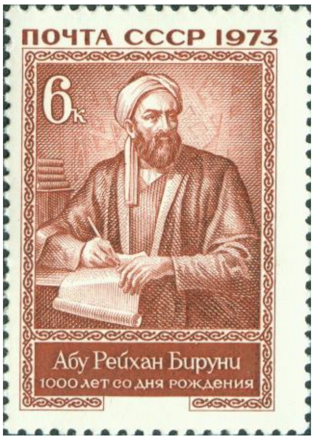
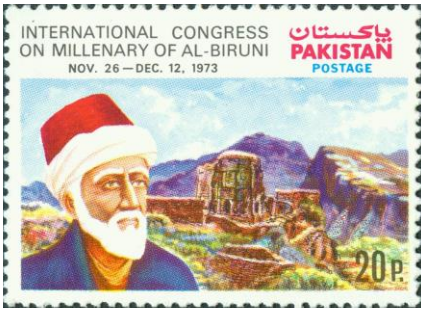
ABU ARRAYHAN AL-BIRUNI (973 – 1048)

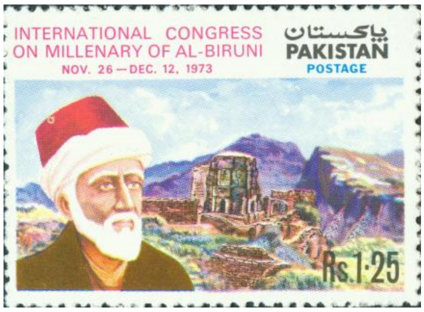
by HEINZ KLAUS STRICK, Germany



As the thousandth anniversary of AL-BIRUNI's birth approached in 1973, several states claimed the right to hold jubilee events to mark the occasion – the Soviet Union, because AL-BIRUNI was born in a place south of the Aral Sea that now belongs to Uzbekistan (one of the Soviet Union's Asian republics in 1973); Iran, because his mother tongue was Persian; and Afghanistan, because he lived in that region for a long time and died there. Arab states also celebrated the polymath, because the majority of his 146 works with a total of 13,000 pages were written in Arabic.

Nothing is known about AL-BIRUNI's origins; the first hint of his forthcoming career as a scholar is given in a publication from the year 990: the 17-year-old determined the latitude of his hometown Kath (today it bears the name Biruni) by finding the maximum of the daily peaks of the sun. His teacher and patron was ABU NASR MANSUR, a mathematician and astronomer who belongs to the ruling family. In 995 AL-BIRUNI had already published several works, but then a civil war interrupted his work.

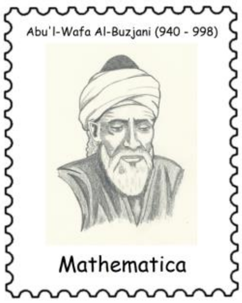




AL-BIRUNI had to flee his homeland, stayed for some time near present-day Tehran, and lived in great poverty for a time. Information about his whereabouts can be reconstructed from astronomical events such as solar and lunar eclipses, during which he took measurements, evaluated and published them.

For example, he could determine the difference in the geographic longitudes of the two observation sites from the data determined by ABU'L-WAFA during a lunar eclipse in Baghdad and his own measurements.

The now famous scholar compiled an overview of the calendars used in different countries so that the observations of astronomical events could be compared with each other. In 1004 he returned to his homeland and, together with ABU NASR MANSUR, made further astronomical observations.



(drawing © Andreas Strick)

When, in 1017, Abu'l Abbas Ma'mun, the powerful ruler of Ghazna (today: Afghanistan), also annexed the territories south of the Aral Sea, the two were taken as prisoners to the regent's capital. Al-Biruni later complained about how little support they received from the ruler. Although the ruler allowed them to conduct research, they were forced – as prisoners of the regent – to accompany him everywhere so that they were always available to him as advisers.

In 1022, Abu'l Abbas Ma'mun began the conquest of India, especially the areas that belong to today's Pakistan. His troops even reached the Indian Ocean.

