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## Al-Biruni: A Great Muslim Scientist, Philosopher and Historian (973 – 1050 Ad)

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Abu Raihan Muhammad bin Ahmad, Al-Biruni was born in the suburb of Kath, capital of Khwarizmi (the region of the Amu Darya delta) Kingdom, in the territory of modern Khiva, on 4 September 973 AD.<sup>1</sup> He learnt astronomy and mathematics from his teacher Abu Nasr Mansur, a member of the family then ruling at Kath. Al-Biruni made several observations with a meridian ring at Kath in his youth. In 995 Jurjani ruler attacked Kath and drove Al-Biruni into exile in Ray in Iran where he remained for some time and exchanged his observations with Al-Khujandi, famous astronomer which he later discussed in his work *Tahdid*. In 997 Al-Biruni returned to Kath, where he observed a lunar eclipse that Abu al-Wafa observed in Baghdad, on the basis of which he observed time difference between Kath and Baghdad. In the next few years he visited the Samanid court at Bukhara and Ispahan of Gilan and collected a lot of information for his research work.

In 1004 he was back with Jurjania ruler and served as a chief diplomat and a spokesman of the court of Khwarism. But in Spring and Summer of 1017 when Sultan Mahmud of Ghazna conquered Khiva he brought Al-Biruni, along with a host of other scholars and philosophers, to Ghazna. Al-Biruni was then sent to the region near Kabul where he established his observatory.<sup>2</sup> Later he was deputed to the study of religion and people of Kabul, Peshawar, and Punjab, Sindh, Baluchistan and other areas of Pakistan and India under the protection of an army regiment. During this he learnt local languages including Sanskrit.<sup>3</sup> He was already well versed with Greek, Arabic, Persian, Turkish languages. On the basis of command over these languages he made himself aware of the literature in these languages. By his extraordinary skill he wrote about 180 books

in Arabic and Persian languages, of which few have survived the test of time. After the death of Sultan Mahmud in 1030, he completed his *Kitab al-Hind*, a compendium on the history, religion and thought of the people of Pakistan and India. During the rule of Sultan Masud, son of Mahmud, he completed his *Qanoon-i-Masudi* and translated a number of works from Sanskrit to Arabic. Sultan Masud honored him a lot. He died in 1050 in Ghazni.

Al-Biruni emerged as a famous scholar of Central Asia, Pakistan and India. He was a prolific writer. His writings covered the areas of history, philosophy, society, culture, astronomy, mathematics, geography and other areas.<sup>4</sup> In this paper not only the importance of his contribution towards human knowledge is discussed but a summary of his most important works is also presented. This will also show his importance as a scholar who was well versant with the chief languages of the time but contributed to the existing knowledge and literature with new scientific discoveries hitherto unknown to the world. All through his writings there is much of the modern spirit and method of critical research and in this respect he represents a great phenomenon in the history of Eastern learning and literature.

The fourth and fifth century of the hijra calendar represent a turning point in the history of Islam in all respects.<sup>5</sup> It was because of the efforts of the scholars like Al-Biruni whose contributions brought new ideas and observations in the thought of Muslims not only in Central Asia, Pakistan and Iran but in the Arab, North African and Spanish lands. These areas emerged as centers of great learning due to the efforts of such scholars, but, in keeping with the size of this paper, our effort will be confined to the contribution of Al-Biruni.

Although all of his works are important but for want of space I will make mention of some of them so that we can summarily assess the contribution of the great scholar. In his *Chronicle of Khwarism* he has tried to record all the traditions relating to heritage of his native country and specifically the history of those events which he himself witnessed. This work appears to have been lost but an extract of this can be found in Al-Baihaki's chronicle of the royal house of Sultan Mahmud which was made available by the late W.H.Morley (*Bibliotheca Indica*, Calcutta,

