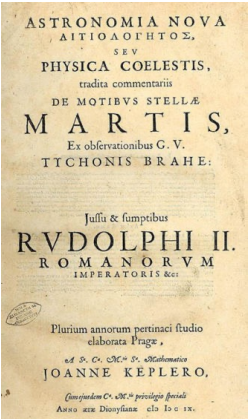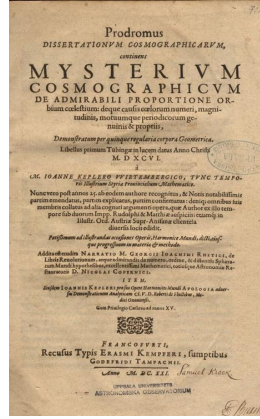# 16. Johannes Kepler (1571-1630)

- (1596) *Mysterium Cosmographicum* (*Cosmographic Mystery*)
- (1609) *Astronomia Nova* (*New Astronomy*)
- (1619) *Harmonices Mundi* (*Harmonics of the World*)

1. Neoplatonic Influences

(a) The 5 Platonic solids separate
    the 6 planetary orbits:

- sphere of Saturn
- *cube*
- sphere of Jupiter
- *tetrahedron*
- sphere of Mars
- *dodecahedron*
- sphere of the Earth
- *icosahedron*
- sphere of Venus
- *octahedron*
- sphere of Mercury
- Sun
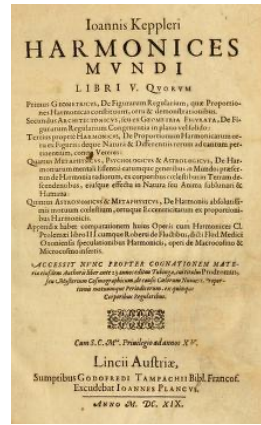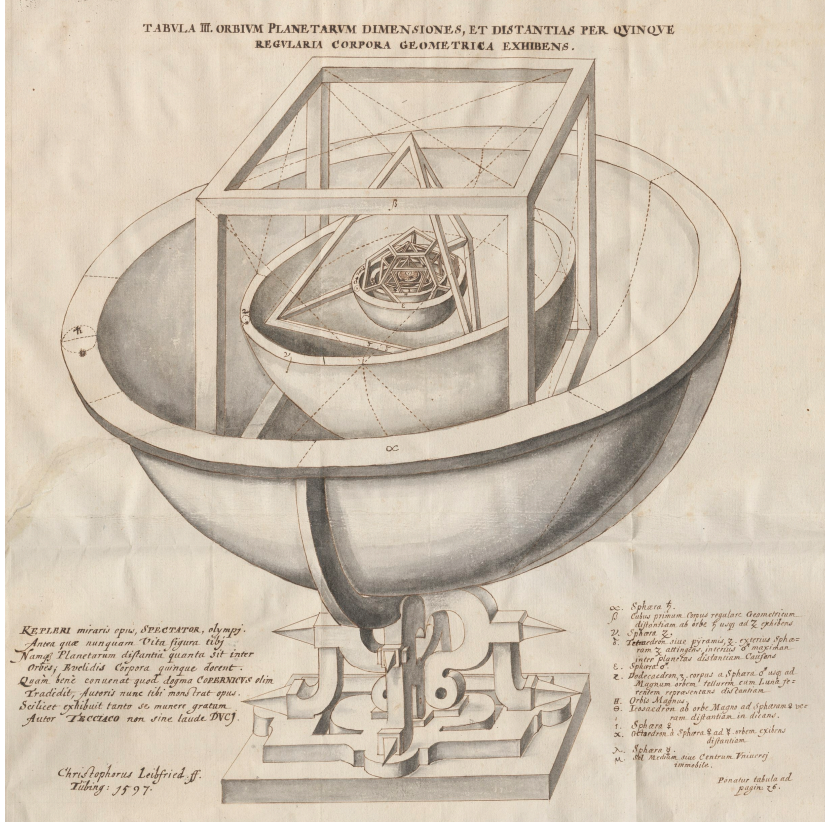
- Explains number of planets and distances separating them.

