HISTORY OF PLANETARY MOTION

Prepared
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- Much of the history of mathematical and physical thought was inspired by curiosity about the motion of planets.

- The first observation of the celestial bodies predate recorded history. The inertial position of the vernal equinox vector was observed and recorded in stone construction-stone-henge, for example –as early as 1800 B.C.

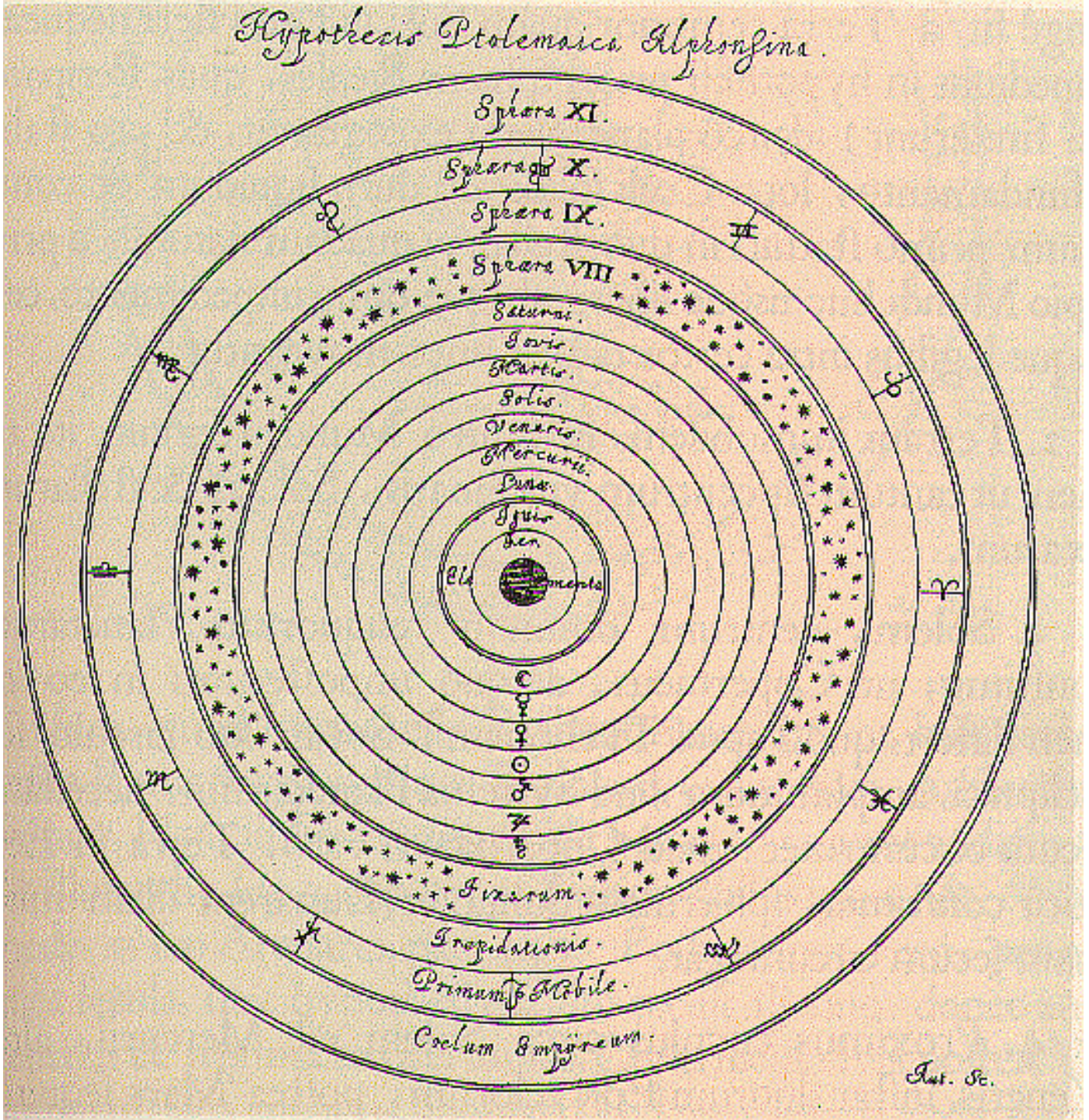
- Written evidence of stellar evidence observation was left by the Egyptians and the Babylonians from about 3500 years ago.

