

OMAR KHAYYAM (1048-1131)

HEINZ KLAUS STRICK, Germany

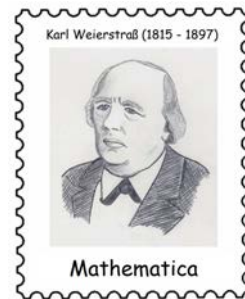
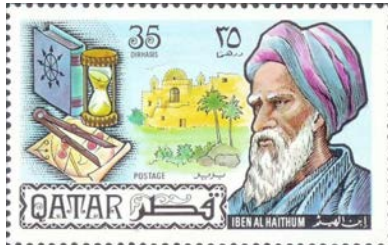
The Persian mathematician, astronomer, philosopher and poet OMAR KHAYYAM (GHIYATH AL-DIN ABU AL-FATH UMAR IBN IBRAHIM AL-NISABURI AL KHAYYAMI, also CHAJJAM) was born in Nischapur, where he died at a very old age. The name "al-Khayyam" means "tent maker", his father's profession.

OMAR KHAYYAM is considered one of the most important mathematicians of the Middle Ages; in his *Algebra* he was the first to give a systematic overview of solving cubic equations.

He dealt with the parallel axiom of EUCLID and tried to prove it – based on the work of the mathematician and physicist IBN-AL-HAITHAM (965–1039).

In Europe, however, he is best known for his poems (*Rubaiyat*), published in translation by EDWARD FITZGERALD in 1859; probably not all of the poems in the collection actually come from OMAR KHAYYAM.

The two Albanian stamps (see above) commemorate the two sides of OMAR KHAYYAM, the scientist and the poet. The statement by the German mathematician KARL WEIERSTRASS (1815–1897) fits in with this: *A mathematician who is not also a poet will never be a perfect mathematician.*

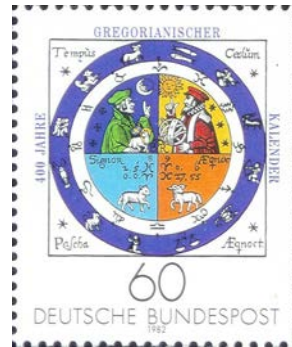


(drawing: © Andreas Strick)

In Nishapur, OMAR KHAYYAM studied philosophy, which included all sciences. At the age of 25, he had already written books on arithmetic and algebra as well as on music. He continued his studies in Samarkand (now in Uzbekistan) and wrote his most famous mathematical work there, *Risalah fi'l-barahin 'ala masa'il al-jabr wa'l-muqabalah* (Treatise on problems of algebra).

In the middle of the 11th century, the Seljuk people from Central Asia established an empire that extended from the Mediterranean to Persia. When MALIK-SHAH took over the government in 1073, he invited OMAR KHAYYAM to build an observatory in Isfahan. OMAR KHAYYAM created a list of stars and determined the length of a year with unimaginable precision. He proposed a calendar reform with 8 leap years in 33 years. This is *more precise* than the *Gregorian calendar* introduced 500 years later in Europe. Based on his observations of the sky, he was convinced that the earth was rotating and the starry sky was fixed.





Greek mathematicians like MENAECHMOS (around 360 BC) had already dealt with the intersections of conic sections (circle, ellipse, parabola, hyperbola).

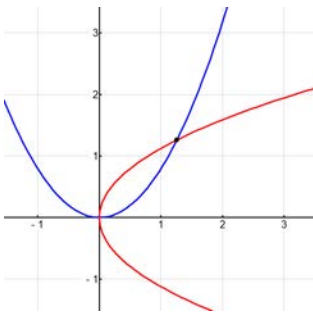
OMAR KHAYYAM recognized that the solution of all cubic equations could be traced back to the intersection of suitable conic sections. However, his approaches to this were mostly tricky. In total, he distinguished 14 types of equations (with positive coefficients and positive solutions).

He discovered a cubic equation can also have two positive solutions. However, he did not recognise that three solutions were even possible. He regretted that he was unable to determine the solutions using *algebraic* methods and hoped that *someone after him* would succeed.

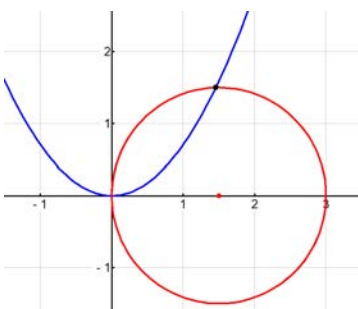
This was done in the 16th century by SCIPIONE DEL FERRO (1465 – 1517), NICCOLO TARTAGLIA (1500 – 1557) and LUDOVICO FERRARI (1522 – 1565).

