

## Muhammad al-Biruni

Starting around 750 A.D. science flourished under the caliphs of Baghdad, and over the next 600 years its influence gradually spread as far west as Spain and eastwards into Central Asia. The early scholars translated existing Greek, Indian and Persian texts into Arabic, and in the process accumulated the largest body of scientific knowledge anywhere in the world. One of the most learned Central Asian scientists



and scholars was **Abu Raihan Muhammad al-Biruni** (973 – 1048), an outstanding astronomer, astrologer, mathematician, physicist, physician, geographer, geologist, historian, and indefatigable traveler. Conversant in Turkish, Persian, Sanskrit, Hebrew and Arabic, he became the most important interpreter of Indian science to Islam. His many scientific achievements include: pioneering the notion that the speed of light is much greater than the speed of sound, disputing the European Ptolemaic view that Africa stretched infinitely to the South, insisting it was surrounded by water, advancing the controversial but correct view that the Indus valley was once a sea basin, and explaining natural springs by the laws of hydrostatics.

Al-Biruni was born at Kath in Khwarazm (now Uzbekistan). He studied with the renowned astronomer and mathematician Abu Nasr Mansur, a prince of the ruling Banu Iraq. Al-Biruni's knowledge of several languages allowed him to understand existing ideas and bring a fresh and original approach to his own work. At 17 he computed the latitude of Kath by observing the maximum altitude of the sun. Before the year 995, he had written several short works. One that survived is *Cartography*, a work on map projections. He regularly corresponded with his contemporary, the famous physician Ibn Sina,

better known to the West as Avicenna, who reconciled Greek learning with Muslim thought with his translation of Euclid into Arabic.

At the end of the 10<sup>th</sup> century and the beginning of the 11<sup>th</sup> century there were numerous civil wars in the region where al-Biruni lived. In 995 the rule of the Banu Iraq was overthrown in a coup that forced al-Biruni to flee the region, but to where is not quite clear. Some theorize by analyzing his writings that he then went to the city of Rayy, near the present day Tehran, where he had no patron and lived in poverty. It is known he returned to his homeland by June 4, 1004, which then was ruled successively by brothers Ali ibn Ma'mun and Abu'l Abbas Ma'mun, because he described an eclipse of the moon from Jurjaniyya, a major city of . provided generous support for al-Biruni's scientific work, carried out in collaboration with his teacher Abu Nasr Mansur, but at the cost of not being free to leave. By 1017 Sultan Mahmud of Ghazni (in Afghanistan) conquered Abu'l Abbas Ma'mum's kingdom even though both Abu'l and his brother had married Mahmud's sisters.

This political upheaval did not interfere with al-Biruni's research. On the contrary, his scholarship so impressed Mahmud that he took the scholar with him on his military excursions in India. Over a period of 20 years al-Biruni traveled all over the country, learning Hindu philosophy, mathematics, geography and religion from the Pandits, and in turn he taught them Greek and Arabic science and philosophy. His observations of his travels in India are recorded in his book *Kitab al-Hind*. In this work he mentions that he translated two Sanskrit books into Arabic. One, named *Sakaya*, deals with the creation of things and their types, and the second, *Patanjal*, examines what happens after the soul leaves the body.

On returning from India, al-Biruni wrote his famous *Qanun-I Masoodi*, a book in which he discusses several theorems of astronomy, trigonometry, solar, lunar, and planetary motions. Among his other books is the *al-Athar al-Baqia* in which he connects accounts of ancient histories of nations with

known geographical facts. In it he also discusses whether or not the Earth rotates on its axis, and gives the correct longitudes and latitudes of several places. His treatise *Kitab-al-Saidana* contains the then existing Arabic knowledge of Indian medicine. It is estimated that al-Biruni wrote approximately 146 books and articles, with only about a fifth having survived. One of his most important texts is *Shadows*, which covers shadows, gnomonics, the history of the tangent and secant functions, applications of the shadow functions to the astrolabe, shadow observations for the solution of astronomical problems and for the fixing of times for Muslim prayers. In addition, al-Biruni gave a full description of the Hindu positional principle of numeration and proved Heron's formula and Brahmagupta's generalization. In physics he studied specific gravity and the causes of artesian wells.

In *Kitab-al-Jamahir*, al-Biruni became the first to determine the hardness of minerals and their specific weights. He described the ratios between the densities of gold, mercury, lead, silver, bronze, copper, brass, iron and tin. He displayed his results as combinations of integers and numbers of the form  $1/n$ , with  $n = 2, 3, 4, \dots, 10$ . He was the first to see gas-liquid inclusions in gems – ancient fluids that took part in the formation of mountain crystals, topaz, amethysts, sapphires, ambers, and other minerals. He was also an astrologer who astonished people with the accuracy of his predictions. In *Kitab al tafhim li awa'il sina'at al tanjim* (“Book of Instructions in the Elements of the Art of Astrology”), also known as the *Tafhim*, al-Biruni followed a logical progression from first principles, beginning with geometry, then arithmetic, astronomy, geography, chronology and a discussion of the astrolabe before reaching his introduction to astrology. He described the general characteristics of the “planets,” Saturn, Jupiter, Mars, the Sun, Venus, Mercury, and the Moon and describes their role in determining people's actions and professions, their bodies and diseases, animals, vegetables & minerals. As an illustration, he claimed Saturn rules farming, grave-digging, captivity, fathers, slaves, wicked people, hair, skin, bones, old age, sickness, poverty, death, horses, olive trees, almonds, hard stones, lead, pepper, sleep, and poisons. These are only a small sampling of those things ruled by Saturn, and in a like manner the other

six “planets” rule as many things. Al-Biruni died at the age of 75, having spent 40 years gathering knowledge and significantly contributing to its growth.

**Quotation of the Day:** “My experience in the study of astronomy and geometry and experiments in physics revealed to me that there must be a Planning Mind of Unlimited Power. My discoveries in Astronomy showed that there are fantastic intricacies in the universe which prove that there is a creative system and a meticulous control that cannot be explained through sheer physical and material causes.” – Abu al-Biruni