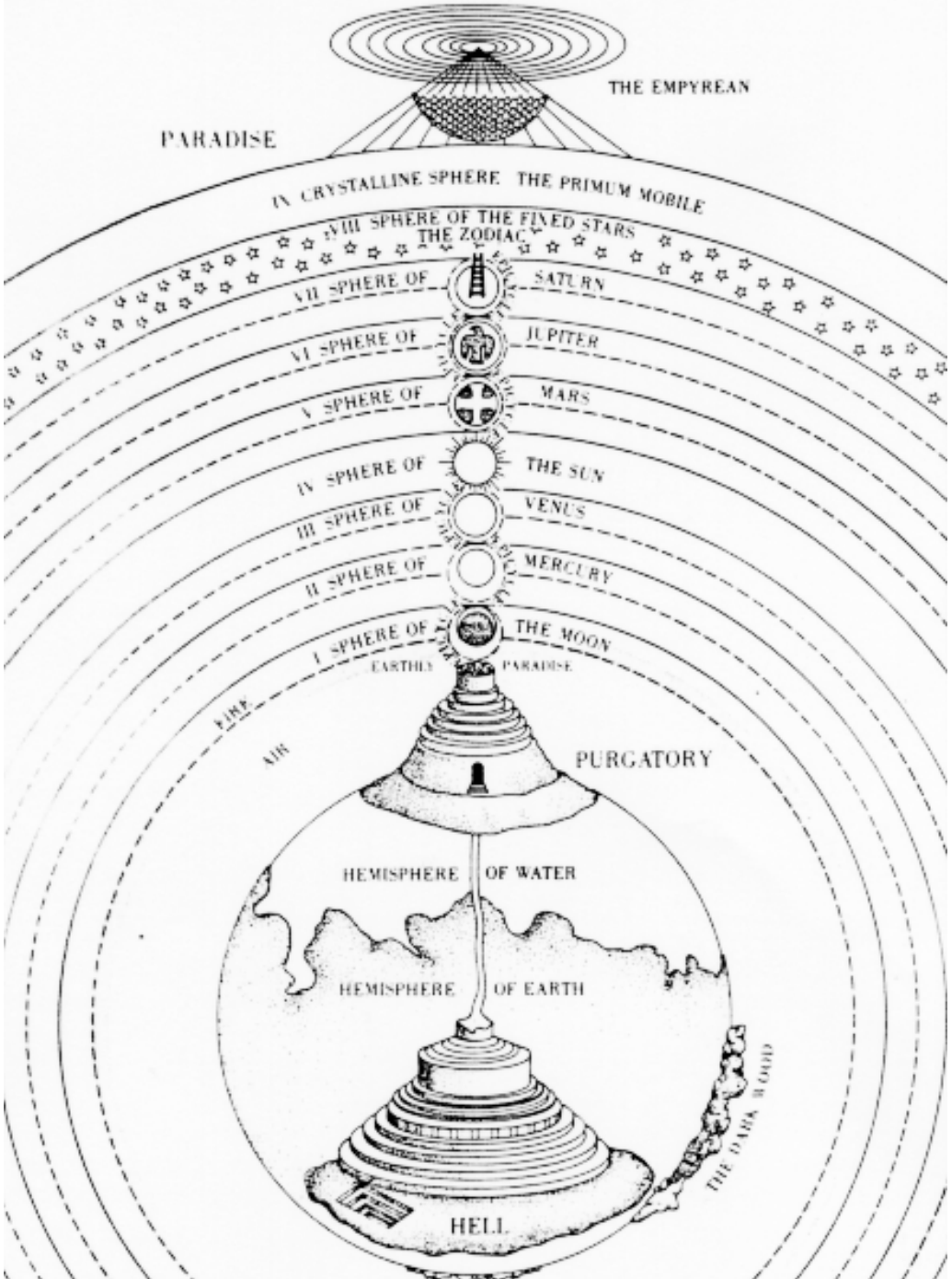
- In about 350 B.C. **Aristotle** explained the wandering motion of planets by proposing universe was composed of 55 concentric rotating sphere centered in earth.

- Outer most sphere contain the fixed star.

- Inner most sphere containing moon.

- The retrograde loop of mars is renowned. To explain the motion, Aristotle invented the remaining 53 concentric spheres. Each planets was located in one of the spheres, and its motion was influenced by rotation of several other spheres.


Hypothecis Ptolemaica Alphonsina.
Sphæra XI.
Sphæra X.
Sphæra IX.
Sphæra VIII
Saturni.
Jovis.
Martis.
Solis.
Veneris.
Mercurii.
Lunæ.
Aquæ
Aer.
Elementa
Fixarum.
Trepidationis.
Primum Mobile.
Cœlum Empyreum.
Aut. Sc.

