152.

⁴⁰⁶ *The Commemoration Volume*, (ar. A. Iskandar), pp. 384-385./ *al-Qanun al-Mas'udi* (ar. S. H. Barani), p. XVI./ *Nazar-e motefakkerān-e eslāmi darbāre-ye ṭabī'at*, Sayyid Hossein Nasr, P. 244./ *Andīshmand va ensān*, Najafī and Khalili, p. 152.

10. Historiography and calendar

a. Historical inquiries

Bīrūnī's commission to developing a new method of historical investigation demanded much effort, in addition to comprehensive knowledge and meticulous way of scrutinizing the past events along with awareness of the relationship between them. This is what makes his historical reports alive to us, as if we are living the same lives. With his profound philosophy and science, especially geography, he was able to recognize natural and human factors involved in history and historiography. He was well aware that the accounts of far events in history are highly probable not to match the facts; therefore, a genuine history had to be the history of the institutions and thoughts.⁴⁰⁷ He started the introduction of *Mā li al-Hind (India)* with the evaluation of different kinds of documents and evidence upon which human and social investigations can be established. His first word is the confirmation of the proverb 'seeing is believing'. Observation is of two types: (1) objective observation as the method of experimental sciences and (2) documentary observation as the method of historical sciences, i.e. the 'historical annals and reports', either from written texts or oral sources, which are likely to be true or false.⁴⁰⁸

Therefore, Bīrūnī embarked on criticizing the historical reports exhaustively, discussing the problems of reporting in full. As we have said about his methodology and his critical school of thinking, report criticism has long been regarded a basic aspect of Bīrūnī's historical method. Such criticisms are similar to those applied in the sciences of tradition-examination (dirāya) or tradition-biographies (rijāl), and the methods of ????? (tajrīh) and extrapolation (taxrīj) or validating narrators (ta'dīl) and precedence (tarjīh) in the Islamic science of tradition studies. But, he accomplished this scientifically as it is exercised today under the title subject criticism.⁴⁰⁹ Among other things, concerning the beginning of the creation and the ancient nations, he remarks that, due to the distance in time and little care in preserving the documents, the problem here have been mingled with myths and invented stories so much that one cannot accept them. However, one should inevitably refer to a trustful book to satisfy the qualifications of accuracy and trustfulness of the narrations as 'most plausible', although the very narrations need to be selected through meticulous criticism so that their possible truth may be examined. Then, through a sort of objectivism, based on the condition of

⁴⁰⁷ *Zendegīnāme-ye Bīrūnī* (Ali al-Shābbi), p. 113./ *al-Biruni Commemoration Volume*, (ar. A. Pope), pp. 281-282.

⁴⁰⁸ *Tahqīq mā li al-Hind*, pp. 1, 2./ *India*, I, pp. 3, 4./ 'Elm va tamaddon dar eslām, Sayyid Hossein Nasr, p. 248-???./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Azartash Azarnush), p. 169./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Fatullah Mjtabae), p. 277./ *Zendegīnāme-ye Bīrūnī* (Ali al-Shābbi), p. 116-???./ *Tārīkh al-falsafa fī al-islām*, De Boer, pp. 300-303./ *The Commemoration Volume*, (ar. A. Chabbi), pp. 496-497.

⁴⁰⁹ *Al-āthār al-bāqiya*, pp. 4-5, 20, 74, 89./ *Chronology*, pp. 2-3, 23, 78, 92./ *Tahqīq mā li al-Hind*, pp. 2, 3./ *India*, I, pp. 4, 5./ *Tārīkh al-falsafa fī al-islām*, De Boer, pp. 300-301./ *Zendegīnāme-ye Bīrūnī* (Ali al-Shābbi), pp. 116-120./ *The Commemoration Volume*, (ar. A. Chabbi), pp. 500-502.

rationally rejected or accepted studies, he takes an indifferent position in his criticisms and quotations. He sometimes reminds, for instance, that “this book is not a polemical one”, or stops criticizing if he finds it unnecessary. For example, while discussing the myths of ancient nations, he states “they relate things which do not seem admissible to the mind of the reader. However, the aim of our undertaking being to collect and communicate chronological material, not to criticize and correct historical accounts, we record that on which the scholars [...] agree among themselves”.⁴¹⁰

He rejects consensus at certain points, saying that, although we are informed of the case in point through plurality of narrators, it can be confirmed only by experience. Evaluation, i.e. comparison and corresponding, used by him especially in religion studies and beliefs and histories of the nations, has brought him unparalleled reputation, along with the criticism of the materials of his historiography. He admired Abu al-Faraj Zanjānī’s book on the history of the Iranians due to the fact that it was founded upon the evaluation of sayings of different sorts.⁴¹¹ His critical method of studying the documents and written sources was totally modern: he criticized historical reports and the variant readings or recordings in the manuscripts just like contemporary linguists and corrected incorrect, distorted or misrepresented items as well.⁴¹² A famous criticism by him is about the fact that kings and lords resort to preparing unreal family trees or irrelevant grandiloquent titles for themselves and their hooligan supporters.⁴¹³ His critical nature and historiographical brevity rooted in his truthseeking spirit. He says that he felt no “inclination or fear” in his histories and follows his own conscience. We have already mentioned that the maxim he always repeated was the Quranic verse “Tell the truth, even against a loved one” and frequently advised that one needed not to be afraid of the awesome kings, because if they do not own your body, they will surely have no domination on your soul and conscience.⁴¹⁴

In addition to what we have mentioned, the two unique characteristics of Bīrūnī’s historiography can be summarized as his learned caution and scholarly inferences. He used to study history and society through a purely mathematical method. His inclination to the calendar history, i. e. mathematical not political history, can be understood from the tables he

⁴¹⁰ *Tārīkh al-falsafa fī al-islām*, De Boer, pp. 300-301./ *Al-āthār al-bāqiya*, pp. 4, 20, 115./ *Chronology*, pp. 2, 23, 108-109./ *Taḥqīq mā li al-Hind*, pp. 5, 19./ *India*, I, pp. 7, 25./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 91./ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Azartash Azarnush), p. 171.

⁴¹¹ *Al-jamāhir*, pp. 168, 182./ *Al-āthār al-bāqiya*, p. 132./ *Chronology*, p. 118./ *Andīshmand va ensān*, Najafi and Khalili, p. 10./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 124./ *Tārīkh al-falsafa fī al-islām*, De Boer, p. 301./ *The Commemoration Volume*, (ar. A. Chabbi), p. 506.

⁴¹² *India*, I, pp. XXVI, 3, 4, 163; II, p. 77./ *Taḥqīq mā li al-Hind*, pp. 13-14, 126, 409./ *al-Biruni Commemoration Volume*, (ar. A. Pope), p. 284./ *Taḥdīd nihāyāt al-amākin* (Ar.), p. 196; (Pers.), p. 170.

⁴¹³ *Al-āthār al-bāqiya*, pp. 45, 171-173./ *Chronology*, pp. 101, 111-115./ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Azartash Azarnush), pp. 170, 174./ *Andīshmand va ensān*, Najafi and Khalili, pp. 124-125./ *The Commemoration Volume*, (ar. A. Chabbi), p. 499.

⁴¹⁴ *Tārīkh-e Beyhaqī* (Quoted in *Al-musāmara*), p. 668./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), pp. 114, 131./ *‘Elm va tamaddon dar eslām*, Sayyid Hossein Nasr, p. 250./ *Taḥqīq mā li al-Hind*, pp. 4, 5. / *Biruni Symposium*, p. 21.

presented from the rulers' classes and nations' eras and calendars extracted from previous histories. Bīrūnī consciously established this mathematical method for historical inquiries, as his contemporary scientist Al-Hazen of Baṣra founded the method for natural investigations.⁴¹⁵ The basic characteristics of Bīrūnī's historical methodology, though not specific to him, yet unparalleled from the viewpoint of brevity and impact, can be summarized as following: objective observation in his sociology and documentary observation and historiography; lack of presuppositions in his studies, and yet having a critical approach towards the materials; selection of the objective facts and leaving the fancies; subject criticism of the facts and evaluating them rationally; and finally the mathematical and calendrical explanations of the subjects whenever necessary. Moreover, a manifest similarity can be seen between Bīrūnī's historical method and that of Ibn Khaldūn (732-808/1332-1406). In fact, Bīrūnī embarked on gathering the materials and later, Ibn Khaldūn managed to establish his own general opinions about human history upon them. Another similarity is that none of the two thinkers had any follower to apply their thought systems. Bīrūnī's method can be seen, to some extent, in the works of his contemporaries, particularly in the historiography of Bayhaqī, and later in the writings of Rashīd al-dīn Faḍl Allah Hamadānī (645-749/ 1247-1348 A. D.) and Ibn Khaldūn both influenced by him.⁴¹⁶

b. Historical data

As a historian scientist, Bīrūnī provided us with a large amount of reports from the past, particularly on the social aspect of the ancient nations. His book *Al-āthār al-bāqīya* (*Vestiges of the Past*) is a monumental masterpiece, illustrating an exact picture of that age. Bīrūnī's sources of historiography and chronology were, in general, diverse and of prime importance. It has been remarked that he gathered historical reports about the Jewish and Christian tribes and nations not only from Syriac and Nestorian texts and the believers of the two religions in the middle Asia, but from his prior fellow scientist Abū al-ʿabbās Irānshahrī, and the scholarly Christian friends Abū al-khayr Khammār and Abū Sahl in the court of Khwārazm Shāh.⁴¹⁷ Concerning the sources of *India*, there is much to say. Apart from Iranian sources, he made use of all of the *Sīyar al-furs* (*Conducts of the Persians*), Khwadāy Nāmags and the Shāh Nāmes, translated from middle Persian sources, none of which existing today, along with the Syriac, Arabic, Persian, Khwarazmī and Sugdian sources, and also the reference books in the scientific-literary schools and the libraries of the cities Ray, Gurgan, Khwārazm and Ghazna, the cities where he lived each for a while.

⁴¹⁵ *The Commemoration Volume*, (ar. F. Rosenthal), p. 547./ *Zendegīnāme-ye Bīrūnī* (Ali al-Shābbi), pp. 108, 115./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Azartash Azarnush), pp. 179-185.

⁴¹⁶ *ʿElm va tamaddon dar eslām*, Sayyid Hossein Nasr, Tr. Ahmad Aram, pp. 247, 255./ *Zendegīnāme-ye Bīrūnī* (Ali al-Shābbi), Tr. Parviz Azkaci, pp. 80, 128-131./ *The Commemoration Volume*, (ar. A. Chabbi), pp. 507-512./ *India*, I, p. XLIII.

⁴¹⁷ *Biruni Symposium*, (ar. G. H. Youseffī), p. 19./ *Chronologie Orientalischer Völker* (vor. E. Sachau), p. XXXII./ *India*, II, p. 255.

In addition to his vast and deep knowledge of national historical reports, Bīrūnī was fond of the ancient Iran's culture, although the love did not hind him from criticizing what was contrary to his scientific conscience. He wrote the history of his hometown under the title *Al-musāmara fī akhbār Khwārazm* (*Stories about the History of Khwarazm*) (*Kārnāme*, n. 160), lost today, and only quoted partly by Beyhaqī in his *The Mas'ūdī History*.⁴¹⁸ Bīrūnī was reported by some of the historians of the Arabic literature as being a cultural Shu'ubite writer as the Abu 'Ubayda Akhbārī and Ḥamza Iṣfahānī (893-961?/ 1487-1553?).⁴¹⁹ It seems quite meaningful that Bīrūnī was fond of Ḥamza's works. I do not think that anybody else ever quoted from the nationalist scholarly historian as much as Bīrūnī did. Bīrūnī even cited verse examples from Iranian, Shiite and anti-Arab Shu'ubite poets in his book *Ifrād al-maqāl* (*The Exhaustive Treatise on Shadows*), a book on the trigonometrical discussions of the shadows.⁴²⁰ Sachau severely criticizes the Umayyids of Damascus over the accusation that they paid no attention to the science, literature, and civilization of Greece, Egypt and Iran, always being busy with war affairs, politics and wealth, while the eastern kingdoms of the Islamic Caliphate with its deep roots in the Sassanian empire were deeply cared for the historical reports and the scientific and literary heritage of the past.⁴²¹

The account presented by Bīrūnī of the Achaemenian kings has made historians astonished to the extent that some Iranian and Indian scholars have conducted research on it.⁴²² It should be noted that the factual pre-Sassanian history of Iran was totally neglected by the Islamic historians and was reported in the form of imaginary tales about Dārā and Iskandar, i.e. Darius III and Alexander. It was only Bīrūnī who introduced the reign of the Medes as the "mountainous kingdom", presented a list of the 'Babylonian and Median kings', and then identified the names of the legendry Kayani Iranian kings with those of the Assyrian, Babylonian and Achaemenian rulers.⁴²³ Therefore, it seems, as he mentions, that his reference in this case was Babylonian-Greek, reported in Syriac. Yarshater points out that the historian Bar Hebraeus (1226-1286), the second in rank after Bīrūnī, too took advantage of the Syriac, Hebrew, and probably Greek sources in his book *Tārīkh Mukhtaṣar al-duwal* (*Concise History of the Dynasties*) and then he presents a common Syriac source and an Achaemenian history for the two historians, i.e. the Syriac book of *Chronography* (*Ketābhādhe Makhtebānūth Zabhanē*) compiled by Michael the Elder. This Syriac chronology is in turn

⁴¹⁸*Tārīkh-e Beyhaqī*, (ed.) Fayyaz and Ghani, p. 688-/ *Zendegīnāme-ye Bīrūnī* (Ali al-Shābbi), p. 124-/ *India*, I, p. XXVII.

