Omar al-Khayyami (1048-1131?)

[usually just Omar Khayyam in both English and Persian]

Best known nowadays as a poet, due to a translation of poems attributed to Khayyam by Edward FitzGerald (1859), Rubaiyat of Omar Khayyam.

He worked in mathematics and astronomy, and some philosophy.

He was sponsored for much of his career by the government of the Seljuk Empire.

A somewhat dubious legend is that two of his schoolmates were
Nizam al-Mulk (became the Grand Vizier of the Seljuk Empire)
& Hassan i-Sabah (became the founder of the Assassins).

Nizam arranged for Khayyam to get support for his research, and a government job for Hassan. Apparently Hassan plotted against Nizam and had to give up the job.

Nizam was assassinated in 1092, apparently by members of of the Assassin sect.

As a mathematician we worked on solving algebraic problems using geometric methods.

Seems to have been the first Persian mathematician to use "shay" ("something") for the unknown in an equation. This was translated as "xay" into Latin later in the Middle Ages, from this we eventually got the convention that "x" represents an unknown quantity.

He also worked on binomial coefficients and gave Pascal's Triangle as a way of computing them. In geometry, he criticized various previous attempts to prove Euclid's Fifth Postulate from Postulates I-IV.

As an astronomer, he contributed to a reform of the Persian calendar and published a star map. (The latter now lost.)

Here is an example of his "geometric algebra" in modern notation [much more succinct than he could do]:

To solve the cubic equation $x^3+ax^2+b^2x+b^2c=0$, intersect the hyperbola $y=\frac{bc}{x}+b$ with the circle $(x+\frac{1}{2}(a+c))^2+y^2=\frac{1}{4}(a-c)^2$, and then discard the solution $x=-c$. [i.e. the point $(-c,0)$].

Why does this work? Substitute $y=\frac{bc}{x}+b$ into the equation for the circle:

$$\left(x+\tfrac{1}{2}(a+c)\right)^2+\left(\frac{bc}{x}+b\right)^2=\tfrac{1}{4}(a-c)^2$$

$$\Rightarrow\quad x^2+(a+c)x+\tfrac{1}{4}(\cancel{a^2}+2ac+\cancel{c^2})+\frac{b^2c^2}{x^2}+2\frac{b^2c}{x}+b^2=\tfrac{1}{4}(\cancel{a^2}-2ac+\cancel{c^2})$$

$$\Rightarrow\quad x^2+(a+c)x+ac+\frac{b^2c^2}{x^2}+2\frac{b^2c}{x}+b^2=0$$

$$\Rightarrow\quad x^4+(a+c)x^3+(ac+b^2)x^2+2b^2cx+b^2c^2=0$$

Divide out the factor $x-(-c)=x+c$. Long division!

$$
\begin{array}{r}
x^3 + ax^2 + b^2x + b^2c \\
x+c \overline{\big) \, x^4 + (a+c)x^3 + (ac+b^2)x^2 + 2b^2cx + b^2c^2} \\
-(x^4 + cx^3) \qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad \\
\hline
ax^3 + (ac+b^2)x^2 \qquad\qquad\qquad\qquad \\
-(ax^3 + cax^2) \qquad\qquad\qquad\qquad \\
\hline
b^2x^2 + 2b^2cx \qquad\qquad \\
-(b^2x^2 + b^2cx) \qquad\qquad \\
\hline
b^2cx + b^2c^2 \\
-(b^2cx + b^2c^2) \\
\hline
0
\end{array}
$$

So any common point of the hyperbola & the circle that is <u>not</u> given by $x=-c$ must satisfy

$$\cancel{(x+c)}(x^3 + ax^2 + b^2x + b^2c) = 0,$$

that is it is a solution of the cubic.

Bonus for the notes:

Verse LI from

The Rubaiyat of Omar Khayyam,

as translated by

Edward FitzGerald (1859):

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.