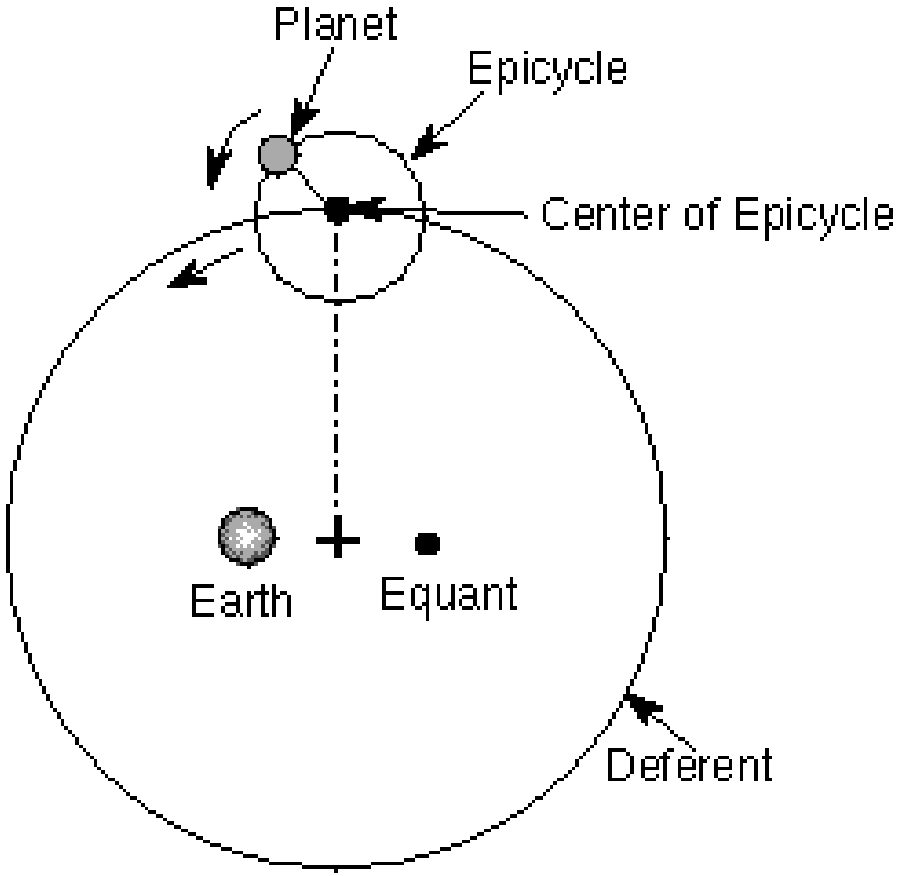

THE EMPYREAN
PARADISE
IX CRYSTALLINE SPHERE THE PRIMUM MOBILE
VIII SPHERE OF THE FIXED STARS
THE ZODIAC
VII SPHERE OF SATURN
VI SPHERE OF JUPITER
V SPHERE OF MARS
IV SPHERE OF THE SUN
III SPHERE OF VENUS
II SPHERE OF MERCURY
I SPHERE OF THE MOON
EARTHLY PARADISE
FIRE
AIR
PURGATORY
HEMISPHERE OF WATER
HEMISPHERE OF EARTH
THE DARK WOOD
HELL

Aristarchus

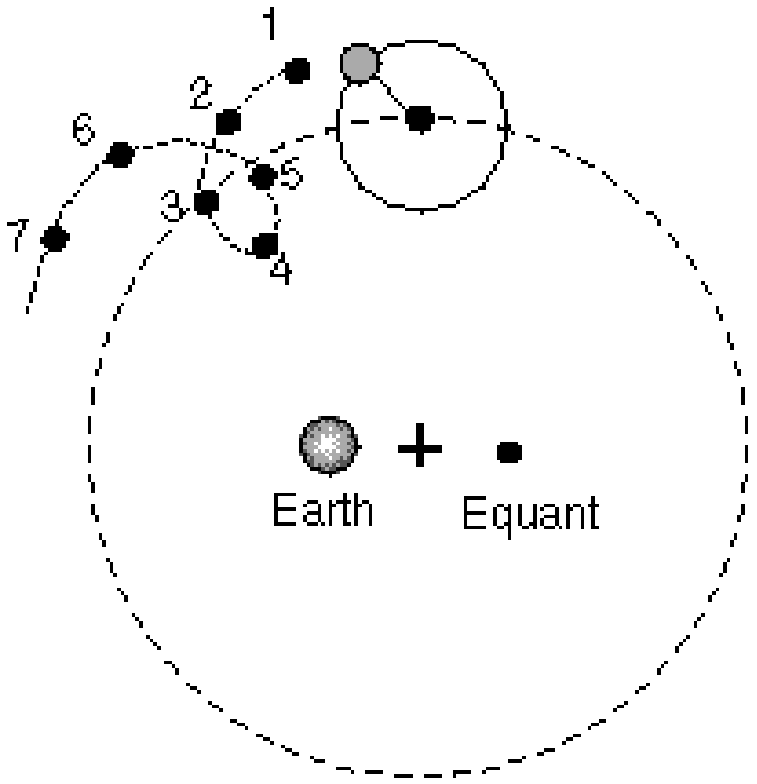
- At the same time a Greek named Aristarchus proposed a much simpler theory in which the Sun and stars were fixed and the planets rotated about sun.
- But the theory was not accepted.
- Aristotle theory dominates scientific thought for 18000 years.