- *But*: *Geometrically*, not *numerologically*.

"...I wish to prove nothing from the mystique of numbers, and I believe nothing can be proved."*

- *However*:

"I feel carried away and possessed by an unutterable rapture over the divine spectacle of the heavenly harmony."

"I gave myself up to sacred frenzy. I have plundered the golden vessels of the Egyptians, in order to furnish a sacred tabernacle for my God out of them far from the Borders of Egypt... God himself was too kind to remain idle and began to play the game of signatures signing his likeness on to the world; therefore I chance to think that all nature and the graceful sky are symbolised in the art of Geometria"

(b) Apprentice to Tycho Brahe.

- *Most extensive collection of astronomical data assembled in 16th century.*
- *Astrologer to Danish royal family.*

Tycho Brahe
(1546-1601)

- Kepler's attitude towards astrology:

"Regard this as certain, that Mars never crosses my path without involving me in disputes and putting me myself in a quarrelsome mood."

- *However*:

"The astrologers are accustomed to cast the nativity of every year, just as though it were another person being born... Now I cannot deny that this is a ridiculous fantasy... one day has no power to govern another day or alter it, but they must all together pass by according to the divinely established pristine order, each in its own special way."

*Quotes taken from Rosen (1984).

(c) Influence of Gilbert.

- *Sun and planets are ensouled: sun has an anima motrix (moving soul) by which it moves the planets.*

"If we want to get closer to the truth and establish some correspondence in the proportions (between the distances and velocities of the planets) then we must choose between these two assumptions: either the souls which move the planets are less active the further the planet is removed from the sun, or there exists only one moving soul in the centre of all the orbits, that is the sun, which drives the planets the more vigorously the closer the planet is, but whose force is quasi-exhausted when acting on the outer planets because of the long distance and the weakening of the force which it entails."

(d) Debate with Robert Fludd.

- 1605. *Medical license from Oxford.*
- 1609. *Admitted to Royal College of Physicians (after ~6 failed attempts).*
- *College Censor* (1618, 1627, 1633, 1634).

Robert Fludd
(1574-1637)

- Two strands of mathematical thought in magical tradition:
  - *Numerology (Pythagoras)*
  - *Geometry (Plato)*

- Fludd's (1617-21) *A Metaphysical, Physical and Technical History of the Macro- and the MicroCosm.*

"[A]ll kinds of natural things, and those which are supernatural, are bound together by particular for-mal numbers. The mystery of these occult num-bers is best known to those who are most versed in this science, who attribute the Monad or unity to God the artificer, the Dyad or duality to Aqueous Matter, and then the Triad to the Form or light and soul of the universe, which they call virgin."

- # Kepler on Fludd
  - *Appendix to Harmonices Mundi and Apology* (1622).

  - "enigmatic", emblematic, and Hermetic
  - writes in an "occult and shadowy manner"
  - engages in "dreams"
  - creates "dense mysteries"
  - prefers the ancients to the moderns
  - delights in "pictures" and "pure symbolism"

- # Fludd on Kepler
  - *The State of Truth in which the Tragic Curtain of Error is Parted, the Smaller Stage Curtain of Ignorance is Raised and the Truth Itself is Brought Forth Publicly by its Minister* (1621); and *Monochord of the World* (1622).

  - "excessively verbal"
  - concerned only with "quantitative shadows" rather than "substance"
  - concerned only with "exterior movements" rather than "internal and essential impulses"
  - sees "effects rather than first causes"

Westman, R. (1984) 'Nature, Art, and Psyche: Jung, Pauli, and the Kepler-Fludd Polemic', in B. Vickers (ed.) *Occult and Scientific Mentalities in the Renaissance*, Cambridge Univ. Press, 177-229.

"I did not make my book as embellished as yours nor such as to appeal to the taste of the future reader; but I excused this defect on grounds of my profession, for I am a Mathematician... He who is of a sort to seek out the mystical philosophy (which only treats things through riddles) wishes to feast the eyes on pictures; but he who seeks such things in my book shall not find them there."

