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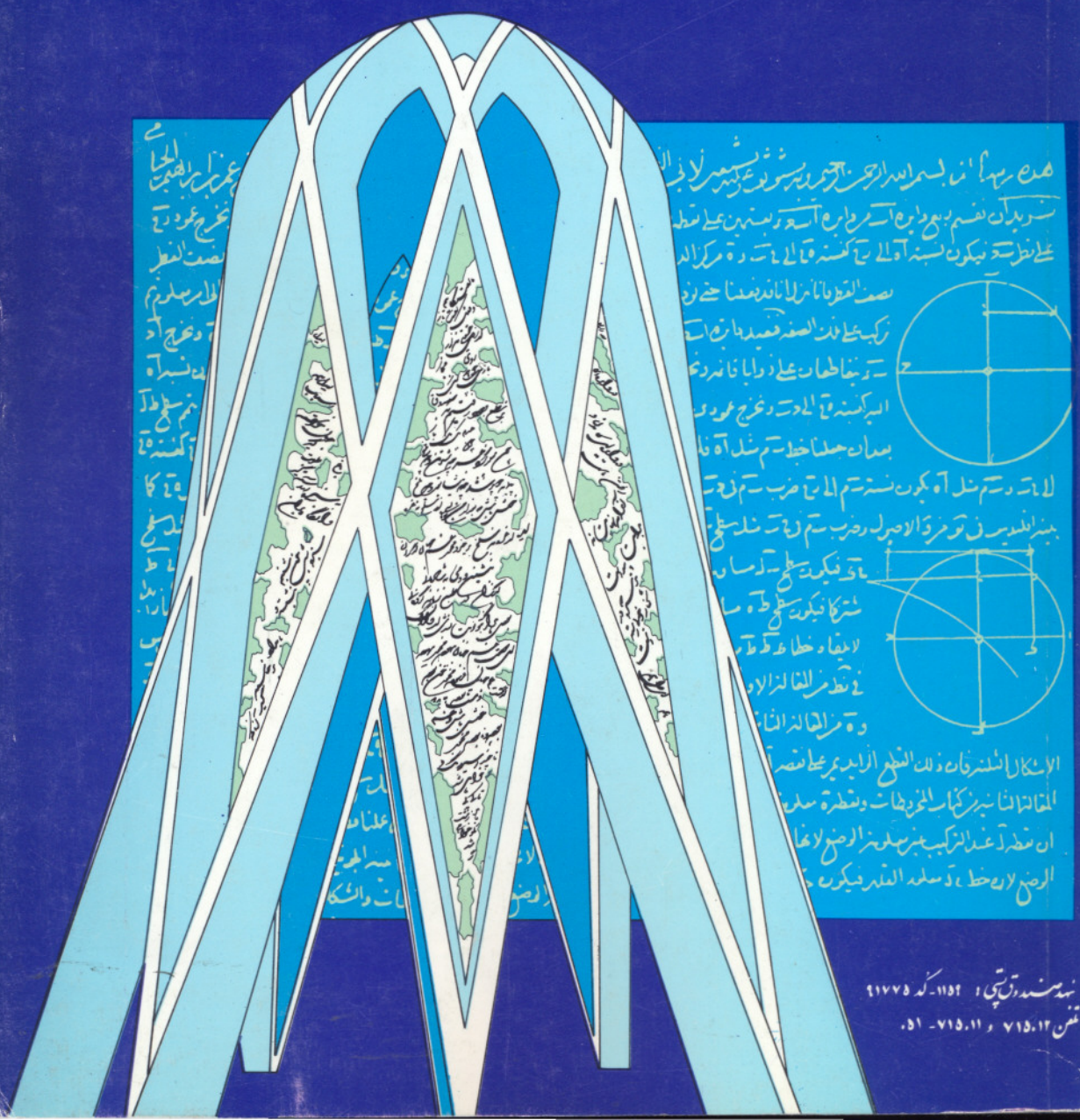

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Omar Khayyām
The Iranian Mathematician, Astronomer, Poet and Philosopher

Mohammad Bagheri
Tehran P.O.Box 1345-1785, Iran

Omar Khayyām was born in the city of Nishābur (in Khorāssān province, north–east of Iran), and flourished in this city, in second half of 11th century. Unfortunately, there is little information about his biography, some of which is doubtful or incorrect. The word "Khayyām" means tent–maker, and possibly this was his father's profession.

It is said that he made several trips inside Iran, and that he was not a flexiable man and didn't like to transfer his knowledge to others. Maybe in fact he was not a pretentious man and didn't like to speak too much, and also was annoyed for the dominant ignorance and fanaticism around him.

