The Solution of the Cubic and Quartic Equations II

Girolamo Cardano (1501-1576)
(also Gerolamo)

- illegitimate but acknowledged son of a wealthy lawyer (Fazio Cardano) who was a friend of Leonardo da Vinci's.

- studied at Pavia and Padua and obtained a doctorate in medicine

- he became a very prominent physician, about half of his ten volumes of publications are on medicine
  - the first to describe typhoid fever

- he took on a professorship in mathematics at least in part due to difficulties getting a license to practice medicine

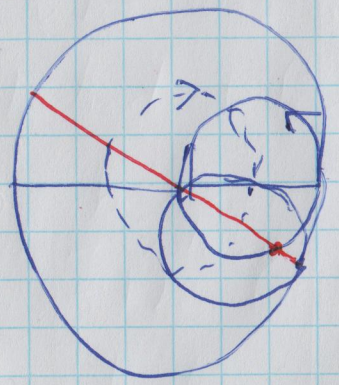
- he was a gambler (made and lost at least a couple of fortunes)

- he also supported himself as an astrologer

- besides math, he was a physician, gambler, astrologer, inventor, mechanical engineer, philosopher, astronomer, ...

As a mechanical engineer he is at least partly responsible for inventing a combination lock, gimbals, joints for transmitting rotary motion across angles, a device for converting rotary motion into linear motion, etc.

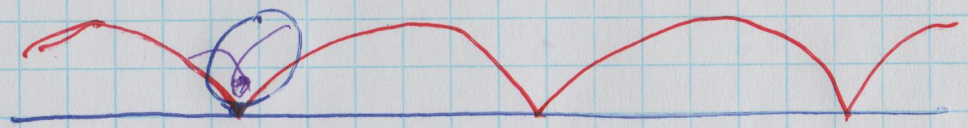
His device for converting rotary into linear motion used a circle rolling inside another circle



Have a small circle rolling inside a circle of twice the diameter. Each point on the outside of the small circle traces out a diameter of the lager one, moving back and forth along that diameter.

(Known to an Arab astronomer al-Tusi centuries before.)

Cardano might have rediscovered this on his own, since he studied the curves generated by points on rolling disks (hypocycloids).



As a mathematician, he worked in geometry (cs hypocycloid), algebra - he published the general solutions to the cubic & quartic equations [giving credit to del Ferro, Tartaglia, and his own student Ferrari for their contributions], in which work he acknowledged the existence of imaginary numbers and accepted negative numbers as equal citizens with positives; probability theory (Liber de Ludo Aleae, written in the 1560's, published in 1663) in which he gives the first known systematic treatment of probability. [In his book he also has a chapter on cheating...]

Ludovico Ferrari (1522-1565)
- got started as a mathematician in his teens while working as a servant for Cardano
- actually got a math professorship in Rome while still in his teens on Cardano's recommendation.
- solved the quartic equation
- eventually moved to a professorship in Bologna where he died shortly after of arsenic poisoning.

Rafael Bombelli (1526-1572)

Wrote a textbook Algebra that was published in 1572.

- He did Cardano one better by accepting imaginary numbers on a par with negatives and positives.
- This textbook was for ordinary people, and written in Italian, not Latin.

examples of his rules:

(for negatives)

"Plus times plus makes plus.
Minus times minus makes plus.
Plus times minus makes minus.
Minus times plus makes plus."

(for imaginary numbers)

"plus of minus by plus of minus makes minus"

"plus of minus" is a positive multiple of $i = \sqrt{-1}$

"minus of minus" is a negative multiple of $i = \sqrt{-1}$

& soon.

- he used complex numbers quite freely in solving the cubic & quartic equations (Cardano acknowledged them, but avoided them when he could, returned to ~~one~~ them once as "as subtle as it is useless").
- he also developed techniques for computing approximations to square roots