1862, pp. 834 &c.).<sup>6</sup> When he engaged himself with the Indian and Pakistani studies by going through travel and learning in these areas specially the areas of present Pakistan where at that time Sanskrit was prevalent and he met Hindu Pandits and Buddhists and remained with them for more than a decade, it added to his researches on mathematics, astronomy, geography, chronology and natural sciences including natural resources and jewels. All these experiences he compiled and expressed in his *Kitab-al-Hind* in which he discusses the geography, history, language, literature, manners, and customs of the Hindus and the local people of these two countries.<sup>7</sup>

Sultan Masud succeeded Sultan Mahmud after the latter's death in 1030 AD and continued to rule until his death in 1041 AD. Sultan Masud gave him special place in the empire. Al-Beruni also dedicated his work to his master titled *Al-Qanoon al-Masudi* (published from Hyderabad (Dn) in 1954-56, 3 vols.).<sup>8</sup> Sultan Masud became so happy with this that he offered Al-Biruni an elephant-load of silver pieces for this accomplishment, but he refused this gift on the plea that the Sultan was already very kind to him.<sup>9</sup> There is another story about this and that is when "an elephant-load of silver, which, however, he returned to the Royal Treasury, "a proceeding contrary to human nature", according to the testimony of Shahrazuri.<sup>10</sup> Therefore, he did not need any extra favour. Despite this, Al-Biruni continued to enjoy full benefits from the Sultan in order to carry further his scientific and literary research.<sup>11</sup> After his death when Maudud, son of Masud, became Sultan in 1041 AD Al-Biruni completed his work on mineralogy known as *Kitab al-Jamahir fi Ma'rifat al-Jawahir*, which was edited by F. Krakow, published from Hyderabad (Dn), 1936.<sup>12</sup> Sultan Maudud ruled up to 1049 AD. The last work accomplished by Al-Biruni was *Kitab al-Sadala fi'l Tibb*, on medicinal drugs towards the close of the regime of Sultan Maudud.<sup>13</sup> The death date of Al-Biruni is 440 AH but while fixing it there is a variation of its being either (according to the solar calendar) 1048 or 1050.<sup>14</sup>

Total numbers of Al-Biruni's publications or the works, as already mentioned, are 180. Of these 103 were published in his own lifetime, 12 were completed after his death in his name by Abu Nasr, 12 by Abuy Sahl and one by Abu Ali al-Hasan b. Ali Djili, thus making a total of 138, but taking into account all his

later works the total number of his works comes to 180.<sup>15</sup> Apart from the works referred to above, four mathematical and astronomical works have been published in Hyderabad (Dn) in 1948 in a single volume titled *Rasa'il al-Biruni*. Another volume was separately published from Hyderabad in the same year titled *Rasa'il Abu Nasr ila al-Biruni* which comprises 15 mathematical and astronomical treatises of Al-Biruni edited by Abu Nasr.<sup>16</sup> There are twenty others published in different parts of the world.<sup>17</sup> Al-Biruni's *Ghurra al-Zijat or Karana Tilaka*, a handbook of astronomy translated from the original Arabic was published by Dr. N.A. Baloch in 1973.<sup>18</sup> As explained by Dr. Baloch in his preface to this work the two photo copies of the manuscript were secured through the good office of late Kazi Ahmad Mian Akhtar of Junagadh, Professor of History at the University which was translated into English by Mr. Fazluddin Qureshi, a teacher of Physics Department of the University. It was in 1973 that Qureshi completed its translation, and then published with a preface by Dr. Baloch in October 1973.<sup>19</sup> This work is an Arabic translation of a manuscript in Sanskrit done by Al-Biruni. According to Al-Biruni the word *Zij* or *Ziq* originated in Persian from the word *Zih*, i.e. the bow string which in its setting signified a measure of chord. In case of Indian works (*Zij al-Hind*) every *Zij* often dealt with the subject of 'Eclipses'. In his *Qanoon al-Masudi*, Al-Biruni differentiates between the two main categories of the Hindu astronomical works, by using the different terminology of *Sidhanta and Zijat*. Therefore, he refers to about a dozen works of *Zijat* category in the Greek, Hindu and Muslim traditions. Among the Hindu traditions he specifically mentioned *Zij Khanda-Khadyaka* or *Zij al-Arkanad* or the present work *Zij Karna Tilaka*.<sup>20</sup>