⁴¹⁹*Yādnāme-ye Bīrūnī*, (ar. Kuru Yanaki), p. 60.

⁴²⁰*The exhaustive treatise on shadows*, II, (ar. E. S. Kennedy), p. 2

⁴²¹*India*, I, pp. XXVII, XXIX.

⁴²²*Majmu'e-ye maqālāt (Dr. Mo'in)*, vol. 2, Tehran, 1988, pp. 57-87./ *Barrasihā-yī darbāre-ye Bīrūnī*, (ar. Azartāsh Azarnush), pp. 221-223./ *All Conference*, XII, -*India Oriental* 1943-1944, no. 3, (ar. B. Anklessaria), pp. 692-702./ *The Commemoration Volume*, (ar. E. Yarshater), pp. 45-61./ *Biruni Symposium*, (ed.) Yarshater, pp. 49-65./ *Der Islam*, 26, 1942, (ar. M. Krause), pp. 1-15.

⁴²³*Al-āthār al-bāqiya*, pp. 100, 118-127; *Ta'līqāt*, Azkaei, pp. 566-579./ *Al-qānūn al-Mas'ūdī*, vol. 1, pp. 129, 154-156.

based on the history by the Armenian Eusebius (263-339 B. C.) adopted from the well-known book *The History of Babylonia* by Berossus the priest (written in 290 B. C.).⁴²⁴

Besides, Bīrūnī made use of all testament texts which contained references to the Median-Achaemenian kings. Concerning the Median Darius (*Al-āthār*, p. 126, *Al-qānūn*, p. 154) in the *Old Testament*, it should be noted that his identity was under investigation by the Fathers and scholars in Europe for more than the recent one hundred and fifty years until Mohammad Mo‘in (1914-1971) identified him with the Achaemenian Darius I, but finally Yarshater truly proved his identification with the great Median king Cyaxares, viz. Huwakhshatra (585 B. C.).⁴²⁵ Another astonishing report, as we mentioned among Bīrūnī’s discoveries, was about digging the channel in Egypt between the Red Sea and the Mediterranean Sea, ordered by the Achaemenian Darius I (522-486 B. C.) and reported by Bīrūnī only. Before that the event had just been reported by Herodotus (2, 58; 4, 39).⁴²⁶ Among his historical discoveries can further be mentioned the exact determination of the date of the establishment of the Sassanian state according to the data in the book *Shāpūrgān* of Mani for the first time.⁴²⁷

Witnessing the circumstances at the end of the Samanian period, Bīrūnī reflected the political and social conflicts caused by the invasions of the primitive tribes from Turkamān, hence his political book *Warning about the Eastern Turks* (*Kārnāme*, n. 89). Like Firdawsī, he undoubtedly considered the eastern Turks as a tremendous danger for Iranian civilization and the book was meant to make aware the *Khwārazm-Shāh*, who, frightened of the domination of the Turkish Maḥmūd *Ghaznavī* over the eastern Iran, took the danger not seriously enough.⁴²⁸ It is a pity that this book and the book *The Historical Report of the White-robed and Karmatians* (*Kārnāme*, n. 162) have been lost. He also wrote a book under the title *Correction of the Dates and the Like* (*Tanqīḥ al-tawārīkh*) (*Kārnāme*, n. 103). We should add here that the only great followers of Bīrūnī’s historical school were Abū al-faḍl Beyhaqī, ‘Abd al-ḥayy Gardīzī and Raṣīd al-dīn Hamādānī.⁴²⁹

3. Chronology of the nations

The book *Al-āthār al-bāqīya* (*The Vestiges of the Past*) is an abstract of the various astronomical or national calendars of the nations, providing the reader with a complete

⁴²⁴*The Commemoration Volume*, (ar. E. Yarshater), pp. 50-51./ *Biruni Symposium*, (ed.) Yarshater, pp. 53-55./ *Al-āthār al-bāqīya*, *Ta’līqāt*, Azkaei, pp. 527-529.

⁴²⁵*Majmū‘e-ye maqālāt* (Dr. Mo‘in), vol. 2, p. 75./ *Biruni Symposium*, p. 56.

⁴²⁶*Taḥdīd nihāyāt al-amākin* (Ar.), p. 49; (Pers.), p. 23./ *Tārīkh al-adab al-jughrāfī*, Krachkovsky, pp. 249, 253./ *Yādnāme-ye Bīrūnī*, (ar. Jalāl al-dīn Homāee), p. 107./ *Yādnāme-ye Bīrūnī*, (ar. Bahram Faravashī), pp. 539-540./ *Payām-e Yunesko*, no. 59, p. 20./ *The Persian Wars*, Herodotus, pp. 197-305.

⁴²⁷*Al-āthār al-bāqīya*, p. 134./ *Chronology*, p. 121./ *Yādnāme-ye Bīrūnī*, (ar. Jalāl al-dīn Homāee), p. 107./ *Ekhterā‘āt va ekteshāfāt-e Abu Rayḥān*, Jalāl al-dīn Homāee, p. 36.

⁴²⁸*Payām-e Yunesko*, no. 59, (ar. Babajan Ghafurof), p. 6./ *Yādnāme-ye Bīrūnī*, (ar. Mohit Tabatabaee), p. 48.

⁴²⁹*India*, I, pp. XLIII, XXVII.

description of all chronologies and ritual festivals. The first chapter includes different eras and customs of dating and enjoys other advantages too. The next chapters embrace the definition of day and year, kinds of years, calendrical discussions, tables of the ordinal-chronological histories of the prophets and rulers of Iran, Babylonia, Egypt and Rome. Next, the second half of the book deals with the feasts, days of worship, and fasting of the nations, and finally comes the discussion of the mansions of the moon and [body projection](#), etc.⁴³⁰ Further, in *Al-qānūn* too he discusses in full almost the issues of the feasts, calendars and chronologies of the nations. Perhaps the aforementioned lost book, *Tanqīḥ al-tawārīkh wa amthāl dhālikā* (*Correction of the Dates and the Like*) was most probably on the correction of the eras and chronologies. One of the well-known eras used in the ancient world was the Alexandrian-Seleucid history or calendar. Bīrūnī made a mistake here because of his wrong supposition about the year of Alexander's attack on Asia (*Al-āthār*, p. 176); however, on realizing the wrong era, he wrote a corrective treatise under the title *Al-i'tidhār 'ammā sabaqa lī fī tārikh al-Iskandar* (*Apology for What I Have Already Written about the Era of Alexander*) (*Kārnāme*, n. 54), what he correctly referred to as the *Seleucid History* in *Al-qānūn*.⁴³¹

The Indian calendar and history was discussed exhaustively in *India* and in the sixth chapter of the second article of *al-qānūn*.⁴³² In his book *Ghurra al-zījāt* (*The Highlighted Zigs*), Bīrūnī additionally discusses the problems of the conversion of the Indian 'saka' calendar to the Hijri and Yazdgirdi and Greek (Alexandrian) calendars.⁴³³ The seventh chapter of *Al-āthār* deals with an exhaustive discussion of the Jewish calendar.⁴³⁴ Over the Melchites of Antioch, the fifteenth chapter of the book has been widely admired.⁴³⁵ In addition to the chapters on the Christian calendars and festivals in *Al-āthār* and *Al-qānūn*,⁴³⁶ he wrote an independent treatise, lost again, under the title *Tadhkira fī al-irshād ilā ṣawm al-naṣārā wa al-a'yād* (*Memoir on Guidance on the Christian Fasts and Feasts*) (*Kārnāme*, n. 53). As far as the ancient Iranain chronology is concerned, Bīrūnī is unanimously believed to be a unique figure. Apart from *Al-taḥfīm* on the Iranian chronology and festivals, he discusses

⁴³⁰ *Tārīkh al-adab al-jughrāfī*, Krachkovsky, pp. 245, 251./ *Zendegīnāme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 314.

⁴³¹ *Gāhshomārī dar Iran-e qadīm* (Taḡizade), Tehran, 1316, p. 31, 240./ *Tārīkh-e tārīkh dar Iran* (Reza Abdollahi), Tehran, Amir Kabir, 1366/1987, pp. 143-146.

⁴³² *J. N. E. S.*, 1965, no. 24, (ar. Kennedy), pp. 247-284.

⁴³³ *Zendegīnāme-ye 'elmi-ye dāneshmandān-e eslāmi*, (ar. Kennedy), p. 318./ *Islamic Culture*, no. 37-39, 1963-1965, (ar. S. S. H. Rizavi).

⁴³⁴ *Revue de études Juives*, t. 12, 1886, (ar. M. Schreiner), pp. 258-276.

⁴³⁵ *Patrologie Orientale*, t. 10, 1915 (ar. R. Grivoux), pp. 289-312./ *The Commemoration Volume*, (ar. F. E. Boustany), pp. 211-218.

⁴³⁶ *The Commemoration Volume*, (ar. G. Saliba), pp. 291-364.

the widely used calendars and eras of the nations, besides their days and feasts. The book *Al-qānūn* (pp. 259-266) contains a summary of the issues and their discussions.⁴³⁷

4. Indiology

Indiology is the discipline in which Bīrūnī is undisputedly a specialist, although it can be classified more as a social branch of science. By now, the book *Mā li al-Hind (India)* as the historical basis and a prime material for the Indian historiography has proved to serve as a foundation for the ancient sociology, and religious ethnography of India. India has always been an exotic land full of wonders. However, Bīrūnī demonstrated that the oddity lies more in the customs than in thought systems, and that there were groups of people there with ideas similar to those of the Greeks and the like.⁴³⁸ Just at the time when Maḥmūd Ghaznavī invaded and plundered India under the pretext of Islam, massacring the Indians as unbelievers, Bīrūnī was sincerely trying to study their religions and to make known their customs and cultures. So, he was the first Muslim who made enquiries deeply into the Indian philosophy and acted as an important medium between Iran and India.⁴³⁹ The book *India* is a unique masterpiece ever astonishing in its historical context. In addition to that, he wrote fifteen other books on the Indian arithmetic, astronomy, numbers, calendar, astrology, medicine, philosophy and mysticism.⁴⁴⁰

In his Indiology, Bīrūnī generally avoids speaking himself, and rather lets the Indians speak: the picture he presents from the Indian civilization is what they themselves depict. Each of the chapters of the book *India*, depending on the subjects, has three sections: introduction of the problem, exposition of the Indian teachings, and finally, the identification and evaluation of the ideas with those of the Greeks and the like. It has been said that Bīrūnī's methodical studies in *India*, both in matter and content, are the same as what contemporary ethnographers conduct. The book involves the explanation of the Indian myths, religion studies, natural sciences, social forms, laws, medicine, astrology, and many other minor subjects- all accomplished entirely by himself, without the expertise aids, magazines, source books and catalogues we enjoy today.⁴⁴¹

⁴³⁷ *Yādnāme-ye Bīrūnī*, (ar. Jalal al-din Homaei), p. 107./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Azartash Azarnush), pp. 195-217./ *The Commemoration Volume*, (ar. Katrak), pp. 129-151.

⁴³⁸ *Tahqīq mā li al-Hind*, pp. 5, 144. / *India*, I, p. XLI, 7, 179/ *The Scholar and the Saint*, (ar. F. E. Peters), p. 25.

⁴³⁹ *Biruni Symposium*, (ar. G. H. Youssefi), p. 14./ *Al-biruni wa Hind*, Kabul, 1973, (ar. Sayyid Qabul Ahmad), pp. 19-32.

⁴⁴⁰ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Fathollah Mojtabaei), p. 256./ *Kānāme-ye Bīrūnī*, J. Boilot, Tr. P. Azkai, nos. 5, 34, 36, 37, 38, 52, 71, 75, 92, 93, 96, 98, 174, 175, 176, 177.

