Omar Khayyam

People

Omar Khayyam, or Ghiyāth al-Dīn Abū al-Fath ʿUmar ibn Ibrāhīm al-Nisābūrī al-Khayyāmī according to Encyclopedia Britannica, was born May 18, 1048 in Neyshābūr (also spelled Nīshāpūr), Iran and died December 4, 1131 also in Neyshābūr, Iran. Neyshābūr is in northeastern Iran.

Omar’s father was Ebrahim Khayyami, a wealthy physician. Omar’s mother’s name is not known. Some authors have written that Omar’s father earned a living making tents because Khayyami means tent-maker. In his early teens Omar worked in his father’s surgery learning about medicine. In 1066 Halley’s comet appeared in the heavens, William the Conqueror’s Norman Army invaded England, and Omar’s father Ebrahim died. A few months after Ebrahim’s death, Omar’s tutor Bahmanyar also died.

Full details of Khayyam’s personal life are not known. He is believed to have married and had at least one son and one daughter.

Math influences: Archimedes, Euclid

Mathematicians influenced/advised: Khayyám has significantly influenced the style and themes of many poets of the nineteenth and twentieth centuries. Praised for its lyrical form and moving insight, the Rubáiyát was imitated by such poets as Alfred, Lord Tennyson and Algernon Charles Swinburne.

Setting

Location: Khayyam was born Neyshābūr, Iran. Then he went to Samarkand, city in Uzbekistan for work. He went to Esfahan, invited by Seljuq sultan Malik-Shāh, to set up an observatory. Later in his life he went to Merv where he completed more mathematical works.

Language: Farsi, also known as Persian Language, is the most widely spoken member of the Iranian branch of the Indo-Iranian languages, a subfamily of the Indo-European languages.

Religion:

Omar’s family were Muslims. His father seems to have been relaxed about religion, employing a mathematician by the name of Bahmanyar bin Marzban, a devotee of the ancient Persian religion of Zoroastrianism, to tutor Omar. Bahmanyar had been a student of the great physician, scientist, and philosopher Avicenna, and he gave Omar a thorough
education in science, philosophy, and mathematics. Khawjah al-Anbari taught Omar astronomy, guiding him through Ptolemy’s Almagest.

Politics:

Khayyam grew up during the political events of the 11th century. The Seljuq Turks were tribes that invaded southwestern Asia in the 11th Century and eventually founded an empire that included Mesopotamia, Syria, Palestine, and most of Iran. The Seljuq occupied the grazing grounds of Khorasan and then, between 1038 and 1040, they conquered all of north-eastern Iran. The Seljuq ruler Toghrïl Beg proclaimed himself sultan at Nishapur in 1038 and entered Baghdad in 1055. It was a difficult unstable military empire, which also had religious problems as it attempted to establish an orthodox Muslim state.

Khayyam himself described the difficulties for men of learning during this period in the introduction to his Treatise on Demonstration of Problems of Algebra:

“I was unable to devote myself to the learning of this algebra and the continued concentration upon it, because of obstacles in the vagaries of time which hindered me; for we have been deprived of all the people of knowledge save for a group, small in number, with many troubles, whose concern in life is to snatch the opportunity, when time is asleep, to devote themselves meanwhile to the investigation and perfection of a science; for the majority of people who imitate philosophers confuse the true with the false, and they do nothing but deceive and pretend knowledge, and they do not use what they know of the sciences except for base and material purposes; and if they see a certain person seeking for the right and preferring the truth, doing his best to refute the false and untrue and leaving aside hypocrisy and deceit, they make a fool of him and mock him.”

Mathematics

Works: Treatise on Demonstration of Problems of Algebra, Problems of Arithmetic, Music of a Distant Drum

Primary research: Philosophy, jurisprudence, history, mathematics, medicine, and astronomy are among the subjects mastered by Omar Khayyam according to the editors of Encyclopedia Britannica.

Claim to fame

Contribution to Algebra:

Khayyam conjectured correctly that it is not possible to solve cubic equations using the traditional Ancient Greek geometrical tools of straightedge and compass.

At the age of 22, in 1070, Khayyam published one of his greatest works: Treatise on Demonstration of Problems of Algebra and Balancing. In it he showed that a cubic equation can have more than one solution. He also showed how the intersections of conic sections
such as parabolas and circles can be utilized to yield geometric solutions of cubic equations.

While Archimedes considered a specific problem a thousand years earlier. Khayyam considered the problem in a more general, methodical way. Khayyam’s solutions avoided negative coefficients and negative roots because negative numbers were not acknowledged in Islamic mathematics. Although Khayyam’s achievement was magnificent, he was personally disappointed that he needed to utilize geometry to solve cubic equations — he had hoped to discover an algorithm using only algebra.

Quote the shows that Khayyam knew that algebra and geometry were linked: “Whoever thinks algebra is a trick in obtaining unknowns has thought it in vain. No attention should be paid to the fact that algebra and geometry are different in appearance. Algebras are geometric facts which are proved by Propositions 5 and 6 of Book 2 of Euclid’s Elements.”