Al-Biruni used the campaign in his own way: after his return he wrote an extensive work, *Kitab tarich al-Hind*, in which he dealt with Hinduism in a comparative and never judgemental way, described the caste system and described the geographical conditions of the conquered territories. When he discovered earth formations containing shells and fossils during his excursions in northern India, he concluded that there must once have been a sea there.

He studied the language and writing of the country with particular interest, so that he was able to translate texts from Sanskrit into Arabic. The linguistically gifted polymath even translated texts from Arabic and Greek into Sanskrit, including the *Elements* of Euclid.

He surveyed Indian literature on astronomy and astrology, history and geography, mathematics and medicine. The work, which comprised several volumes, also dealt with the notation for numerals used in India, as well as the units of measurement and weight.

He remained in Ghazna even when the ruler died and his successors finally granted him freedom of movement. Numerous treatises on very different topics followed until the end of his life.

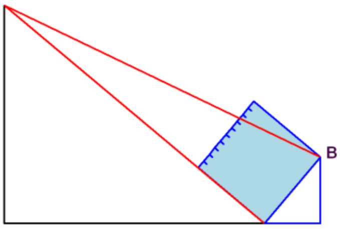
At the age of 22, Al-Biruni had already dealt with the question of the appropriate representation of the spherical earth by plane maps and developed the method of cylindrical projection for this purpose (this was rediscovered by Gerardus Mercator in 1569).

He systematised the methods of land surveying, applying the sine theorem of plane trigonometry as well as that of spherical geometry to determine the distances between places.

Ptolemy and Al-Khwarizmi had already drawn up lists with the coordinates of important cities and geographical points and Al-Biruni verified and completed them.

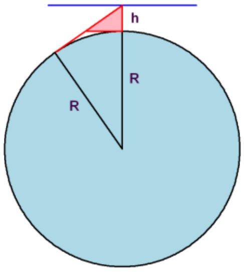
In addition, he gave the direction to Mecca (*Quibla*) for all places, which was important for Moslem believers.

He determined the height of mountains using the following method:



A square board is placed vertically on one of the corners and fixed in such a way that the lower edge is aligned with the top of the mountain. From point B, the top of the mountain is also aimed at; from the position of the mark made on the opposite side of the square, the height of the mountain can then be calculated using the intercept theorem.

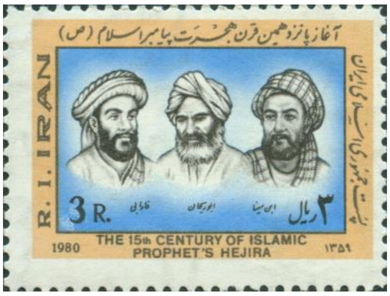
From the knowledge of the mountain's height *h*, Al-Biruni determined the earth's radius *R*:



From the mountain peak, he measured the angle of inclination between the "astronomical horizon" (perpendicular to the plumb line to the earth's centre) and the "true horizon" (tangent to the earth's sphere) and then, step by step, he calculated the distances in the figure shown and obtains a value of 6340 km as the earth's radius. (The true distance is actually: 6378 km.)

Al-Biruni came to the conclusion that the available measurement results offered no possibility of deciding whether the geocentric or the heliocentric world model was correct. He criticised Ptolemy for publishing only those observation data that fitted his theory, but on the other hand, he also pointed out possible errors in his own measurements and calculations, because he alone considered this to be scientifically justifiable.

He also took issue with some of the teachings of Aristotle advocated by his contemporary Ibn Sina (also known as Avicenna in Europe). Above all, he criticised the latter's "philosophical method" of positing theories without empirical verification. (The Iranian stamp on the left shows the philosopher Al-Farabi as well as Al-Biruni and Ibn Sina).



The polymath carried out measurements of the speed of light and sound, determined the density of various substances with the help of a pycnometer he had invented and compiled a list of the effects of 720 medicinal plants (including the names in Arabic, Greek, Persian, Syriac and an Indian language), which were used for centuries afterwards.

First published 2010 by Spektrum der Wissenschaft Verlagsgesellschaft Heidelberg

https://www.spektrum.de/wissen/abu-arrayhan-al-biruni-973-1048/1036358

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