⁴⁴¹ *India*, I, pp. XIX-XXV./ *al-Biruni Commemoration Volume*, (ar. A. Pope), p. 281./ *Biruni Symposium*, (ar. B. Lawrence), p. 43./ *The Scholar and the Saint*, (ar. Embree), p. 14.

He says that Indian customs and traditions are so contrary to ours that they warn their children against trusting us and they attribute mischiefs to us. But if it is attributable to us, then contrary will be necessary as well, because what we have in our culture is the same as what all nations have generally in common [...]. In former times, Khurāsân, Persis, [...] was Buddhistic, but then Zarathustra went forth from Âdharbajân and preached Magism in Balkh (Baktra)".⁴⁴² Bîrûnî's tendency to the Indian mystical philosophy, i.e. the Brahmin philosophy of *Bhagavadgita*, roots in the books *Samkhya* and the Yogic *Patanjali*, viz the same books that he rendered from Sanskrit to Arabic (*Kārname*, n. 98, 174). It seems that he was not interested in the Buddhist philosophy or 'Shamaniya' (shamanism). What reinforces this conjecture was his monotheistic belief which presupposed that all human beings were originally equally pure and pious, believing the same single sublime God and yet the social dark desires caused idolatry and caused controversies among the followers of the religions and the philosophy.⁴⁴³

One of the brilliant results of Bîrûnî's scientific thinking can be seen in his explanation of the customs of sanctification of the cows in India. He believed that the sanction of the slaughtering of the animals was strongly due to economical reasons: the animal was made use of for travelling, carrying burdens, milking, especially on the farms.⁴⁴⁴ There are numerous examples of such novel objective analyses in his Indian studies: his remarks on the *Rig Vedas*, evaluative quotations from the Greek texts and the like, references to various religions and sects, geographical explanations of the names in India, ethnography, linguistics and literature and plentiful examples of Indiology are among the innumerable subtleties of the great book *India*. A series of comparative studies have been carried out on Bîrûnî's *India* and Bâbarî's geography (10th/ 17th century) which generally approve the great impact of *India* on later works.⁴⁴⁵

⁴⁴²*Taḥqīq mā li al-Hind*, pp. 14-15./*India*, I, 19-20./ *The Scholar and the Saint*, (ar. Embree), pp. 3-4./ *The Scholar and the Saint*, (ar. P. Soucek), pp. 115-116.

⁴⁴³*Barrasīhā-yī darbāre-ye Bîrûnī*, (ar. Fathollah Mojtbaee), pp. 257, 288./ 'Elm va tamaddon dar eslām, Sayyed Hossein Nasr, p. 247./ *Al-biruni wa Hind*, (ar. Biratov), p. ???/ *India*, p. XVIII, *al-Biruni Commemoration Volume*, (ar. Moreno), pp. 209-216./ *The Scholar and the Saint*, (ar. B. Lawrence), pp. 30, 43.

⁴⁴⁴*Taḥqīq mā li al-Hind*, p. 468./ *India*, II, p. 152. / *Turāth al-insānīya*, Cairo, vol. 3, (ar. M. Ahmad Mahmud al-Sadati), p. 136.

⁴⁴⁵*al-Biruni Commemoration Volume*, (ar. A. Bausani), pp. 53-76./ *al-Biruni Commemoration Volume*, (ar. J. Tavadia), pp. 287-292./ *Al-biruni wa Hind*, (ar. W. H. Hasanov and S. N. Sin Ashrafiyan), pp. 118-176.

11. Social sciences

1. Economical views

Bīrūnī considered mathematics and geometry as established upon arithmetic, good exchanges and inheritance laws, because different branches of knowledge originated from inevitable human needs and developed based on them.⁴⁴⁶ His term, as that of Ibn Khaldūn, “ma’āsh” (making a living) customarily means ‘economy’. Thus, he says that natural transactions as the true basis of the systems of making a living among civilized peoples are to provide cooperation, and conventional transactions, according to the reports of the cities and countries generally depend on (the transaction) of the metals that glimmer in people’s eyes, please their hearts and improve their relations.⁴⁴⁷ By “natural transaction” he refers to the primitive barter transactions and here he means the ‘good-money’ economy, not the productive economy to which he refers briefly somewhere else. His term “conventional transaction” too means good-money transactions among city dwellers, in that they established the systems of exchange and price upon the meltable metals and valuable gems and whatever seldom found, lasting and beautiful akin to them.⁴⁴⁸

He explains the ‘good’, i.e. the product aspect of money, as it is discussed in modern economical theories: “As gold and silver come out from the mines, they are determined to be allowable, like agricultural products and slaughtered domestic animals, to be consumed. If the ornamental use could be separated from gold and silver, the only thing would be determining the need-values, highly likely to be satisfied by the transaction”. And concerning the accumulation of properties, he seems to have a vague conception of the economical ‘accumulation of the capital’, saying “what brings strength to people’s hearts is hoarding and storing properties which cannot be obtained save by banditry, sovereignty, retaliation and (the exploitation of) the peasantry...; and this gold and silver has to be used by people in exchanging (the goods) with respect to the ‘prices’, not in gathering treasures, depriving people of them and disobeying God’s order [the Quranic verse: ‘And those who gather treasures...’]”.⁴⁴⁹

⁴⁴⁶*Tahdīd nihāyāt al-amākin* (Ar.), pp. 27, 29; (Pers.), pp. 5, 8.

⁴⁴⁷*Aljamāir fī ma’rifā al-jawāhir*, p. 9./ *Majalla al-majma’ al-‘ilmī al-‘arabī bi Damishq*, vol. 15, 1935, (ar. Mohammad Yahya al-Hashimi), pp. 456-457.

⁴⁴⁸*Tahdīd nihāyāt al-amākin* (Ar.), p. 26; (Pers.), p. 4.

⁴⁴⁹*Al-jamāhir fī ma’rifā al-jawāhir*, pp. 9-10, 13./ *Nazarīyāt al-iqtisād ‘ind al- Bīrūnī*, Mohammad Yahya al-Hashimi, *Majalla al-majma’ al-‘ilmī al-‘arabī bi Damishq*, vol. 15, 1935, pp. 456-465.

2. Sociology

We have already mentioned that, to Bīrūnī, the social evolution is gradual: firstly, the societies appeared based on sociability and the two principles of homogeneity and contrast. Secondly, the appointment of certain persons to the executive positions was due to the equilibrium of the two principles or the establishment of order and justice for the worldly purposes. The justice involves politics and legislation. The custodianship conditions, *viz.* the government and politics, confirmed in some way by God and the holy books, was what the Iranians believed as being true about their (Sassanian) kings, as the (Shiite) imamate in Islam was based on the Quranic condition of *mawaddata fi al-qurbā* (the love for those near of kin).⁴⁵⁰ The homogeneity principle refers to people's common aims lead them to the society and civilization and the contrast principle means the differences in people's ends and wishes, driven by their occupations. The inequality and differences, as quoted from a certain king, is the cause of the order of society, and the cooperation of the civilized nations, as long as they are dependent upon one another, cannot endure but through these differences, right in the same way that God created the world with different dispositions and natures.⁴⁵¹

Bīrūnī says that this is why the Iranian kings achieved superiority over other kings of the world in politics and social manner, and that they created an order in their countries based on the classes, each dependent upon its inviolable class disciplines.⁴⁵² In his sociological view, he always bears in mind the two social classes, upper and lower ("mulūk" and "sūqa" in the world of Islam respectively), culturally viewed by him as the elite and the commoners. The dichotomy, in accordance with his general philosophical dualism, is represented in the form of the opposition of reason and ignorance. He quotes from the Vāsudeva ("Bāsdīv") of India that "If the civilization of the world is that which is intended, and if the direction of it cannot proceed without our fighting for the purpose of suppressing evil, it is the duty of us who are the intelligent to act and to fight, not to bring an end that which is deficient within us, but because it is necessary for the purpose of healing what is ill and banishing destructive elements"... that men shall be different in their conditions of life, and that on this difference the world is to be based. The mutual assistance of civilised people presupposes a certain difference among them... All those (opposite environmental) things include civilised people carefully to select the places when they want to build towns. That which makes people do these things is usage and custom. However, religious commands are much more powerful, and influence much more the nature of man than usage and customs".⁴⁵³

We have already discussed Bīrūnī's political philosophy. Independent of the age he lived in, he explicitly tackled the problem in a humanistic way, avoiding concealing facts and using

⁴⁵⁰ *Al-jamāhir*, pp. 7-8, 24-25./ *Yādnāme-ye Bīrūnī*, (ar. Abd al-Javad Falturi), pp. 517-519.

⁴⁵¹ *Taḥqīq mā li al-Hind*, p. 464./ *India*, II, p. 146./ *Al-jamāhir*, p. 6.

⁴⁵² *Fihrist kutub al-Rāzī*, (ed.) Mehdi Mohaqeq, pp. 23, 61.

⁴⁵³ *Taḥqīq mā li al-Hind*, pp. 458-459, 464-465./ *India*, II, pp. 138, 146-147./ *Taḥdīd nihāyāt al-amākin*, p. 4./ *Yādnāme-ye Bīrūnī*, (ar. Abd al-Javad Falaturi), p. 521.

inexplicit words. Concerning the sultan as God's shadow, he argued that if he should act not in accordance with people's advantage or start destroying the society and civilization, he will by no means be God's representative in the earth. Bīrūnī, as it were, believed in the unity of the human society and put trust in the same old ideal of mankind as something occurring in the future.⁴⁵⁴ In brief, he considered social sciences highly important and the book *India*, as we have mentioned already, has been taken as a perfect example of sociology. It has been said that, after Fārābī, he paid special attention to the subjects of human civilization, social forms and sociological issues and that, concerning the application of scientific methods in the study of the human societies and history, Bīrūnī was prior to Ibn Khaldūn as he appears in his *Introduction*.⁴⁵⁵ The Malthus demographic principle, as expressed by Bīrūnī, is quite surprising even after a thousand years: "The life of the world depends upon sowing and procreating. Both processes increase in course of time, and this increase is unlimited, whilst the world is limited..."⁴⁵⁶

3. Religion studies

Centuries before the modern science of religion emerged, taking the manifestation of the truth everywhere and at every time as possible, Bīrūnī recognized human religions as a general fact and sought common rules for studying the spiritual life of different peoples, and centuries before great scholars of the phenomenology of religion appeared, he found these basics and adopted, through his innate intelligence, the method which is in full agreement with the modern ones. It should be said that his religion study was a seldom found mixture of the four basic qualifications of his: brilliant multilingualism, emotional richness, willful enthusiasm and religious experience. Therefore, he is commonly held as the founder of comparative studies in human culture and, above all, comparative religion studies, or history of religions. Besides, he is considered as one of the founders of the history of science.⁴⁵⁷ A Muslim, Bīrūnī presented unprejudiced and clear reports from non-Islamic beliefs, that is, the creeds and sects against his personal faith. He was tolerant, objective and a defendant of truth, comparing Indian ideas with Greek ones and, at the same time, those of the Iranians with the Jewish and Arabic ones. Perfect accuracy and exhaustive investigation are among the features of his wonderfully contemporary methodology which makes use of testimony of documents, in addition to objective observation, document criticism and theoretical

⁴⁵⁴ *Ifṛād al-maqāl*, p. 8./ *India*, I, p. 98. / *Andīshmand va ensān*, Najafī and Khālilī, p. 127./ *India*, I, P. XIX./ *Tahqīq mā li al-Hind*, p. 75.

⁴⁵⁵ *Tārīkh al-adab al-jughrāfī*, Krachkovsky, p. 247./ *Majalle-ye dāneshkade-ye adabīyāt va 'olum ensāni-ye dāneshgāh-e Tehran*, no. 89, 1975, (ar. Mohammad Taqī Danesh Pajuh), p. 194./ *'Elm va tamaddon dar eslām*, Sayyid Hossein Nasr, pp. 247-255.

⁴⁵⁶ *Tahqīq mā li al-Hind*, p. 336./ *India*, I, p. 400.