He was an expert in mathematics, astronomy, medicine, philosophy, theology and history, but in the books written by his contemporaries there is no reference to his poems. For the first time, about 50 years after his death, Khayyām is mentioned in a list of poets of Kkorassan. Seemingly, the mental atmosphere of his time didn't allow him to present freely his philosophical four–lined Persian poems: "Rubā'iyāt". His philosophical point of view manifested in this classical form of Persian poetry is mainly based on skepticism and perplexity (about purpose of certain and human life), nostalgia for martality, and necessity of making the most pleasurable use of one's passing life. These points of view has evoked many oppositions and criticism against him, in many other author's works. Undoubtedly, his annoyance of this fanaticism and his philosophical sufferings aggravated each other. Maybe his engagement in science was, besides a satisfication of curiosity, seeking a shelter in an ordered intellectual world which at least temporarily kept him from engagement with everybody problems and philosophical sufferings, and calmed his curious mind.

Khayyām passed 18 years of his life in Isfahān (in centeral part of Iran)

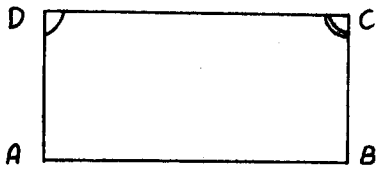
and in this city together with other astronomers made observation and improved the Iranian calendar. The newly devised calendar was named Jalāli or Maleki, after the name of the ruler Jalāl ad-Din Malek Shāh. This calendar was based on solar years and is still a base for the calendar currently used in Iran. It deviates from real solar year only in a rate of 3 days per 10,000 years and is the most accurate calendar ever devised. Khayyām was also skilful in astrology, but he never believed in astrological anticipations.

Khayyām Rubā'iyāt (poems) were translated into English by Fitzgerald (1859) and therefore became known all over the world. His scientific works also have been widely studied and translated into other languages. He wrote in Arabic which was the scientific language "Now ruz-Nāmeh" is about the history of most famous Iranian feast Nowruz (New day) which begins on 21th of March and is the first day of Iranian year. The book also describes the history of pre-Islamic Sassanide dynasty of Iran. His famous work in astronomy was named Zij-a Malek Shāhi. "Zij" is a general name for astronomical books containig astronomical tables and descriptions.

His famous work in mathematics is "The book on Algebra and Muqbila". The original work is in Arabic, and is translated into persian, English and French. Its content has been discussed in several books and articles. In this work, Khayyām for the first time has been classified the first, second and third degree polynomial equations by an elegant scientific method. Historains of science believe that this successful classification is one of the highest apogees, or maybe the highest apogee of mathematics in middle ages. Khayyām explains the geometrical solution of cubic equations and mentions the necessity of solving them by pure numerical method. The latter was done three centuries later by Pierre Cardan.

Another work of Khayyām which is specially important in history of mathematics is "Discussion on problems of the axioms in Euclide's book" in which he speaks about the parallel axiom in Euclide's "Elements". Euclide's Elements was translated into Arabic in early decades of 9th century and influenced the progress of Islamic geometry which was in its maximum flourishment during 9th, 10th, and 11th centuries. The Arabic text of this work is printed in Tehran and Alexandria (Egypt), and its translation into Persian and Russian are also published. The content of this work is discussed in many books and articles. Khayyām in this book tries to prepare a proof for parallel axiom. He starts with another axiom which he assigns it to Aristotle: "If two lines are becoming nearer, they will intersect, and if two lines are becoming farther, they will not have any intersection point on the side where their distance is becoming more." These assumptions are in

fact equivalent to Euclide's parallel axiom. Having accepted this, Khayyām proves that in an isoscelles birectangular quadrangle, the remaining two angles are also right. He first suggests that the two remaining angles ($\hat{C}$ and



D which are equal) are acute, and then suggests the case where they are obtuse, and in both cases,using his mentioned axiom, proves that the assumptions will lead to contradiction. Therefore, he attempts to prove the parallel axiom.

Iranian and Islamic mathematicians continued working on the subject of parallel lines in a period of 5 centuries and their works influenced seriously the later investigations of European mathematicians in this field. In 18th century, an Italian mathematician named Saccheri presented his theory on parallel lines, based on the same isoscelles birectangular quadrangle used by Khayyām.

These assumptions made by Khayyām and other Islamic mathematicians for the angle $\hat{C}$ and $\hat{D}$ being acute or obtuse, are in fact the first theorems of non-Euclidean geometries developed by Lobatchevsky and Riemann. Acute angles and obtuse angles correspond to non-Euclidean geometries of Lobatchevsky and Riemann, respectively. Therefore it is apparent that the works of Khayyām and other Iranian and Islamic mathematicians on the theory of parallel lines have been the main inspiring factor for discovery of non-Euclidean geometries.

Khayyām in another mathematical work named "Treaties on division of circular quadrant", investigates a geometrical problem which leads to a cubic equation, then he solves the cubic equation using conic sections. The original Arabic text of this treatise and also its Persian, English, French and Russian versions are published.

Khayyām also knew the expansion of binomials for natural number exponents, so the triangle of coefficients for bionomial expansion is sometimes called "Khayyām-Pascal triangle".

In any case, for an average Iranian person, Khayyām is first of all the composer of the beautiful and meaningful Rubā'iyat with their philosophical message of making the best use of the passing time.