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Millenary of
Abū Raihān Muhammad Ibn Ahmad Al-Birūni

AL-BIRUNI AS A MATHEMATICIAN

by

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In this paper we are going to consider Abu Raihan Muhammad ibn Ahmad al-Biruni as a mathematician. The term mathematician applies to any person who is a serious student of mathematics. That al-Biruni was a serious student of mathematics is evident from his books on mathematics and astronomy. Even his travel books contain an account of the new mathematics that he came across in India.

When al-Biruni entered India, he probably had a good knowledge of Indian mathematics, astronomy and chronology, acquired by the study of Brahmagupta and his Arabian editors. In India al-Biruni recommenced his study of Indian astronomy, this time not from translations, but from Sanskrit originals. Assisted by learned pandits, he tried to translate them. He tried to check his pandits by whatever Sanskrit he had contrived to learn. He also tested the data of the Indian astronomers by calculations. To al-Biruni the Hindus were excellent philosophers, good mathematicians and astronomers.

To al-Biruni we owe the best mediaeval account of Hindu numerals. Before the time of our Holy Prophet (May peace be on him) the Arabs had no numerals. Numbers were written out in words. Later, the numerous computations connected with financial administration over the conquered lands made a short symbolism indispensable. In some localities, the numerals of the more civilized conquered nations were used for a time. Thus, in Syria, the Greek notation was retained; in Egypt, the Coptic. The Diwani-numerals, found in

an Arabic-Persian dictionary, are supposed to be such abbreviations. Gradually it became the practice to employ the 28 Arabic letters of the alphabet for numerals, in analogy to the Greek system. This notation was in turn superseded by the Hindu notation, which quite early was adopted by merchants, and also by writers on arithmetic. Its superiority was generally recognized, except in astronomy, where the alphabetic notation continued to be used. As regards the form of the so called Arabic numerals, the statement of Al-Biruni, who spent many years in India, is of interest. He says that the shape of the numerals, as also of the letters in India, differed in different localities, and that the Arabs selected from various forms the most suitable. There was among people much difference in the use of symbols, especially for those for 5, 6, 7, and 8. The symbols used by the Arabs can be traced back to the tenth century. But most surprising is the fact that symbols of both the East and of the West Arabs deviate so extraordinarily from the Hindu Devanagiri numerals of to-day, and that they resemble much more closely the apices of the Roman writer Boethius. This strange similarity on the one hand, and dissimilarity on the other, is difficult to explain. The most plausible theory is the one of Woepcke: (1) that about the second century after Christ, before the zero had been invented, the Indian numerals were brought to Alexandria, whence they spread to Rome and also to West Africa; (2) that in the eighth century, after the notation in India had been already much modified

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and perfected by the invention of the zero, the Arabs at Baghdad got it from the Hindus; (3) that the Arabs of the West borrowed the zero from those in the East, but retained the old forms of the nine numerals, (4) the old forms were remembered by the West Arabs to be of Indian origin, and were hence called Gubar-numerals; that, since the eighth century, the numerals in India underwent further changes, and assumed the greatly modified forms of the modern Devanagiri-numerals. This is rather a bold theory, but whether true or not, it explains better than any other yet propounded, the relation between the apices, the Gubar, the East Arabic, and Devanagiri numerals.

Al-Biruni composed an astronomical encyclopaedia and a general treatise on mathematics, astronomy, and astrology. He was deterred neither by formidable computations nor by the most difficult geometrical problems of his time, those called after him albrunic problems. He discussed the problems of summation of a geometric progression, trisection of the angle and other problems which cannot be solved with ruler and compass alone. He gave a method for accurate determination of latitudes and longitudes. We are also certain that al-Biruni knew the law of sines in trigonometry.

I regret that due to non-availability of his original work in mathematics, it is not possible to give details of the manner in which he solved different problems. But we give below an appreciation of his work by George Sarton, given in his book, "Introduction to History of Science", page 693.

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"It is because of al-Biruni and ibn-Sina that the first half of eleventh century was one of great excellence distinction in the history of science. These two men, who, by the way knew one another, were extremely different; al-Biruni represents the more adventurous and critical spirit, Ibn Sina the synthetic spirit; al-Biruni was more of a discoverer and in that respect he came nearer to the modern scientific ideal, Ibn Sina was essentially organizer, an encyclopaedist, a philosopher. Both, even the latter, were primarily men of science, and it would be difficult to choose between them but for the accidental fact that al-Biruni life covered more fully the present period and thus may be said to represent it more completely. Ibn Sina was only 20 at the beginning of the century, and his life was untimely cut short in 1037. Al-Biruni's first important work appeared about the year 1000 and he lived until 1048. Thus his time of activity and the first half of the eleventh century are identical period, and we are fully justified (more fully so than in almost every other case) in calling it the time of al-Biruni".

"Al-Biruni appeals to the scientific mind because of his relative freedom from prejudice and of his intellectual curiosity and courage. For example, he was the first Muslim to make a deep study of Hindu philosophy and became the most important link between

the two great provinces of mankind, India and Islam".

"He was a stern judge both of himself and of others. Himself perfectly sincere, it was sincerity which he demanded from others. Whenever he did not understand a subject, or only knew part of it, he would at once tell the reader so, either asking the reader's pardon for his ignorance or promising, though a man of fifty-eight years, to continue his labours and to publish their results in time, as though he were acting under a moral responsibility to the public. He always sharply drew the limits of his knowledge, and although he had only a smattering of the metrical system of the Hindus, he communicated whatever little he knew."

"Judging al-Biruni in relation to his predecessors we come to the conclusion that his work formed a most progress. His description of Hindu philosophy was probably unparalleled. His system of chronology and astronomy was more complete and accurate than had ever before been given."

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