⁴⁵⁷ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Fathollah Mojtabae), pp. 264, 274-275./ *Yādnāame-ye Bīrūnī*, (ar. Fathollah Mojtabae), pp. 131-132./ *Payām-e Yunesko*, no. 59, (ar. Nasr), p. 40./ *al-Biruni Commemoration Volume*, (ar. A. Jeffery), pp.125, 126./ *The Commemoration Volume*, (ar. Morgenstierne), pp. 1-9.

discussion.⁴⁵⁸ The list of the most important features and subjects in Bīrūnī's investigations, as represented in the best inquiry by the celebrated Islamic scholar Arthur Jeffery (1892-1959), under the title *Biruni's Contribution to the Comparative Religion Studies*, are as following: exhaustiveness, exactness, unprejudiced approach, evaluation of the examples, criticism of the documents, theoretical discussions (e.g. idolatry, traditions, writings) including geography, demons, finding the Qiblas, burial ceremonies, faith profession words, sects, Hinduism, Zoroastrianism, Manichaeism, the Greek religion, Judaism, Samerians, Christianity, Sabians, Khwarezmians, the Arab pre-Islamic paganism period, and Islam.⁴⁵⁹ In Jeffery's inquiry, an exhaustive evaluation is made of Bīrūnī's contribution towards the history of religions, and his research method in this field, especially in *Al-āthār* and *India*. Bīrūnī believed that idolatry rooted in the nature of human beings, viz. in the natural conditions of his life. Kissing the sacred stones, shrines and temples are all indeed symbolic acts through which people are concretely associated with religious thinking. He argues that before the advent of prophets, all human beings were idolaters by which he means two stages of religious experience: "first, the primitive insight which held that God is identical with matter, and second, the view originated through the experience of the elite maintaining that God's presence can be recognized and confirmed only in specific sacred places".⁴⁶⁰

In describing the Indian religion, Bīrūnī refers to a distinction between the religion of the uncultivated commoners, i.e. the Hindu religion, and that of the cultivated elite, i.e. the Brahman religion, and he goes far to identify the commoners with the idolaters in the Greek pre-Christian paganism. As it were, he used to refer to Buddhism as Shamaniyat. According to his methodology of religion studies, he considered the Patanjali Yogic in agreement with the Iranian Sufism doctrines. He maintained that metempsychosis is the sign of the Indian religion, as the Islamic sign is 'the two articles of creed', the Christian sign being the Trinity and that of Judaism being the Sabbath. Then, concerning the idea of metempsychosis among the Indians, he adds that "Abū Ya'qūb Sajzī believes in his *Uncovering the Veiled (Kashf al-maḥjūb)* that species are well-preserved and metempsychosis cannot transubstantiate one species into another. The same is held by the Greeks too, since Yaḥyā Naḥwī [John Philoponus] quoted from Plato that rational souls are embodied as quadrupeds and that Plato followed the Pythagorean prejudices in this respect; and that Socrates maintains, in the book *Phaethon*, that the corpus is earthly and heavy, therefore, loving it so much, the soul moves and will be absorbed to another place which waits for it."⁴⁶¹ Regarding Zoroastrianism, i. e.

⁴⁵⁸ *al-Biruni Commemoration Volume*, (ar. A. Jeffery), pp. 128-132./ *al-Biruni Commemoration Volume*, (ar. A. Pope), p. 283./ *Biruni Symposium*, (ed.) E. Yarshater, p. V./ *Payām-e Yunesko*, no. 59, (ar. Boilot), p. 11./ *Al-falsafa al-hindīya ma'a muqārīnāt bi falsafa al-yūnān wa al-taṣawwuf al-islāmī*, Abū Rayḥān al-Bīrūnī, (ed.) 'Abd al-Ḥalīm Maḥmūd and Uṭṭman 'Abd al-Mun'im Yusif, Cairo, 1958.

⁴⁵⁹ *al-Biruni Commemoration Volume*, (ar. A. Jeffery), pp. 125-160.

⁴⁶⁰ See *Resāle dar tārikh-e adyān*, Mircea Eliade, Tr. Jalal Sattari, Tehran, Sorush, 1993, pp. 226 ff./ *al-Biruni Commemoration Volume*, (ar. A. Jeffery), p. 136.

⁴⁶¹ *Taḥqīq mā li al-Hind*, pp. 18, 38, 49./ *India*, I, pp. 24, 50, 65./ *al-Biruni Commemoration Volume*, (ar. A. Jeffery), pp. 142-147./ *al-Biruni Commemoration Volume*, (ar. A. Pope), p. 282./ *The Scholar and the Saint*, (ar. B. Lawrence), pp. 30, 34, 43./ *The Scholar and the Saint*, (ar. P. Soucek), pp. 115-116.

the faith of most people in Iran at the time of Bīrūnī, he discusses in full. Basically the Iranian creeds are of particular importance in his religion studies and his exposition and references in this respect are in accordance with the religious middle Persian texts. It should be mentioned again that he was the only scholar well aware of the pre-Zoroastrian Magian religion to which he refers as the “ancient Magi”.⁴⁶²

Regarding the Greek ancient religion which he compared with that of the Indians, it should be remarked that he took the religion of the common people as idolatry and a kind of personification of their divinities. Yet, among their elite appeared philosophers such as Socrates and, to him, this is the source of a basic distinction from the Indian religion. The philosophers considered the idol as the mediation between the ‘first cause’ and themselves and worshiped them in the names of the stars and the supreme substances, as Plato described them, in the fourth article of his book *Laws* (*Al-nawāmīs* in Arabic), as the means of approximation to God. He says of course only as a quotation that, like Greeks, Rāzī believed in the five eternal entities, viz. the Creator, the absolute Soul, the Matter, Space and Time.⁴⁶³ As with Judaism and Christianity, we have already mentioned that Bīrūnī was completely aware of their writings and rites, had access to the *Old Testament* texts, *Bible*, the Talmudic and the Apocryphal traditions and was almost familiar with Hebrew. Yet, it has been noted that the source of his Jewish and Christian knowledge was entirely the Syriac narrations, customarily called *the apostles’ account*, existing today as the Syriac western traditions.⁴⁶⁴ He was also well acquainted with the Christian sects of the Melchites, Jacobians and Nestorians through their traditions and texts, and besides, through a few Christian friends in Khwārazm and some of the Fathers of the eastern churches the calendars of which he copied, and also made several references to the Christians of Marv, India, etc. Christianity studies is a prominent aspect of his works and even the problem of the Trinity, as discussed in his writings, has been compared with Averroes’s account by some contemporary Christian scholars.⁴⁶⁵

Bīrūnī’s Manichaean studies seem rather mysterious, because he was led to Manichaean books and texts through Rāzī’s works. However, he was the greatest scholar aware of the mystical principles of the religion, although he was always refuting the ideas lest they would not be taken as his own beliefs. He really means it when he says that he felt an overwhelming longing for the Manichaean books for more than forty years and when he attained them (i. e. *Pragmatia*, *Giants*, *Treasure of Life/ Thesaurus Vivificationis*, *Subḥ al-yaqīn*, *Al-ta’sīs*,

⁴⁶² *Al-āthār al-bāqīya*, p. 407./ *Chronology*, p. 314./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Azartash Azarnush), pp. 187-195./ *al-Biruni Commemoration Volume*, (ar. A. Jeffery), p. 148./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. J. Tavadia), pp. 287-292.

⁴⁶³ *Taḥqīq mā li al-Hind*, pp. 18, 94, 270./ *India*, I, pp. 24, 123, 319./ *al-Biruni Commemoration Volume*, (ar. A. Jeffery), pp. 151-152./ *The Scholar and the Saint*, (ar. F. E. Peters), p. 22 ff.

⁴⁶⁴ *The chronology of ancient nations*, Tr. E. Sachau, London, 1879, pr. XII./ *The exhaustive treatise on shadows*, vol. II (co. Kennedy), p. 141.

⁴⁶⁵ *The Commemoration Volume*, (ar. A. Bausani), pp. 479-494./ *al-Biruni Commemoration Volume*, (ar. A. Jeffery), pp. 152-154./ *al-Biruni Commemoration Volume*, (ar. G. Messina), pp. 221-232.

Living Gospel, Shabuhrgan, Epistles, and Secrets), he fainted out of enthusiasm and then appears to be pretending to have bitterly found that he had been wrong about their value. He was actually in touch with the Manichaean communities in Transoxiana and had access to their writings and texts. He believed that Mani was a follower of Jesus Christ with a religion as a mixture of the Iranian Magian dualistic, and Babylonian Christian teachings. He cites several quotations, especially in *India* and compares the beliefs in Mani's books and the texts produced by his followers.⁴⁶⁶ And finally, regarding other religions such as Sabians, Harranian Sabians, and the religion of the pre-Islamic Arab, his inquiries are still exact, deep, at times, unique.⁴⁶⁷

⁴⁶⁶ *Fihrist kutub al-Rāzī*, (ed.) Mahdi Mohaqqueq, pp. 3-4./ *Al-āthār al-bāqīya*, pp. 253-254./ *Chronology*, p. 191./ *Tahqīq mā li al-Hind*, pp. 29, 36, 41, 123, 220, 320, 431, .../ *India*, I, pp. 39, 48, 54, 170, 364, 381; II, p. 104. / *al-Biruni Commemoration Volume*, (ar. A. Jeffery), pp. 149-151./ *al-Biruni Commemoration Volume*, (ar. A. Pope), p. 283.

⁴⁶⁷ See *al-Biruni Commemoration Volume*, (ar. A. Jeffery), pp. 156-160.

12. Language and literary skill

1. Multilingualism and lexicography

Among Iranian Muslim scholars and philosophers, Bīrūnī can be regarded as the only one who knew at least two or three languages more than any body else. Apart from Khwārazmian, Sogdian, Persian and Arabic, on the one hand, and Syriac, Greek and more or less Hebrew, on the other, he was the only scholar in the Islamic world who knew Sanskrit. Sachau's opinion in his introductions on some of Bīrūnī's books can be summarized as following: Bīrūnī was almost acquainted with Hebrew and Syriac, but did not know Greek and learned the Greek philosophy via the Arabic translations available at that time and the Syriac texts, and also through his celebrated physician friend, Abu al-khayr Khammār, who knew Greek and translated Theophrastus' book via Syriac.⁴⁶⁸ However, as Zaryab Khoyee argued that if Sachau had studied the book *Al-ṣaydala* (*Pharmacy*) which happened to be known after his death in 1930, he would have surely come to the conclusion that Bīrūnī did know Greek as well. In the sixth chapter of the introduction of the book, Bīrūnī says that since childhood, he had much enthusiasm towards gathering knowledge, so he asked a Roman (i.e. Greek) person the names of the herbs and medicines in his language and then wrote them down.⁴⁶⁹

Moreover, apart from the extracts and quotations that Bīrūnī cites from Greek, mentioned by Sachau as well, there are other pieces of evidence which prove that he knew Greek well. Concerning Syriac, there is no doubt, for he himself explicitly acknowledges his complete acquaintance with the language. Firstly, as it were, it is mostly held that he educated the Greek knowledge, among other things, via Syriac language, and secondly, he acquired the Jewish and Christian teachings entirely from the Syriac narrations, available in the western traditions by the name of [the apostles' account](#).⁴⁷⁰ And as for Sanskrit, one can claim that he was the first Iranian scientist in the Islamic period to learn it for the sake of documentary Indian studies, the long story of which has evoked the contemporary Indian experts write lengthy articles.⁴⁷¹ The main topics in these writings are Bīrūnī's quotations from Sanskrit texts, his renderings and interpretations of the items and terminologies of the language, literary information and extracts from *Ramakatha*, *Mahabharata* and other Vedic writings.

⁴⁶⁸*The chronology of ancient nations*, Tr. E. Sachau, p. XII./ *India*, II, notes, p. 256./ *The Commemoration Volume*, (ar. A. Badawi), p. 155.

⁴⁶⁹*Al-ṣaydana fī al-ṭibb*, (ed.) Zaryab Khoyee, p. 15./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 136.

⁴⁷⁰*The exhaustive treatise on shadows*, vol. II (co. E. S. Kennedy), p. 141./ *Sharḥ-e ḥāl-e nābeghe-ye shahīr-e Irān Abū Rayḥān*, Dehkhoda, pp. 22, 83.

⁴⁷¹*al-Biruni Commemoration Volume*, (ar. C. Bulke), pp. 77-82./ *al-Biruni Commemoration Volume*, (ar. S. Chatterji), pp. 83-100./ *al-Biruni Commemoration Volume*, (ar. G. Utrecht), pp. 111-118./ *The Scholar and the Saint*, (ar. D. Pingree), pp. 67-81./ *Al- Bīrūnī wa Hind*, (ar. B. K. Nayer), pp. 39-46./ *The Scholar and the Saint*, (ar. Ajay Mahatra Shastri), pp. 53-117.