In his introduction to this translation of Al-Biruni's work, Dr. Baloch discusses in detail about the visits of Al-Biruni to a number of cities like Mansura, Uchch, Multan, Lahore, Nandana (near Chakwal), Peshawar and other places and gives extracts from other works of Al-Biruni. Giving extract from *Qanoon al-Masudi*, Baloch quotes: "If the same eclipse is observed in the territories of Sindh and in Spain and its time is recorded at both the places as we have explained, it will become clear from this

that the noon of Sindh is the sunrise of Spain while their (Spaniards) noon is the sunset of Sind".<sup>21</sup>

Al-Biruni's most important and neglected work is *Qanun al-Masudi*, originally written in Arabic and later translated into Persian. In 1866 Russian Orientalist Nicholas de Khanekoff first drew attention of the European scholars towards this scholarly work of Al-Biruni.<sup>22</sup> Although Edward Sachau, the German scholar, translated two important works of Al-Biruni, the *Atharul-Baqiya* and the *Kitabul-Hind* in 1878 and 1887 respectively, but the *Qanun* could not be translated. A proposal in this connection was made by Dr. Ziauddin Ahmed, Vice-Chancellor of the Aligarh Muslim University in April 1913.<sup>23</sup> Finally it was under the supervision of Dr. H.J.J. Winter, a British scholar, that the work was published in original Arabic text in 1954 by Dairatul Maarif al-Osmani, Hyderabad, Deccan, India.<sup>24</sup> M. Nizamuddin was the Chief Editor of this work. This book contains certain theories in the field of physical and mathematical sciences which were later discovered in Europe in 18<sup>th</sup> century.<sup>25</sup> The Daira was able to secure help from a number of scholars including Maulana Sayyid Zainul Abidin, Prof. Khwaja Mohi'uddin of the Department of Mathematic, of Osmani University to complete this task.<sup>26</sup> Syed Hasan Barani has summarized this work in English which has been published as an Introductory Discourse to this Arabic text.<sup>27</sup>

This work was started by Al-Biruni in 421 A.H./1035 A.D. and completed in 427 A.H./1035 A.D.<sup>28</sup> Al-Biruni possessed "all the well known books on Astronomy written within the area extending from the Mediterranean Sea to the Bay of Bengal" which included all the Greek, Indian and Muslim authors including those of Spain and Egypt.<sup>29</sup> The *Qanun al Masudi*, as a matter of fact, is not only a compendium of almost all of his works, but it also summarizes almost all scientific achievements in the field of astronomy and mathematic preceding Al-Biruni's times. He is very generous in acknowledging the achievements of other scientist.<sup>30</sup> Thus *al-Qanun* is an "up-to-date Encyclopedia of Astronomy supplanting all previous works ranging from Ptolemy's *al Magest* to *al-Magestiu'sh-Shahi* of his own teacher Abu Nasr."<sup>31</sup> Various chapters of this monumental work have been devoted to his theory of the Universe, Cosmogony, Geo-Centric Theory, Calendars and Chronology,

Trigonometry, Obliquity of the Ecliptic, his prediction on the existence of the American continents beyond the Western Seas, General Picture of the World, Measurement of the Earth, Tables of Longitudes and Latitudes, map of India, Afghanistan and Pakistan by showing distances between various cities such as Ghazna, Kabul, Lamghan, Peshawar, Jehlum, Nandna, Lahore, Multan, Sialkot, Somnath, Qanoj, Bombay, Daibal (a place near modern Karachi), Allahabad. For measurement *farsang* was used which is equal to British  $3\frac{3}{4}$  miles. The other aspects covered in the *al-Qanun* are Motion of the Sun, Length of the Solar Year, Length of Lunar Year, Physical Nature of the Sun, Fixed Stars, Movements of the Stars, Various kinds of Stars, Distance of the Sun from the Earth, Distance and Magnitudes of various Stars from the Earth. The Planets, Eclipse and the appearance of the New Moon, Dawn and Sunset, Theory and Practice of Astrology, etc. Despite these descriptions, Hasan Barani writes: "In al-Biruni's case a still wider knowledge of the sciences, languages and history would be necessary, besides the fact that he is rather a difficult writer who, while on his part does everything to furnish the required proofs, demands of the same time an extremely careful and exacting devotion to his work, specially in this one intended for the most advanced scholars".<sup>32</sup> Hasan Barani also observed that Al-Biruni's "firm belief in the laws of nature, his insistence on continuous observations and collection of reliable data and the successful application of all these principles, mark him out as one of the greatest exponents of the true scientific method".<sup>33</sup> Some of the extracts of his theories are given here.