Contribution to Length of a Year:

Khayyam found that 1,029,983 days made 2,820 years. This gives a tropical year length of 365.2422 days to seven significant figures. The average tropical year length quoted today is 365.242189 days. This is exactly what Khayyam measured almost a thousand years ago. Also, he used and accepted Ptolemy’s model of the Universe and the where the Earth is at the center and the moon, the sun and the planets revolved around the Earth.

Contributions to Geometry:

In his book *Explanations of the Difficulties in the Postulates in Euclid’s Elements* he attempted to prove Euclid’s Parallel postulate. Although he only managed to state it in a different way, historians see the first glimmers of non-Euclidean geometry from Khayyam’s ideas.

Contributions to Cubic equations:

Khayyam had came up with two problems:

1. Find a point on a quadrant of a circle in such a manner that when a normal is dropped from the point to one of the bounding radii, the ratio of the normals length to that of the radius equals the ratio of the segments determined by the foot of the normal.

2. Find a right triangle having the property that the hypotenuse equals the sum of one leg plus the altitude on the hypotenuse.

The first problem is equivalent to solving the second problem.

These problems led him to solving the cubic equation: \( x^3 + 200x = 20x^2 + 2000 \)

He found a positive root of this cubic by considering the intersection of a rectangular hyperbola and a circle. An approximate numerical solution was then found by interpolation in trigonometric tables. He states that the solution of this cubic requires the use of conic sections and that it cannot be solved by ruler and compass methods, a result which would not be proved for another 750 years.
Poetry:

The Rubáiyát, his collection of hundreds of quatrains (or rubais), was first translated from Farsi into English in 1859 by Edward Fitzgerald.

A few of his quatrains:

“When Allah mixed my clay, He knew full well My future acts, and could each one foretell; Without His will no act of mine was wrought; Is it then just to punish me in hell?”

“A Book of Verses underneath the Bough, A Jug of Wine, a Loaf of Bread—and Thou Beside me singing in the Wilderness— And Wilderness is Paradise enow.”

“The Moving Finger writes, and, having writ, Moves on: nor all thy Piety nor Wit Shall lure it back to cancel half a Line, Nor all thy Tears wash out a Word of it.”

Extras

Anecdotes/history:

In 1092 there was a power struggle where Malik Shah and his vizier both died. Khayyam was Malik Shah’s personal physician and had become his close personal friend – which had made him enemies, also some of Khayyam’s poetry also made him enemies so he had to lay low.

Khayyam also came under attack from the orthodox Muslims who felt that Khayyam’s questioning mind did not conform to the faith. He wrote in his poem the Rubaiyat:

“Oh, Indeed, the Idols I have loved so long Have done my Credit in Men’s Eye much Wrong: Have drowned my Honour in a shallow cup, And sold my reputation for a Song.”

20 years later he emerged again, at age 64, and in the company of powerful people, but he refused to teach. One of his people suggests why he refused to teach: “The secrets which my book of love has bred, Cannot be told for fear of loss of
head; Since none is fit to learn, or cares
to know, Tis better all my thoughts
remain unsaid."

Malik-Shah's third son Sanjar, who was governor of Khorasan, became the overall ruler of the
Seljuq empire in 1118. Sometime after this Khayyam left Esfahan and travelled to Merv (now
Mary, Turkmenistan) which Sanjar had made the capital of the Seljuq empire. Sanjar created a
great centre of Islamic learning in Merv where Khayyam wrote further works on mathematics.

His years in Esfahān were very productive ones, but after the death of his patron in 1092 the
sultan's widow turned against him, and soon thereafter Omar went on a pilgrimage to Mecca.
He then returned to Neyshābūr where he taught and served the court as an astrologer.

Khayyam’s poetry was popularized in the 1800s by Edward FitzGerald's translations in the
Rubaiyat of Omar Khayyam. In the west he is most famous for his poems.

Khayyam played on the meaning of his name when he wrote:

“Khayyam, who stitched the tents of science, Has
fallen in grief’s furnace and been suddenly
burned, The shears of Fate have cut the tent
ropes of his life, And the broker of Hope has sold
him for nothing!”

Jobs:

In Samarkand, city in Uzbekistan, he made contact with his father's old friend Abu Tahir,
who was governor and chief judge of the city. Tahir, observing Khayyam's extraordinary
talent with numbers, gave him a job in his office. Soon Khayyam was given a job in the
king’s treasury.

Outside the world of mathematics, Khayyam is best known as a result of Edward FitzGerald's
popular translation in 1859 of nearly 600 short four line poems the Rubaiyat. Khayyam's fame
as a poet has caused some to forget his scientific achievements which were much more
substantial. Versions of the forms and verses used in the Rubaiyat existed in Persian literature
before Khayyam, and only about 120 of the verses can be attributed to him with certainty.

Death:

Omar Khayyam died at the age of 83 in his hometown of Nishapur on December 4, 1131. He
was buried in a tomb whose location he had chosen in an orchard where blossom would fall
twice a year.

The lines I could not remember during the podcast:

“To wisely live your life, you don't need to know much
Just remember two main rules for the beginning:
You better starve, than eat whatever
And better alone, than with whoever”

References


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