All this shows Bīrūnī's knowledge of Sanskrit and the 2500 item lexicon he rendered from Sanskrit to Arabic is of great value today. As a matter of fact, in addition to the precious exact information, the book *India* contains hundreds of words, terminologies and expressions in Sanskrit used in a learned way. So far, apart from Sachau's commentaries on his English translation of *India*, other scholars have endeavored to solve the lexical problems of the book. Finally, it is known that Bīrūnī translated some books from Sanskrit to Arabic and vice versa.⁴⁷²

2. Quotations and references

We need not note that throughout his numerous invaluable works, Bīrūnī never ceased to cite the written or oral references and if he rarely happens to forget the name of the reference, he notes it immediately and apologizes for it. It is clear that we are not going to provide the reader with a list of Bīrūnī's references which are, as it were, totally original ones in that age. We just note here that his quotations from the Indian and Greek ancient philosophical texts have attracted contemporary scholars as well. We have already mentioned that, well acquainted with Sanskrit, Bīrūnī quoted from eighteen *Purana* and twenty Brahmin books, altogether forty Sanskrit reference books, in addition to the books we have named earlier.⁴⁷³ Furthermore, in addition to rendering the philosophical books *Samkhya*, *Patanjali* and probably *Al-Shāmil* to Sanskrit, he translated some literary books from Sanskrit to Arabic (*Kārnamē*, p. 49). It is interesting that he was eager to translate the well-known book *Kalila and Dimna* or *Panchatantara* (*Five principles or techniques*) from Sanskrit to Arabic, since the Iranian Ibn Muqaffa' who rendered the book from middle Persian to Arabic, added the Manichaean chapter of the physician Perzoes (Burzuya), the physician.⁴⁷⁴ Now, regarding the Greek literature, in addition to the philosophical-scientific texts and the writings of Plato, Aristotle, Democritus, Galen etc., he knew the epic works of *Iliad and Odyssey*, and even cited the verses of Eumirus as evidence. He also quoted from the books *Phaedo*, *Timaeus*, *Laws* by Plato who had almost the same taste as his (these quotations have been studied in comparison with the original Greek passages).⁴⁷⁵ His quotations from Greek were both from the Syriac and Arabic translations and directly from the Greek texts. As a matter of fact, the number of the works and quotation references is more than what we just mentioned. We are not going to focus more on his quotations from Arabic and Persian texts, because there are

⁴⁷²*Loghāt-e Sanskrit dar Mā li al-Hind*, Jalali Na'ini and Shokla, Tehran, 1974, pp. 4, 11./ *Kārnamē-ye Bīrūnī*, J. Boilot, Tr. P. Azkai, pp. 37-38, 46, 47, 49, 50, 52, 74./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 75.

⁴⁷³*al-Biruni Commemoration Volume*, (ar. Bulcke), pp. 77-82./ *al-Biruni Commemoration Volume*, (ar. G. Utrecht), pp. 111-118./ *The Scholar and the Saint*, (ar. D. Pingree), pp. 67-81./ *Payām-e Yunesko*, no. 59, (ar. Babajan Ghafurov), p. 8.

⁴⁷⁴*Taḥqīq mā li al-Hind*, p. 123./ *India*, I, p. 170./ *Payām-e Yunesko*, no. 59 (ar. Ghafurov), p. 8.

⁴⁷⁵*India*, I, pp. XLI-XLII; II, pp. 271-278, 281-284, 286, 288-289, 291-293, 297, 298, 324, 349-351, 359./ *Taḥqīq mā li al-Hind*, pp. 32, 75./ *al-Biruni Commemoration Volume*, (ar. F. Gabrieli), pp. 107-110./ *The Commemoration Volume*, (ar. J. Mattock and Ch. Burgel), pp. 267-290, 365-378./ *The Commemoration Volume*, (ar. A. Badwi), pp. 153-180.

valuable articles, for example, on the Persian sources of his book *Al-jamāhir (The Gems)* by Mohammad Yahya al-Hashemi, and on the lexical usefulness of that book by Mohammad Mo'in, *The Iranian Dialectal Words in Biruni's Writings* by Sadeq Kya, and poetic examples from eighty Arabic poets in the very book, *The Gems*.⁴⁷⁶

3. Arabic scientific prose

"The Arabic language became tamed and ready to convey the scientific and literary messages by the Arian writers" (Louie Massignon).

It is famous that Bīrūnī preferred writing satires in Arabic to expressing laudations in Persian and wrote "Have you not seen how the scientific book written in Persian obliterates the splendor and brightness of that science, darkens its face and diminishes its usefulness, for that language is not worthy but of telling tales and night stories".⁴⁷⁷ Surprisingly, this was stated by the man who wrote the scientific book *Al-tafhīm (Instruction)*, with his own hand, in Persian in such a way that the splendor of that science is increased, the beautiful face of Persian is brightened, and its use in scientific writing multiplied. Therefore, fair scholars have refuted Bīrūnī's idea that Persian is incapable of conveying scientific messages and have, among other things, mentioned as an example the scientific book *Hudūd al-‘ālam (The Limits of the World)*, written in Persian around half a century before Bīrūnī.⁴⁷⁸ The fact is that with his strong Iranian nationalistic feeling, Bīrūnī gave Arabic priority for scientific writings, because it was only a means of communication for the true scientist, and when, following the tradition of his contemporary men of letters, he attacked Persian, it can be observed that he gained nothing.⁴⁷⁹

The basic point here is that the international Islamic language of Arabic was no more than a formal means for the Iranian thinkers, as the Aramaic-Syriac languages had served almost the same function before the Islamic period, but the philosophical or literary content, was totally Iranian and Persian in essence. This can be understood from the famous report by Ibn Ṭayfūr Baghdādī (cr. 820-893/ 1417-1487) which goes: "The ideas are but in Persian; the language is ours and the ideas theirs". That is why Louie Massignon considered the Iranian's Arabic writing as a source of the might and power of that language and a reason of its worldwide

⁴⁷⁶*Tārīkh al-adab al-jughrāfī*, Ignati Krachkovsky, Tr. Ṣalāḥ al-dīn Uṭmān Ḥāshim, P. 247./ *Al-dirāsa al-adabīya*, nos. 2, 3, Beirut, 1959, pp. 57-65./ *Vāzhehā-ye guyeshī-ye Irānī*....., Sadeq Kiya and Rashed Mohassel, Tehran, 1974./ *al-Biruni Commemoration Volume*, (ar. M. Moin), pp. 237-250./ *Die Quellen des Steinbuches des Bērūnī* (Inaugural-Dissertation), von M. J. Hashemi, Bonn, 1935.

⁴⁷⁷*Al-ṣaydana fī al-ḥibb*, (ed.) Zaryab Khoei, p. 14.

⁴⁷⁸*Tārīkh al-adab al-jughrāfī*, Ignati Krachkovsky, p. 258./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 162.

⁴⁷⁹*Tārīkh al-falsafa fī al-islām*, De Boer, p. 299./ *Tārīkh al-adab al-jughrāfī*, p. 252./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Azartash Azarnush), p. 167./ *Zendegināme-ye Biruni* (Ali al-Shābbi), p. 162.

dominance.⁴⁸⁰ Bīrūnī's Arabic writing style, notorious ever since, roots in his too few words with plentitude of complicated meanings; a style really difficult to comprehend which demands double effort. He says that he does not write for the beginners, and that his true addressees are scholarly scientists, viz the lovers of science, and that if his readers are otherwise, it will be all the same to him whether they comprehend his writings or not.⁴⁸¹

His writing reveals the structure of his thinking and his complicated character. It also has an inseparable relation with his research method and style which is elegant, brief, eloquent, and full of meaning, with little room for rhetorical devices, although not void of covert or overt leonine rhymes here and there, with balance as a major device in his writings. The general brevity due to which his thoughts are conveyed without resort to repetition or synonymy is to make the reader confront difficult interwoven facts. The features have been evaluated as a failure point and a sign of complexity, or sometimes as a symptom of inflexible or unreadable way of expression.⁴⁸² Perhaps boring inquiries led him to some sort of satire and probably the difficult scientific career encouraged him to write and translate stories, including *Wāmiq and 'Adhrā* as an old love story of Greek origin, *Shādbahr and the Life Spring*, *Urmazd and Mihryār* and others from ancient Iranian stories, and the story of the two idols of Balkh from the local narrations, which 'Unṣurī Balkhī (cr. 961-1039) described in the poem, *The Red, and the Pink Idols* (Today, the well-known sculptures of the Buddhist man and woman carved out of a cliff rock). Altogether, Bīrūnī's literary and poetic writings were more for a change of taste. The vocabularies he presented from Sanskrit, Syriac, Greek, Hebrew, Arabic, Persian, Khwārazmian and Sogdian can best demonstrate his extended and unparalleled literary capability.⁴⁸³

⁴⁸⁰ *al-Biruni Commemoration Volume*, (ar. L. Massignon), p. 218./ *India, ???* / *Ketāb-e Baghdād*, Ibn Ṭayfūr, p. 87./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Azartash Azarnush), p. 168.

⁴⁸¹ *Al-mashāṭat li risālat al-fihrist*, Ghāḍanfar Tabrizi, (ed.) Mohaqqueq, pp. 103, 107./ *Tārīkh al-adab al-jughrāfī*, p. 252./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), p. 155./ *Barrasīhā-yī darbāre-ye Bīrūnī*, (ar. Azartash Azarnush), p. 167./ *Chronologie Orientalischer Völker* (vor. E. Sachau), pp. IX, LXIX.

⁴⁸² *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), PP. 155, 156, 168./ *Tārīkh al-falsafa fī al-islām*, De Boer, P.299./ *Yādnāme-ye Biruni*, P. 326.

⁴⁸³ *Payām-e Yunesko*, (ar. Zabihollah Safa), pp. 30-31./ *Zendegināme-ye Bīrūnī* (Ali al-Shābbi), pp. 142-143.

13. Appendix I

1. Science and philosophy

* Bīrūnī quotes from a source of advice “Your science should not be what might be taken back... you have to attempt and haste in preserving it entirely, but the preservation is a divine endowment, bestowed upon certain people” (*Pharmacy*, p.13).

He said: “Knowledge is a result of repetition; one has to keep burnishing it”.

He took knowledge and trial as the two wings that enable medicine to fly (*Pharmacy*, p.13).

He said “saying ‘God knows best’ is no acceptable excuse over one’s ignorance” (*India*, pp. XX, 177; *Introduction to the history of sciences*, p.708).

As I am far from persistence upon falsehood and prejudice, I take it a duty of mine to respect whoever has a priority over me (*Keys, Bīrūnī Nāme*, pp. 413, 462).

He said “People’s endeavor in the world is unequal and the world’s prosperity depends on this inequality. I have girded up my loins to offer benefits, for the time has elapsed for me to gain benefits” (*Patanjali*, p. 2).

*

“To us Bīrūnī is an indefatigable inquirer, a man of science with targets in farthest distance. He is so faithful to his scientific methodology that no criticism can be made against him, a scholar with a vast intellectual knowledge of the exact sciences of his time. We have to note that his enthusiasm for research roots in the honor of his nation in the age still standing ahead other ages” (M. Krause, in *Tārīkh al-adab al-jughrāfī*, p. 257).

Bīrūnī’s sense of Iranian nationality was so strong that the Iranian heritage has been honored in the history of human civilization partly due to his endeavors (Krachkovsky, *Tārīkh al-adab al-jughrāfī*, p. 251).

Sultan Maḥmūd Ghaznavī has been regarded as a conqueror of India; it will be no exaggeration if one claims that Bīrūnī was the discoverer and conqueror the Indian knowledge, culture and customs. He was the introducer and conveyer of that knowledge to other countries (Nā’ini-Shuklā, *Sanskrit Words in India*, P. 8).

Theoretical speculation had no high status in Bīrūnī’s thought. He obtained thorough knowledge of the best scientific theories of his time, but he was not innovator enough and did not develop new theories (Kennedy, *Scientific Biography of the Islamic Scientists*, p. 320).

(1). As a scientist, Bīrūnī would not like to undertake theoretical discussions about a method or subject that he believed would stand in conflict with the sound and reliable data. (2).

Beyhaqī was right when he remarked that Bīrūnī was not interested in the intelligible discussions, for he had nothing to do with metaphysical speculations; as a scientist, he just studied the importance of metaphysics in human life. (3). Another difference between Bīrūnī and Ibn Sīnā and other contemporaries of him is that he had a close relation with Al-Hazen of Baṣra who had an inclination to religion and philosophy. However, Bīrūnī was undoubtedly interested in abstract speculation, as Franz Rosenthal mentioned too.

(*The Commemoration Volume of Biruni International Congress in Tehran*, p. 537).

Bīrūnī's stance towards the Greek philosophy was the same with that of Al Hazen, his contemporary free-spirited scientist and a follower of natural philosophy, in that he too treated the truth of Ptolemaic ideas about the astronomical system of the world with skepticism and believed that it could be falsifiable (Al-shaybī, *Kitāb al-mihrajān li Ibn Sīnā*, p. 128).

Bīrūnī believed in the monotheism principle thoroughly, and, by way of knowing God, he took the pantheistic doctrine seriously. He strongly believed in philosophical monotheism and, to him, there was no contradiction between religious faith and scientific outlook. It should be said that the philosopher Abū al-Ḥassan 'Āmerī elucidated the non-contradictory relationship between science and religion (*Al-i'lām bi manāqib al-islām*, pp. 193, 194).