### Length of the Solar Year

"Hipparchus and Ptolemy had found the length of the Tropical year to be 365 days 5 hours and about 56 minutes. Continuous observations by the Muslim Astronomers from the days of Al-Mamun had shown that the length of the year was really much less. Observations at Damascus found it as 365 days 5 hours and 46 minutes, and the same were confirmed by Yahya bin Abi Mansur in his observations at Baghdad, but his earlier observations had shown it as 365 days 5 hours and 54 minutes.

"Al-Biruni tells us that Al-Mamun was very keen to measure the correct length of the Tropical year, and for that purpose set

up an iron pillar at Dair Marwan in Damascus, but after comparing its measurements was surprised to find out that the pillars had decreased to the extent of barley's length during intervening night. Consequently he almost despaired of ascertaining the true length of the year with the help of the available instruments. Commenting on this episode al-Biruni remarks that a single individual's life – nay, even the lives of several generations put together are not sufficiently long as compared with the requirements of such matters. This, on the other hand, should be a sufficient warning to an individual against constituting himself the sole authority on the basis of his own observations only. It is, therefore, necessary that the process of observation should continue over many generations, one passing the work to the other (p. 637).

Al-Battani's researches had resulted in establishing the solar year as consisting of 365 days 5 hours 46 minutes and 24 seconds. But the subject engaged the attention of other Muslim Astronomers also and eventually al-Biruni undertook to solve it for his own satisfaction. After complicated researches based on his repeated observations as well as those of his predecessors, of which he had rendered a detailed account from the days of Hipparchus and Ptolemy, he found the length of the year 365 days 5 hours, 46 minutes and between 46 and 47 seconds (or 47 seconds as he puts it in *At-Tafhim*).<sup>34</sup>

In an article on the Jalali Calendar, based on the results of the Muslim Astronomers including Omar Khaiyyam (published in *Islamic Culture*, Hyderabad Deccan, 1943, pp. 166-175) an effort has been made to have dealt with the researches of the Muslim Astronomer for determining the correct value, which soon after al-Biruni eventually led to the best reformed calendar of Jalaluddin Malikshah Solicit. It appears that his Astronomers found the length of the year as 365 days 5 hours and 49 minutes, which most nearly approximates to the true length of the mean Tropical year according to the modern researches, i.e. 365 days 5 hours, 48 minutes and 47 ½ seconds.

“It is, however, still a moot question whether the length of the year has always been constant or has been gradually increasing progressively. But for the specialist's al-Biruni's careful researches and observations may yet serve as a useful record.”<sup>35</sup>

### Dawn and Sunset

This subject also enjoyed sufficient importance with the Muslim scientists, as the two phenomena helped in determining the times for some prayers, and fasting. We know that the greatest Muslim writer on Optics, Ibn-ul-Haitham, determined that the twilight begins or ceases when the sun is 19 degrees below the horizon, and attempted thereby also to measure the height of the atmosphere. In Chapter XIII of VIII Maqala al-Biruni deals with the subject, and it is remarkable that he was cognizant of still better results, for he informs us that both these phenomena occurred when the Sun was 18 degrees below the horizon. He adds that some people determined it as 17 degrees. The former result corresponds exactly with the best modern researches. Evidently both the results, slightly different from Ibn-ul-Hatham's, are based on independent researches. We know that Optics was one of al-Biruni's favorite subjects in which he left some original researches of his own. It is a pity that none of his books on this subject are available now, although at least one of them *al-Lam'at*, was known and utilized in India by the author of *Jami'-i-Bahadur Khani*, an Encyclopedia of Mathematics, produced in the beginning of the last century.<sup>36</sup>