Numbers as art:

- abstract symbols of cosmos
- alchemical symbols
- cosmic harmony as mysterious, hidden, knowable only to initiates
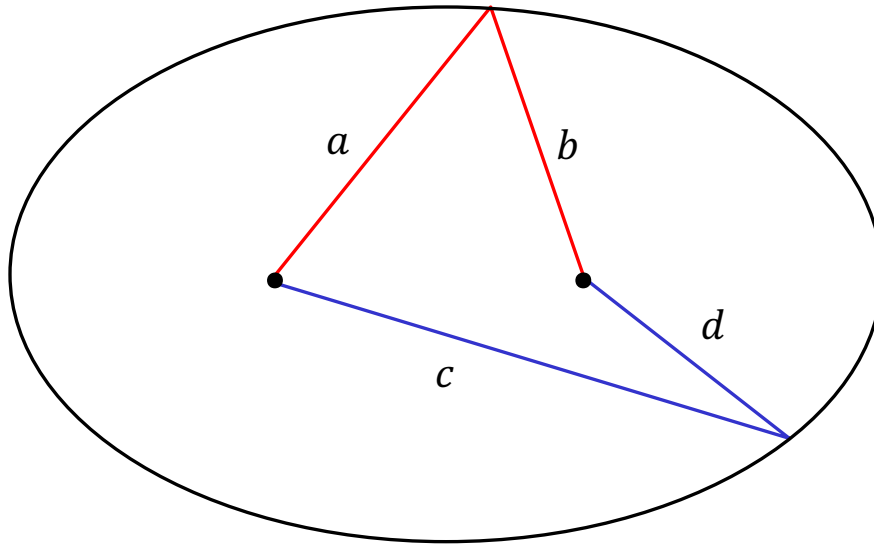
Numbers as quantitative measures:

- symbols of quantitative geometric aspects of nature (ratios and proportions)
- cosmic harmony is quantifiable and knowable

2. Laws of Planetary Motion

(1) Ellipse Law (*Astronomia Nova*).

The orbit of each planet is an ellipse with the Sun at one focus.
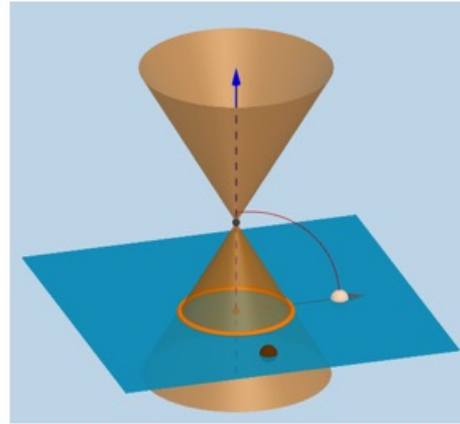

The sum of distances from the foci to any point on an ellipse is constant:
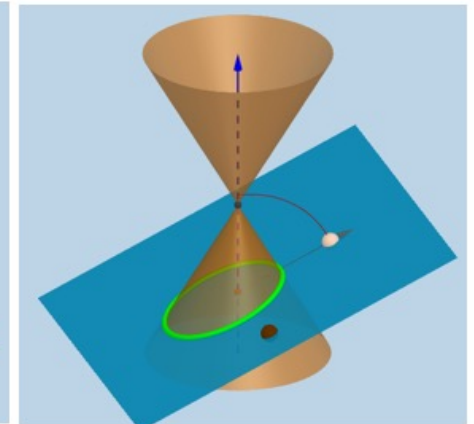
$$a + b = c + d$$

- Based on an analysis of data on Mars in Brahe's tables.
- *Primary significance*: No circles!
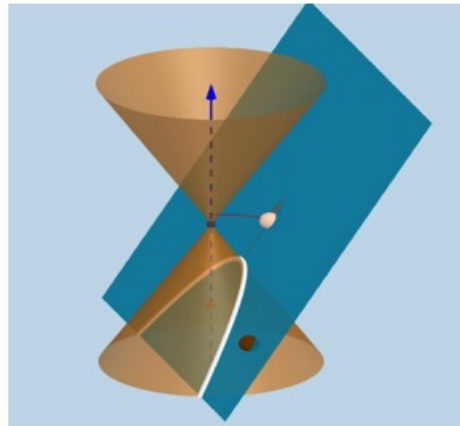
Deeper Significance:

- Conic sections replace circles as geometric descriptions of natural phenomena:
  - _orbits of planets = ellipses_
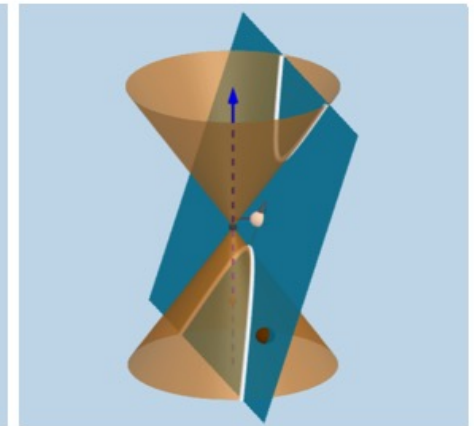 - _paths of projectiles = parabolas_

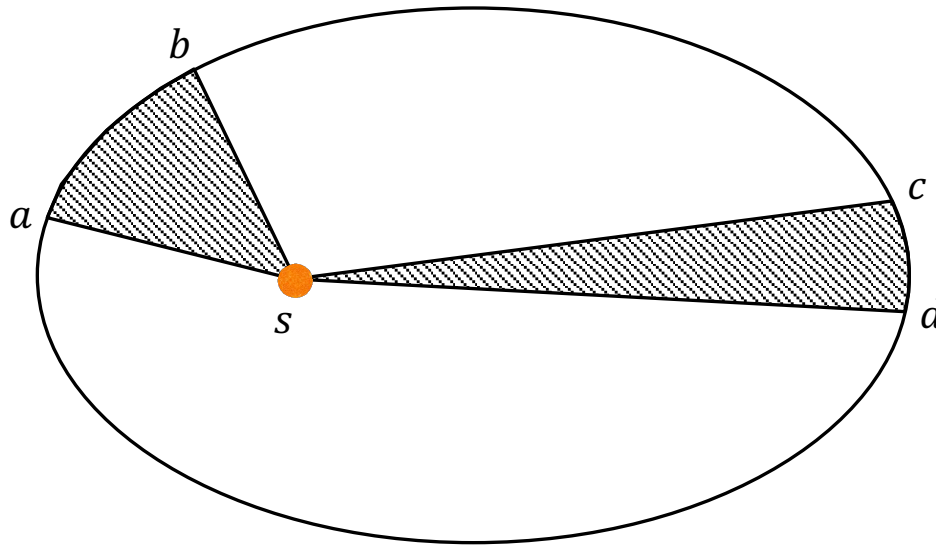
Circle

Ellipse

Parabola

Hyperbola

(2) Area Law (*Astronomia Nova*).

   *In any equal time intervals, a line from a planet
   to the sun will sweep out equal areas.*

- <u>*Suppose*</u>: Time to travel from a to b is the same as time to travel from c to d.
- <u>*Then*</u>: Area abs is the same as area cds.
- <u>*Consequence*</u>: A planet travels faster when it is closer to the sun.

(3) Harmonic Law (*Harmonices Mundi*).

The cube of the average distance of a planet from the sun is proportional to the square of its period.

$$D^3 \propto T^2$$

- <u>Or</u>: $\dfrac{D^3}{T^2} = const.$

- <u>So</u>: $\dfrac{D^3_{Earth}}{T^2_{Earth}} = \dfrac{D^3_{Mars}}{T^2_{Mars}} = \dfrac{D^3_{Venus}}{T^2_{Venus}} = \cdots$

- What sort of control does the Sun possess that results in these relations?

  - *<u>Kepler</u>: Sun possesses an anima motrix, which pulls planets into circular orbits, plus magnetic powers, that deform circular orbits into ellipses.*

  - *A causal explanation of orbits: no longer just saving the phenomena.*