(1). A basic question is that if Bīrūnī believed in the principle of the 'one', with respect to the rule 'the one emanates but one', how could he believe in the emanation of the two origins of light and darkness from the 'one' in his philosophical dualism? We have to explain that, firstly, Bīrūnī's monotheism is acquired, not numerical; secondly, the rule is true only about the Aristotelian continuous combination of matter and form to make a body, while Bīrūnī's idea of the discontinuous combination of the indivisible atoms cannot be considered as an instance of the truth of that rule.

(2). Following Rāzī, Bīrūnī uses the term 'transmutation' in the same sense as the Mu'tazilite terms of 'concealment/ latency and manifestation', equal to the Aristotelian terms potentiality/ possibility and action/ actuality

(*Fīlsūfe Rey*, p. 83; *Falsafe-ye 'elm-e kalām*, pp. 543, 547).

Bīrūnī says "In his nature, human body is composed of opposite mixtures that combine but with a dominant compulsion; the soul is dependent upon the temper of the body in its most states, thus it changes and shows various moods" (*The Gems*, pp. 6-7). From this quotation can be understood the principle of contrast and the unity of contraries, and the principle of the transformation of quantity to quality.

2. Epistemology

He says "The ultimate desire of a man is to advance from the concrete present to the intelligent absent" (*The Gems*, tatemmat, p. 7).

Concerning Bīrūnī's methodology, one should note that the acquired science is in fact a movement from object to subject, as, according to Bīrūnī's testimony, the Quranic verse (al-āfāq wa al-'anfus) asserts so.

He said "Human senses befit his animal nature, however, with his thought and powerful inference, he adjusts them and leads the sensory to its end, viz the intelligible" (*The Gems*, p. 6).

His epistemological movement from object to subject, from the concrete to the intelligible, and from known to unknown is entirely modern and free from metaphysical fancies.

Certain knowledges result only from sensations gathered in a logical way and turns into abstract general categories by the intellect; therefore, induction, experience and subjective abstraction are the foundations of Bīrūnī's research and, above all, they are the means of the truth (*Tārīkh al-falsafa*, p. 270; *Zendegī Nāme*, p. 92).

This is exactly the same as what his contemporary scientist Al- Hazen believed: truth can be sought only through propositions with concrete matter and rational form ('*Uyūn al-anbā'*, p. 50; *Zendegī Nāme*, p. 87).

Regarding the micro and the macro nature of the celestial cycles according to the followers of the Indian Aryabhata view, Biruni says we need only to know that it suffices inasmuch as light reaches, and that we do not need anything unvisibile, because if it is of macro type by itself, it cannot be perceived, since light does not reach it, and whatever is insensible, cannot be known, i. e. intelligible (*Mā li al-Hind*, p. 183).

From the above quotation, it can be understood, as De Bores mentioned, that Biruni's philosophy relies on certain knowledge as a result of sensory perception along with rational inferences in a logical way (*Tārīkh al-falsafa*, p. 270; *Abu Rayhan al-Biruni*, pp. 75, 76).

3. Relativity hypothesis

As it were, Bīrūnī attributed gravitation to the earth's motion, the idea that stood in opposition with the opinion of the philosophers, specifically Aristotle and Ibn Sīnā (see. *The Questions and the Responses*, I; *India*, pp. 203, 224-225; *Fixation*, pp. 14, 19, 25, 28, 33). Therefore, he found the apparent aspects of the earth's rotation (*Al-qānūn*, pp. 49, 51; *Al-āthār*, p. 25). But while introducing the astrolabe of Abū Sa'īd Sajzī, he suggests that the problem should be solved by natural philosophers. Copernicus took the earth's motion as a preferred hypothesis in his book *The Spheres' Circles*. However, it was first Galileo (d. 1642) who proved that there was no contradiction between the idea of the earth's motion and the physical laws, and then Newton (d. 1727) who established the theoretical formulation by his laws of the general gravity (*Tārīkh-e nujūm-e eslāmī*, pp. 312-314).

The issue of the earth's motion was discussed by the Islamic astronomers centuries before Copernicus and some of them believed in the hypothesis. As for the theory of general gravity,

proposed by Newton centuries later, it should be added that although Bīrūnī did not believe in such a ‘general potency’, he argued, in line with Einstein, that gravity was but acceleration or the velocity of the body and not something external. This idea of Bīrūnī was extended by Abd al-Raḥmān Khazīnī (*Mizān al-ḥikma*, p. 16): gravitation is the same force by which heavy bodies move towards the center of the earth always with its essential potentiality [...]. But that potentiality is essential, not acquired; it does not act from outside (the body), nor is it distinct from it. And it has an inclination towards the center of the earth or the universe without any obstacle.

(*Al-qānun al-Masudi*, pp. XVIII-XIX).

Newton’s general theory of Universal Gravitational pull was undisputedly leading for two centuries, before it was replaced by Einstein’s relativity, the theory which caused a revolutionary change in our idea of space, time, matter and energy. Now, we can say that, as Bertrand Russel said, “In fact because all motion is relative we cannot distinguish between the hypothesis that the Earth goes round the sun and the hypothesis that the Sun goes round the Earth. The two are merely different ways of describing the same occurrence like saying that A marries B or B marries A. [This is exactly the same as what Bīrūnī believes]. To Kepler and Galileo and their opponents, however, since they did not recognize the relativity of motion, the question in debate appeared to be one of convenience of description but of objective truth” (*Religion and Science*, 30-31; *al-Qanun*, Barani, p. XVII).

14. Appendix II

After the book was finished, a scholarly friend of mine generously lent me a book, then unobtainable, with the following bibliography:

The Scholar and The Saint (studies in commemoration of Abu'l Rayhan al-Biruni and Jalal al-Din al-Rumi), edited by Peter J. Chelkowsky, New York University, 1975.

The first eight articles of the book are about Bīrūnī's knowledge four of which are, according to their titles or subjects, almost the same as those which had appeared, by the same authors, in previous collections about Bīrūnī. I have already quoted from them in the references of the present book. The other four articles did not contain new information for me and their summaries or gists are reflected in their proper places in the present book. Yet, to complete our discussion, a brief report of them will be presented in what follows:

1. The appendix of the Indiology

(1) In the first article, under the title "Foreign Interpreters of India: The Case of al- Bīrūnī", Ainslee T. Embree remarks, among other things, that Bīrūnī's account of India is totally different from those of others, since he proposed a new way to the study of civilizations which enabled him to understand and introduce the Indian civilization, what was unparalleled up to the nineteenth century when fruitful inquiries were performed on the subject matter (p. 14).

(2) The second article, "Science, History and Religion: Some Reflections on the *India* of Abū'l-Rayhān al- Bīrūnī", by F. E. Peters focuses on Bīrūnī's Hellenic methodology, for instance, saying "how well al- Bīrūnī mastered his own chosen field is revealed by a simple examination of the first half of his *Introduction to the Elements of Astrology*, which is a model of Hellenic mathematical pedagogy..." (p. 19). Bīrūnī showed in *India* that the distinction between the enlightened elite and the ignorant masses is common, because it is the man of knowledge who can be characterized with his understanding of the truth and general principles, while the wisdom of the common people roots in the mythologies and anthropomorphism. "This distinction, which is the cornerstone of al- Bīrūnī's philosophy of culture, was, of course, a common place in the Greek philosophical tradition which in its later stages was densely populated by Platonizing mathematicians, and when al- Bīrūnī takes up the question in detail in Chapter III of the *India*, the platonic *testimonia* are put on full an obvious display" (p. 22). Concerning Bīrūnī's vision of truth cast down by the ignorance of the common people, the writer says that this "rooted in the human condition, and its recurrence reveals al-Bīrūnī in the posture of the philosopher rather than that of the historian" (p. 26).

(3) In the third article, "The Use of Hindu Religious Texts in al- Bīrūnī's *India* with Special Reference to Patanjali's Yoga-Sutras", Bruce B. Lawrence says, among other things, "concerning the Ṣūfī and Greek material used in the *India*, for instance, our information is

uneven and meager. While the Šūfī excerpts in the early India chapters indicate, on close examination, that al-Bīrūnī was far more aware of al-Ḥallāj and his school than he explicitly acknowledges, we still lack certainty in estimating the degree of his exposure to, and familiarity with, the Šūfī tradition” (p. 30). “Only the Hindu scriptural material in the *India* provides us with the opportunity to assess al-Bīrūnī in his dual capacity as hierographer and hierologist. The three works to which he most frequently refers in the opening chapters of the *India* are: the Book *Gītā* (or the Bhagvad Gītā), the Book *Sāmkhya* (possibly the *Sāmkhya-kārikā* of Iśvara-kṛṣṇa), and the book *Bātanjal* (or the *Yoga-sūtras* of Patañjali)” (p. 30). “al-Bīrūnī’s use of the *KB* [Patanjali] is restricted. It relates only to topics which he considers within the early chapters of the *India*: God, creation, metempsychosis, and salvation; and with respect to these topics he picks only a sampling not an inclusive set illustration from the *KB* [Patanjali] (p. 43).

(4) In the fourth article, “al-Bīrūnī’s Knowledge of Sanskrit Astronomical Texts”, David Pingree remarks “I intend to consider the means by which he studied Sanskrit texts on astronomy which were among the most important sources for his knowledge of the Indian science, and to examine the question of the reliability of his reporting of Indian astronomical and physical theories” (p. 67). “But [...], the magnitude of his achievement is little lessened by these flaws. From the point of view of muslim contemporaries, his knowledge of Indian astronomy was unique. And from our point of view, his account of the lost siddhāntas of Vijayanda and of Pauliśa, and of the *Bhāṣya* of Balabhādra, though now we know with what caution we must use them, are invaluable contributions to our knowledge of the Indian astronomical tradition” (p. 78).

(5) In the fifth article, “*A Priori* Positions Determining al-Bīrūnī’s Scientific Work”, Anton M. Heinen presents a highly exact analysis of Bīrūnī’s atomistic view in three sections, Discussions With Atomists, An Atomism Without A Vacuum, Atoms And Elements In Their Interaction, though we cannot agree with some conclusions made by him. He states that Bīrūnī’s “research on various kinds of astrolabes has forced him into difficult discussions with his opponents concerning the atomistic divisibility of bodies [...] The central problem, more or less closely approved by many of these eighteenth questuins, is -in my estimation- the old question of continuity or discontinuity of objective reality: Is our world of extension in space and time [...], or does it ultimately consist of smallest parts, the atoms, which cannot be further split? Al-Bīrūnī approaches this question obviously with an open mind, true to his independence from any school, carefully considering the arguments on both sides, so much that one can hardly tell with a satisfactory degree of certainty whether he accepted or rejected the theory of atoms. But his other works give us the general impression that the atomistic view of reality, however in his own modified form, became the central a priori position on which he firmly based himself. In *The Chronology of Ancient Nations*, for instance, he clearly discussess “the adhesion and connection of the water-atoms amongst each other” flowing out continually of the clepsydra when it is slowly tilted to one side. In the exchange with Ibn Sīnā he is more careful, stating cautiously that atomism as a theory of constitution of objective reality has also its problems, although not as many as Aristotle’s theory of unlimited divisibility of continuum. The argument with which he tries to convince Ibn Sīnā is

surprisingly old-fashioned: It is essentially the well-known paradox of Zeno that two bodies moving in the same direction, but with different speeds, should never meet at exactly the same point. Al-Bīrūnī gives a new dimension to the old problem, however, insofar as he compares the movement of the moon with that of the sun” (pp. 51-52). “For al-Bīrūnī’s peculiar view of atomism it is important to note that for him it is not self-evident that actual division finally has to stop at smallest parts which can be subdivided only potentially. As an example he points out that collyrium can always be ground into smaller particles; or that water can be vaporized to such an extent as to make its smallest parts totally indivisible. Apparently he was convinced that the theory of actually disparate atoms cannot be rejected with the logical arguments of Peripatetic philosophy which always seem to presuppose what they designed to prove, as, for example, the argument that the smallest particles in the realm of composition must always have two extremes and a center, for this would make them further divisible. Since this corresponds to the teachings of Muḥammad b. Zakarīyā al-Rāzī, the later criticism by Nāṣir-i-Khusraw is already anticipated here” (p. 53) “Al-nuqṭa. If a line is infinite its extremities are points. Points have one dimension less than lines, viz. length; they have neither length, breadth, nor thickness, and are indivisible. The point of a sharp needle may be taken as an illustration from the sensible world, but surface, line, and point, although they occur on the solids which bear them, apart from them cannot be apprehended except by the intellect” (p. 54).