### His General Picture of the World

General picture of the world as presented by al-Biruni is remarkably accurate. He tell us that the length of the inhabited world is greater than its breadth. It is surrounded by the seas on all its sides, and the various occasions in the North, East, West and South all combine at different points. In the North, his limits are set by the habitations of the Suwars, Bulgars, Russians, Slavs and Azovs, in the West by the northern regions in Africa, Spain, France and some other parts and unknown lands, and then the coldest regions unsuited for habitation. In the South, except the groups of East Indies Islands and Ceylon and a few others, he admits nothing much is known of the lands or people from the sailors in those parts. In the East, China forms his terminus, although as mentioned above, he very mch believed in the existence for the regions (e.g. Japan ) laying in the Far Eastern ocean as in the West.<sup>37</sup>



## Existence of the American Continents beyond the Western Seas

It is indeed most remarkable that he goes still further in his *at-Tahdid* by asserting that land must exist beyond the seas between the Western and Eastern coast lines of the known world, thus anticipating the discovery of the American Continents in the Western hemisphere. These regions are supposed to exist beyond the known remaining regions of the world surrounded by waters on all sides.<sup>38</sup>

## Calendars and Chronology

Al-Biruni points out that the beginning of the Muslim era of *al-Hijra* corresponded with the first of Ramazan according to the pre-Islamic calendar. He calculates that exactly 3472 days had elapsed between *al-Hijrah* and Yezdgerd. He informs us that the ancient Arabs had learnt the system of inter-collation from the Jews of Yathrab some 200 years before the Prophet's migration to Medina, and the pilgrimage of Mecca as well as the marketing days and festivals fell in fixed seasons. In the year of the Prophet's migration, the pilgrimage fell in *Sha'ban*, and so the Prophet did not like to perform it and restored it to its ancient position after the conquest of Mecca. It is also noteworthy that according to al-Biruni, the Prophet died on the 8<sup>th</sup> of *Rabi'ul Awwal*, and not on the 12<sup>th</sup> as it is generally believed now. He calculated that nine years, eleven months and twenty days had elapsed since the date of his migration.

Very valuable and curious information may be gleaned from this part of the book by those interested in the history of ancient Persians, Jews and Christians living in the Muslim lands in al-Biruni's time. For instance, he points out that the Jews and Christians very much differed amongst themselves in reckoning the date of Adam's birth. He, on his part, wrote that it was not possible to assign any exact date for the remote events for which no reliable reports were available (p. 145). On the other hand like our modern Geologists, he believed that very long periods of time were needed to account for the past history of the Earth.<sup>39</sup>

### Al-Biruni's Theory of the Universe

Al-Biruni had some ideas very strikingly similar to those of Einstein and other modern scientists regarding the Universe as a whole. Like them he considered it to be situated on the outermost surface of a limited sphere. Like Einstein he also rejected the idea of the universal gravitation as an actual force on the ground of its being altogether opposed to experience. Further, Al-Biruni considered that 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. Therefore he is very much in agreement with Einstein, who held that curvature of the space-time in the neighbourhood of the Sun causes the planets to describe eclipses, whereas if all the masses were infinitely removed they would describe straight lines. It goes to the credit of Al-Biruni that he advanced his ideas on the universe much ahead of the modern European scientists but it is a pity that most of his relevant works have not survived. May be in future they may be discovered.<sup>40</sup>

All these aspects go to establish him as a great scholar of his times who not only evaluated all the available knowledge on the issues under discussion, but contributed further by his experience and laborious works especially by establishing laboratories in a number of places in Khawarism, Ghazna, Kabul, Nandana (in present Pakistan), and other places in the present countries of Pakistan, Afghanistan, Uzbekistan, Turkmenistan and Iran. Thus Al-Biruni belongs to be a common heritage to the people of these countries in Central and South Asia.

### Notes and References

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