Example 1: The solution to the equation $x^3 = c$ results from the intersection of $y = \frac{1}{\sqrt[3]{c}} \cdot x^2$,

i.e. a scaled parabola, with $x = \frac{1}{\sqrt[3]{c}} \cdot y^2$, i.e. a rotated scaled parabola (here: $c = 2$).

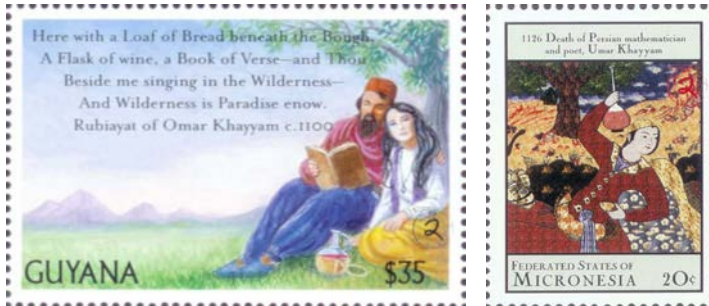


Example 2: He solved the equation $x^3 + bx = c$ by intersecting the circle with radius $r = \frac{c}{2b}$ and center $(\frac{c}{2b}, 0)$, i. e. $(x - \frac{c}{2b})^2 + (y - 0)^2 = (\frac{c}{2b})^2 \Leftrightarrow y^2 = -x^2 + \frac{c}{b} \cdot x$, with a scaled parabola $y = \frac{1}{\sqrt{b}} \cdot x^2$. Inserting $y^2 = \frac{1}{b} \cdot x^4$ returns $\frac{1}{b} \cdot x^4 = -x^2 + \frac{c}{b} \cdot x$, thus $x^3 + bx = c$, for $x \neq 0$ (here: $b = 2$; $c = 2$).



OMAR KHAYYAM also developed a method of dealing with n th roots. He used binomial coefficients, which were only rediscovered in Europe by BLAISE PASCAL (1623 - 1662) five hundred years later.

When MALIK-SHAH died in 1094, the free spirit OMAR KHAYYAM was targeted by the Orthodox clergy; the observatory was closed and the calendar reform was cancelled. He was forced to go on a pilgrimage to Mecca. Afterwards he lived in Nishapur until his death.



In his free translations, EDWARD FITZGERALD tried to preserve the content and form of the verses of the *Rubaiyat*. The success of the poems was so great in the 19th century that some verses entered the English language as standard quotations. Six of these verses were illustrated on stamps published in Dubai in 1967.



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



*Here with a Loaf of Bread beneath the Bough,
A Flask of Wine, a Book of Verse – and Thou
Beside me singing in the Wilderness –
And Wilderness is Paradise enow.*



*So while the Vessels one by one were speaking,
One spied the little Crescent all were seeking:
And then they jogg'd each other,
"Brother! Brother!
Hark to the Porter's Shoulder-knot a-creaking!"*



*Myself when young did eagerly frequent
Doctor and Saint, and heard great Argument
About it and about; but evermore
Came out by the same Door as in I went.*



*One moment in Annihilation's Waste,
One Moment, of the Well of Life to taste –
The Stars are setting and the Caravan
Starts for the Dawn of Nothing - Oh, make
haste!*



*And, strange to tell, among that Earthen Lot
Some could articulate, while others not:
And suddenly one more impatient cried –
"Who is the Potter, pray, and who the Pot?"*

The poems show a person who deals with the question of the instability and insecurity of life as well as with the question of the existence of God. He doubts divine providence and life after death, makes fun of the bigoted pious and sees fulfillment in earthly joys:

*Ah, make the most of what we yet may spend,
Before we too into the Dust descend;
Dust into Dust, and under Dust, to lie,
Sans Wine, sans Song, sans Singer and – sans End!*



*Why, all the Saints and Sages who discuss'd
Of the Two Worlds so learnedly, are thrust
Like foolish Prophets forth; their Words to Scorn
Are scatter'd, and their Mouths are stopt with Dust.*



*The Revelations of Devout and Learn'd
Who rose before us, and as Prophets burn'd,
Are all but Stories, which, awoke from Sleep,
They told their comrades, and to Sleep return'd.*



*Heav'n but the Vision of fulfill'd Desire,
And Hell the Shadow from a Soul on fire,
Cast on the Darkness into which Ourselves,
So late emerged from, shall so soon expire.*

First published 2006 by Spektrum der Wissenschaft Verlagsgesellschaft Heidelberg

<https://www.spektrum.de/wissen/omar-khayyam-1048-1131/858711>

Translated 2020 by John O'Connor, University of St Andrews