An Atomism Without A Vacuum. “To adhere to an atomistic theory as explanation of objective reality, of its constituents as well as of its processes, means as much to accept the existence of a void or vacuum, in or around the world as a whole or in between the smallest parts, the atoms. In the case of al-Bīrūnī, however, it is advisable to speak with caution of his atomism because his is an atomism of a very rare, and perhaps even unique, kind; time and again he emphasizes the contiguity of the atoms and the elements of our world, so that there can be little doubt that the vacuum never found a place in his world [*Al-as’alah wa al-ajwibah*, p. 47]. This does not mean, however, that this question of the void never troubled his mind; on the contrary, he returns to it quite often, from the most diverse of research, and he is aware that the solution of many a problem in natural science would be easiest if the existence of a void could be assumed, for instance, the movement of light rays from the sun down to the earth” [*Al-as’alah wa al-ajwibah*, p. 54] (p. 54). He made other experiments, concerning the existence of the void, and Ibn Sīnā tried to explain the phenomenon (p. 55). “al-Bīrūnī’s atomism without the void, or at least without a definite decision for or against, in many features resembles the theory of elements proposed by pre-Socratic philosopher Empedocles who seems to have been the first one to describe the clepsydra. As a matter of fact, al-Bīrūnī quotes him in his *India* on authority of Ammonius, but in a text about the souls always remaining commingled with the world. But since Aristotle mentions Empedocles in his *De Caelo* as denying the existence of the void, this is probably the direct source of al-Bīrūnī” (p. 56). “And it might well be that atomistic theory is the key for an integral understanding of al-Bīrūnī’s practice of science” (p. 59).

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(6) The article by Hans Robert Roemer, under the title “Research on al- Bīrūnī in Germany”, is the same as his article in *The Commemoration Volume* (p. 181 ff), with some lines added at the beginning and the end to make some points clear.

(7) The eighth article by Priscilla P. Soucek, “An Illustrated Manuscript of al-Bīrūnī’s *Chronology of Ancient Nations*”, deals with a manuscript of the book *Chronology of Ancient Nations* in the Edinburgh University Libraray (no. 161), copied in 707/ 1307 by a certain Ibn al-Kutbī, most possibly the direct or indirect source of all the manuscripts used by Sachau. The manuscript, found in Isfahan in 1951, includes 25 illustrated paintings of the reports in the book, all published by Soucek. He remarks that the manuscript must have been written and illustrated either in Tabrīz or Marāgha (p. 156). According to this and certain other pieces of evidence, I am sure that the manuscript was developed in Tabrīz for the library of the Rashīdī Quarter (Rab‘-e Rashidi) and the vizier Khwāja Rashīd al-dīn Faḍl Allāh Hamadānī in the year 707/ 1207, in the same way that the vizier’s book *Jāmi‘ al-tawārīkh* (*Compendium of Chronicles*) was similarly illustrated by the masters of the craft. It was, however, H. K. Moller who first introduced the manuscript in his article, “The Illustrations of the *Chronology of the Ancient Nations* in the Edinburgh manuscript” (cf. *The Commemoration Volume*, pp. 235-245). Soucek’s comprehensive article is nevertheless so useful, emphasizing, among other things, that Buddhism [in Bīrūnī’s terms, “Shamanīya”] and Zoroastrianism, as it can be inferred from Bīrūnī’s remarks, appears to have some basis in historical facts -in line with the famous theory by H. S. Nyberg, yet Bīrūnī’s “equation of the Buddhists with the Sabians of Ḥarrān is more puzzling” (pp. 115-116).

3. The biography of Abū Naṣr ‘Irāq⁴⁸⁴ (cr. 350-408/ 961-1017)

Abū Naṣr as the nickname of Maṣṣūr Ibn ‘Alī Ibn ‘Irāq al-Ja’dī, together with the name of his grandfather, ‘Irāq, forms the noun by which the scholar is known to us. His title Amīr, mentioned in some histories, relates to the fact that he was from the Afrīghīd Shāhīd dynasty of Khwārazm: He was a great grandchild of Khwārazm-Shāh (?? 19) ‘Irāq (2nd half of the 3rd/ 9th century), the son of Maṣṣūr (1st half of the 3rd/ 9th century), the son of ‘Abdullah b. Pr-Kṣīyathā (???16) and the nephew of Khwārazm-Shāh (???20) Muḥammad ibn ‘Irāq (1st half of the 4th/ 10th century). According to certain facts, we can guess that Abu Naṣr was born around the year 350/ 961. We have already mentioned that the word ‘Irāq in his name is the Arabicized word ‘Irāg, originally meaning ‘of Iranian descent’. And concerning his attribute Ja’dī, we will explain later that it shows his Manichaean inclination or a sort of attribution to Zandaqa. Pupil of the celebrated mathematician, Abū al-Wafā Būzḡānī (328-388/ 939-998), Amīr Abū Naṣr ‘Irāq was one of the greatest scholars of mathematics and astronomy in the fourth century. These two figures helped the science of trigonometry forward in the world. Abū al-Wafā substantially contributed to the science with his discoveries of major theorems

⁴⁸⁴This section is quoted from the author’s article, “Khāndān-e Shāhīye-ye Khwārazm” (*Faṣlnāme-ye Iran Shenākht*, no. 10, Autumn 1377/1998, pp. 168-181).

(including $\tan = \sin/\cos$), and especially with his well-known zigs and solutions to the spherical trigonometry problems, and Amīr Abū Naṣr contributed to the science with his famous geometrical arguments, especially the discovery of the *mughnī* (*lit.* ‘that which dispenses us with other things’) shape, i.e. the shape which obviates us of the sector shape, or the sinus theorem. The scientific heritage was inherited by their outstanding pupil and colleague, Bīrūnī, who arranged trigonometry in its present day form and applied it independently in his astronomical calculations. That is why the historians of mathematics have regarded him, indeed via the works of his master, among the founders of the science of trigonometry.⁴⁸⁵

Bīrūnī frequently refers to the fact that he was a pupil of Abū Naṣr, for example, to explain the way to extract the daily movement and the amount of solar year, he says “The method... which my master Abū-Naṣr ... Irāk... has found out...”⁴⁸⁶, or in defence of him, he says “My lord and patron Abū Naṣr Maṣṣūr Ibn ‘Alī Ibn ‘Irāq, may God help him, has extracted arguments for the like of these... [and] at my request, my master wrote a book on this subject... from whose library I took enormous advantage while I had started to acquire mathematics. He made me write down whatever he had extracted... and having abundant knowledge and extraordinary intelligence and inference, ... it never occurred to me that he might have taken this theorem (of the *mughnī* shape) from anybody else...”⁴⁸⁷ The scholarly prince loved the genius pupil so much, and gave him fatherly care and affection to the degree that seems unparalleled in the history of science: he dedicated him most of his works to the effect that the pupil listed them among his own writings. Bīrūnī says what he dedicated me, are each as godsons hugged and kissed and like necklaces worn around my neck. I cannot discriminate between own sons and them. And among my works are what Abū Naṣr Maṣṣūr Ibn ‘Alī Ibn ‘Irāq dedicated me:

1. The book *Al-sumūt* (*The Azimuth*).
2. The book *‘Illat taṣnīf al-ta’dīl ‘ind ‘aṣḥāb al-Sindhind* (*Reason for Halving the Equation by the Followers of Sidhanta*).
3. The book *Taṣḥīḥ kitāb Ibrāhīm Ibn Sinān fī taṣḥīḥ ikhtilāf al-kawākib al-‘ulwīya* (*Correction of Ibrahim Ibn Sinan’s Book on the Correction of the Dissimilitude of the Upper Planets*).
4. The treatise *Barāhīn a‘māl Ḥabash bi jadwal al-taqwīm* (*Demonstrations of Ḥabash al-Hāsib’s Efforts at His Table of Rectification*).
5. The treatise *Taṣḥīḥ mā waqa‘a li Abī Ja‘far al-Khādhin min al-sahw fī zīj al-ṣafā’ih* (*Correction of the Mistakes Abū Ja‘far Khazin Has Made in the Tables of the Disks/Plains/ Spiders (Zigs of Safa’ih)*).

⁴⁸⁵See my book *Abu Ryahan Biruni*, Tehran, Tarhe No, 1374/ 1995, pp. 64, 65.

⁴⁸⁶*Al-āthār al-bāqiyā*, (ed.) Azkaei, p. 214.

⁴⁸⁷*Maqālīd ‘ilm al-hay’a*, Marie-Thérèse de Barnot, pp. 2, 3, 96-99./ *Bīrūnī Nāme*, Abulqasem Qorbani, pp. 414, 417.

6. The treatise *Mujāzāt dawā'ir al-sumūt fī al-aṣṭurlāb* (*Passages of the Azimuth Circles in the Astrolabe*).
7. The treatise *Jadwal al-daqa'iq* (*The Table of Minutes*).
8. The treatise *Al-barāhīn 'alā a'māl Muḥammad Ibn al-Ṣabbāḥ fī imtiḥān al-shams* (*Demonstrations on the Efforts by Muḥammad Ibn Ṣabbāḥ into Examining the Sun*).
9. The treatise *Al-dawā'ir allatī taḥuddu al-sā'āt al-zamānīya* (*The Circles that Delimit the Temporal Hours*).
10. The treatise *Al-burhān 'alā a'māl Ḥabash fī maṭālī' al-samt fī zījīhī* (*Demonstration on the Effort by Ḥabash al-Ḥasib into the Ascension of Azimuth in his Zigs*).
11. The treatise *Ma'rifa al-qusī al-falakīya bi ṭarīq ghayr ṭarīq al-nisba al-mu'allafa* (*Knowledge of the Spherical Arches by a Method Other Than Composed Proportion*).
12. The treatise *Ḥall shubha 'araḍat fī al-thalātha 'ashar min kitāb al-uṣūl* (*Solving a Difficulty Presented in the Thirteenth Treatise of Euclid's Book, Principles*).

The list above was presented by Bīrūnī⁴⁸⁸; however, out of the 41 treatises in the collection of the (manuscript) treatises found in the Indain Bankipur library (no. 2468), famous as 'Bīrūnī's minor tracts'⁴⁸⁹, 14 or 15 works are by Abū Naṣr 'Irāq, 9 of which are the same as the treatises number 4 to 12 just cited. The other works in the collection are as following:

The list of the known scientific works by Abū Naṣr 'Irāq was announced by Max Krause as containing 22 items (5 mathematical, and 17 astronomical works).⁴⁹⁰ The treatises, in addition to our list (20 works), are among Bīrūnī's minor trates aforementioned. Abū Naṣr 'Irāq's scientific reputation was mostly and primarily due to his presentation of the mughnī shape as a solution to all spherical trigonometrical problems and the simplification of the *almagest efforts/ operations* and astronomical Zigs. In the book *Al-maqālīd* (*Keys*), Bīrūnī says the mughnī shape is one of his master's innovations as a pioneer; he also repeats this claim in the book *Al-sumūt* (*The Azimuth*) (no. 1), the treatise *Jadwal al-daqa'iq* (*The Table of Minutes*) (no. 6) on Specific Trigonometric Functions, the treatise *Ma'rifa al-qusī al-falakīya* (*Knowledge of the Spherical Arches*), the treatise *Masā'il al-handasa* (*Answers to Geometrical Questions*), and the book *Tahdhīb al-ta'ālīm* (*Correction of Mathematics*).⁴⁹¹ His reputation was secondly due to his correction of the Alexandrian Manalaus's *Sphaerica* and his revision of the Arabic version of it in 398/ 1007 (The original Greek book is lost

⁴⁸⁸ *Kārnāme-ye Bīrūnī*, P. Azkai, Tehran, Vezarat-e Farhang, 1352/1973, pp. 58-60.

⁴⁸⁹ *Al-Biruni Commemoration Volume* (ar. Rah. Khan), Calcutta, 1951, pp. 171-175.

⁴⁹⁰ *Dāneshnāme-ye Iran va Eslām*, ج 5, Tehran, 1356/1977, p. 706.

⁴⁹¹ *Tārīkh-e nojūm-e eslāmī*, Nalino, pp. 304, 305./ *Al-tafhīm*, p. 28-29.

today). It should be finally added that it was Carl Schoy who first paid attention to this text in his book *The Trigonometric Doctrines of Biruni, the Iranian Astronomer* (Hannover, 1927, pp. 74-91).⁴⁹² Then, Krause translated and made comments on it in his “The Treatises of the Gothingen’s Association of Sciences (vol. 3, fas. 17; Berlin, Wiedemann, 1936).⁴⁹³ And concerning spheres, we must add that a chapter of the book *The Sphericity of the Sky* by Abū Naṣr ‘Irāq is highly appreciated by Lucky in the significant research he made about it.⁴⁹⁴ Kennedy too presented a discussion under the title *Two Medieval Methods for Determining the Obliquity of the Ecliptic* on Abu Nasr ‘Irāq’s treatise *The Examination of the Sun*.⁴⁹⁵

The Afrīghīd (‘Irāq) Shāhīd dynasty of Khwārazm with Kāth as their capital city was, as it were, overthrown after seven hundred years of sovereignty due to competitive struggles with the dynasty of Ma’mūn of Gurgānāj. After the enemy grew to become dominant and Abū ‘Abdullāh Muḥammad Khwāwrazm-Shāh (cr. 366-386/ 976-996) was killed, the city Kāth was conquered by the Ma’mūnīd Khwāwrazm-Shāhīds. Because of the political event or, in his words, “the dispute (which) occurred between the two lords of Khwārazm” in the year 385/ 995, Bīrūnī’s observation of the obliquity of the ecliptic in the southern Khwārazm was suspended and the astronomer, seeking for a shelter, asked for a safe-conduct and fled away.⁴⁹⁶ It was only then that Bīrūnī was separated from his master, left for Ray, after a while for Gurgan, where he stayed in the court of the Zīyārīd Qābūs for years and compiled *Al-āthār* there, dedicated it to Qābūs (391/1000), in which he mentioned his master once as “the servant subject to the Caliph of the Muslims” (p. 184), politically meaning that Abū Naṣr was the ruler of a province confirmed by the ‘Abbāsīd caliph. Several years after Abū Naṣr was martyred, in the list of Rāzī’s books prepared by Bīrūnī, he referred again to the master using the same title (p. 39). Now, we should bring into consideration the title “Amīr” Abū Naṣr ‘Irāq and also the fact that the southern part of Khwārazm, especially the eastern side of Oxus had ever been in the fief possession of the Afrīghīd Shahīd dynasty, that is to say, the members of the dynasty were the major landowners and indeed the ancient sons of the Prthian Vispuhrs. We may then come to the conclusion that the overthrown of the dynasty never meant that their inherited lands and fiefs were all taken over.

It appears that after martyr Abū ‘Abdullāh Muḥammad Khwāwrazm-Shāh (386/ 996), who was the son of his father’s uncle, Abū Naṣr ‘Irāq became the deputy of the Shahīd rulers of Khwārazm in the capital Kāth with a limited reign over the fiefs. He was among the

⁴⁹² *Abū Ryaḥān Bīrūnī*, P. Azkai, Tehran, Tarhe No, 1374/ 1995, p. 67.

⁴⁹³ *Dāneshnāme-ye Iran va Eslām*, جزوه 5 (ar. Goldstein), Tehran, 1356/1977, p. 706.

⁴⁹⁴ *Deutsche Mathematics*, 1941, no. 5, pp. 405-446./ *Abū Ryaḥān Bīrūnī*, P. Azkai, Tehran, Tarhe No, 1374/ 1995, p. 64.

⁴⁹⁵ *The Mathematics Teacher*, IV (1962), pp. 286-289./ *Dāneshnāme-ye Iran va Eslām*, جزوه 5, Tehran, 1356/1977, p. 706.

⁴⁹⁶ *Taḥdīd nihāyāt al-amākin* (Pers.), p. 83.

noblemen of the court of the Ma'mūnīd Khwārazm-Shāhīd in Gurgānāj, particularly as a member of the celebrated scholars in the academy of the court. 'Arūḏī Samarqandī says: "Abū al-'abbās Ma'mūn Khwārazm-Shāh had a vizier named Abū al-ḥusain Aḥmad Ibn Muḥammad Suhaylī, philosopher and generous by nature, because of whom learned men had gathered in that court, such as Ibn Sīnā, Abū Sahl Masīhī, Abū al-Khayr Khammār, Abū Rayḥān Bīrūnī, Abū Naṣr 'Irāq... (this one) being a second Ptolemy in mathematics and all its branches, and Abū al-Khayr Khammār was a third Hippocrates or Galen, Abū Rayḥān (was) a substitute of Abū Ma'shar (Balkhī) and Aḥmad Ibn 'Abd al-Jalīlī (Sajzī), and Ibn Sīnā and Abū Sahl Masīhī were the successors of Aristotle in philosophy which includes all sciences. These men were free from want of the worldly riches, always in intimate conversations and enjoying writing together but the time was so mean [...] that the Ghaznavīd Sultan summoned the scientists to his court. Abū Naṣr 'Irāq and Abū Rayḥān become ready to go, but Ibn Sīnā and Abū Sahl Masīhī declined. [...] Abū Naṣr 'Irāq was a painter. [The Sultan] ordered him to draw a painting of Ibn Sīnā on paper... etc".⁴⁹⁷ That is why he has been referred to as Ḥakīm as well.

Regarding the faith of Amīr Ḥakīm Abū Naṣr 'Irāq, a historian faces the same difficulties as in the case of his pupil Abū Rayḥān. We have attempted in chapters eight and nine, to treat the subject thoroughly. Our investigation shows that in that political-social and religious environment, they tried to possibly follow the apparent Islamic rules, yet they kept different beliefs in their hearts. Abū Naṣr 'Irāq believed in the ancient ancestral Zoroastrian or Manichaeism faith. The attribute Ja'dī in his name reveals that sometimes he did not care to conceal his 'zandaqa', in the real sense of the word. Even if we accept that the attribute was given by his opponents, we can still think that it was not of the general type of Ghaznavī accusations of zandaqa and Karmatian beliefs (both taken metaphorically as blasphemy). If certain people still take zandaqa the same as blasphemy, they are following the religion of the Sunnite courts and their dogmatic jurisconsults. Zandaqa, originally zandīgīh, was a branch of the Zurvanite materialistic duration cult and the Manichaeism illumination philosophy which had no hidden element of blasphemy, rather it was overtly the philosophical acquired monotheism. Moreover, as we mentioned about the neo-Mazdakite movement, led by Khurrāzād Khwārazm-Shāhī and also about the Afrīghīd 'buzkā' (*lit.* 'wrongdoer') king, Khwārazm and its neighboring Sogdiana were always among the most important centers of Manichaeism and zandaqa. The free-thinking sages and scientists there, from an Iranian descent, were most likely inclined to such beliefs. The Mu'tazilite school of thinking, as an Islamicized form of the pre-Islamic beliefs, was extensively current there. Contrary to the Isma'īlite tendencies attributed, for instance, to Ibn Sīnā and 'Abd al-ṣamad Ḥakīm and the like, Abū Naṣr 'Irāq had no such tendency: he wrote his treatise *Kashf 'awārī al-bāṭiniya* to refute them and Bīrūnī shared the same idea as well.

As we will explain, after the Ma'mūnīd Khwārazm-Shāhī dynasty of Gurgānāj was overthrown (407/ 1016) and Sultan Maḥmūd Ghaznavī conquered Khwārezm, a great number of the Khwārazm-Shāh's agents, scientists and thinkers were murdered, captivated or made

⁴⁹⁷ *Chahār Maqāla*, (ed.) Qazvini, be kooshesh-e Mohammad Mo'in, Tehran, 1333/ 1954, pp. 118-120.

flee. That flourished center of science and philosophy was completely destroyed and the story of the martyrdom of Amīr Abū Naṣr 'Irāq was an episode of the catastrophe. The detailed report of the disaster was written by the historian of Kh̲wārazm, Imām Ḥāfiẓ "Ibn Arsalān" (492-586/ 1098-1190) the book of whom is lost today, but Tāj al-dīn Subkī (8th/ 15th century) who had direct access to *The History of Khwarazm* while compiling his own book *Ṭabaqāt shāfi'īya* (*The Shafiite Classes*), briefly refers to how Abū Naṣr was martyred and this is the only invaluable report we have of the event. Subkī's report can be summarized as the following: "Amīr Abū Naṣr Maṣṣūr Ibn 'Alī Ibn 'Irāq Ja'dī lived in a tall palace in a village named Maṣṣūra near the gate of the city Kh̲wārazm. The people living in the surrounding were wealthy and prosperous because of the trade of the sesame seed oil and always enjoyed the favors of Abū Naṣr 'Irāq who helped them with their business. When Maḥmūd Ghaznavī arrived (408/ 1017), he warmly welcomed the Sultan and his army, but the Sultan accused him of 'disbelief': The great Sultan could see no mosque in the village. When he left for Gurgānaj (Jurjānyā), he had Abū Naṣr, among other accused ones, hung. This happened in the year 408/ 1017".⁴⁹⁸ We should add that, having arrived in Gurgānaj and conquered Kh̲wārazm, the Sultan seized the other master of Abū Rayḥān in the field of philosophy and rational sciences, Ḥakīm 'Abd al-ṣamad Ibn 'Abd al-'awwal too under the accusation of being a Karmatian (blasphemous Shiite) and killed him; he even intended to let Bīrūnī join his master over the same accusation, but, in Yāqūt Ḥamavī's words, "death's looseness happened to befriend and saved him from murder for some reason".⁴⁹⁹

Historians and researchers commonly held that almost the ultimate reason for all those murders and plunders in India by Maḥmūd Ghaznavī was to gain lands and properties. So, he always had all sorts of accusations of blasphemy, zandaqa and Karmatian beliefs to threaten people. Yet, in the case of Abū Naṣr 'Irāq, political reasons might also be involved: After the overthrown of the Ma'mūn Kh̲wārazm-Shāh's government, it might have seemed no good policy to preserve a small Shāhid fief sovereign. The date of Abū Naṣr 'Irāq's death has been a matter of controversy and mistakes, including the year 427/ 1035 mentioned by the editor of *The Treatises of Abū Naṣr*, or the year 430/ 1038 by Bruckelmann. In an article under the title *Ab Nasr Ibn Iraq and the Date of His Death*, relying on the single historical report of Tāj al-dīn Subkī, the late professor Muḥammad Shāfi' Lāhūrī very well showed that the (more) correct date of his martyrdom must be the year 408/ 1017. Then, concerning the attribute Ja'dī as mentioned by Subkī based on the report of Ibn 'Arsalān Kh̲wārazmī, Muḥammad Shāfi' proposed three possibilities: (1) an attribution to Ja'da, the name of some clan; (2) an attribution to al-ja'd, possibly an ancestral name and (3) an attribution to Al-Ja'd Ibn Dirham, the Manichaean zandīq, after whom was the name of the cult of Al-Ja'dī. The first two possibilities do not seem to be relevant to Abū Naṣr 'Irāq and are not reported about the names and the biography of the Afīghīds. However, the third possibility can confirm his

⁴⁹⁸*Ṭabaqāt al-shāfi'īya al-kubrā*, Egypt, vol. 4, p. 306; Beirut, vol. 7, pp. 290-291.

⁴⁹⁹Mu'jam al-udabā', vol. 17, p. 186./ *Abū Rayḥān Bīrūnī*, P. Azkai, Tehran, Tarhe No, 1374/ 1995, p. 18.

disbelief and blasphemy accusation by the Ghaznavīd Sultan -the attribution which can reveal his Manichaean faith.⁵⁰⁰

Al-ja'd Bin Dirham was one of the heads of the Manichaeans at the time of the 'Umayyad dynasty and a client of them at the time of the last 'Umayyad caliph Marwān Ibn Muḥammad (127-132/ 744-749), famous as the Ja'dī Marwān, after the name of his teacher, Ja'd Ibn Dirham. Accused of zandaqa, Ja'd Ibn Dirham was imprisoned for quite a long time in Kufa by Hishām Ibn 'Abd al-malik (71-125/ 690-742) and then his governor of Iraq, Khālīd Ibn Abdullāh Qasrī (105-120/ 723-737) killed him for the sacrificial sheep at the Islamic festive of Aḍḥā. Ja'd was the first one who considered Quran as created, that is, the same Mu'tazilite belief and at the time of the Abbasid caliph, Manṣūr, the number of his followers began to grow rapidly. The more they were assassinated, they increased in multitude. It is believed that the followers of Bābak Khurram Dīn date back to the Ja'dī zandīqs.⁵⁰¹ Accordingly, as Mohammad Shafī'suggested, Abū Naṣr 'Irāq was not a simple Mu'tazilite, rather a distinguished zandīq. Generally speaking, it has been for long believed that an adept scholar will inevitably be zandīq. We have testified the truth of the statement that Iranian sages, all martyred, from Buzurgmehr on, refused to follow the dominant preferred doctrine of the rulers, and chose to follow the dark Manichaean Zurvanite mysticism each in a way. It is true that the Iranian intelligent thinkers have either been zandīqs or had a tendency towards zandaqa.⁵⁰²

⁵⁰⁰ZEKI VELIDI TOGAN'A ARMAĞAN (symbolae in honorem Z. V. Togan), Istanbul, 1950-1995, pp. 484-490.

⁵⁰¹Mānī va dīn-e ū, Taqī Zade, (ed.) Afshar Shrazi, Tehran, 1335/1956, pp. 163, 289, 342.

⁵⁰²Fihrist ma qabl-e al-fihrist, P. Azkai, Mashad, Astan-e qods-e razavi, 1375/1996, p. 120.