Ptolemy

- In about 150 A.D. the Greek astronomer proposed more elaborate earth centered theory.
- The planets moved around the earth in small circle called epicycle whose center moves in large circle called deferents.
- The tables of planetry motion computed by Ptolemy based on his theory were used for 1400 years.

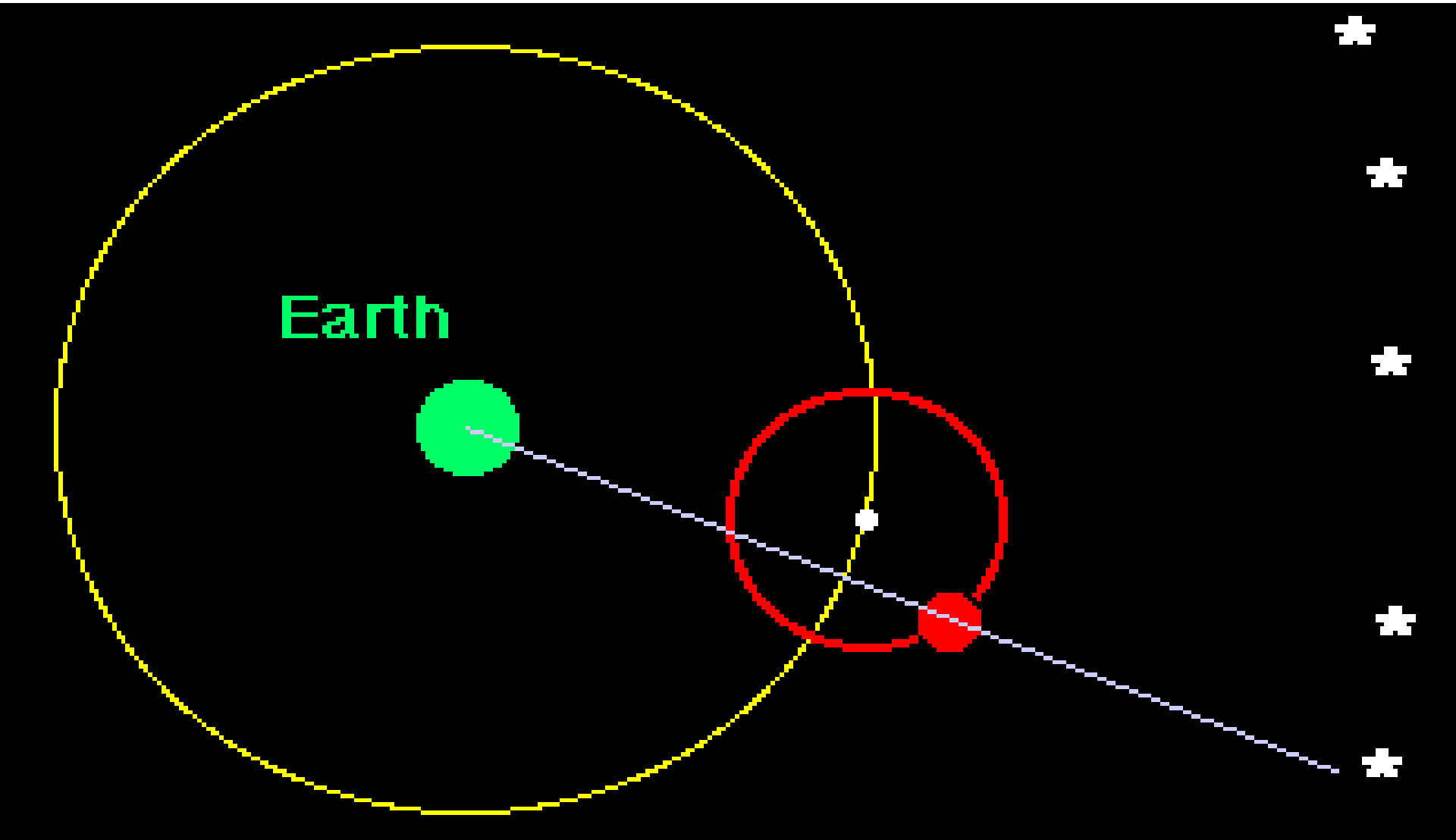


Center of epicycle moves counter-clockwise on deferent and epicycle moves counterclockwise. Epicycle speed is uniform with respect to equant. The combined motion is shown at right.

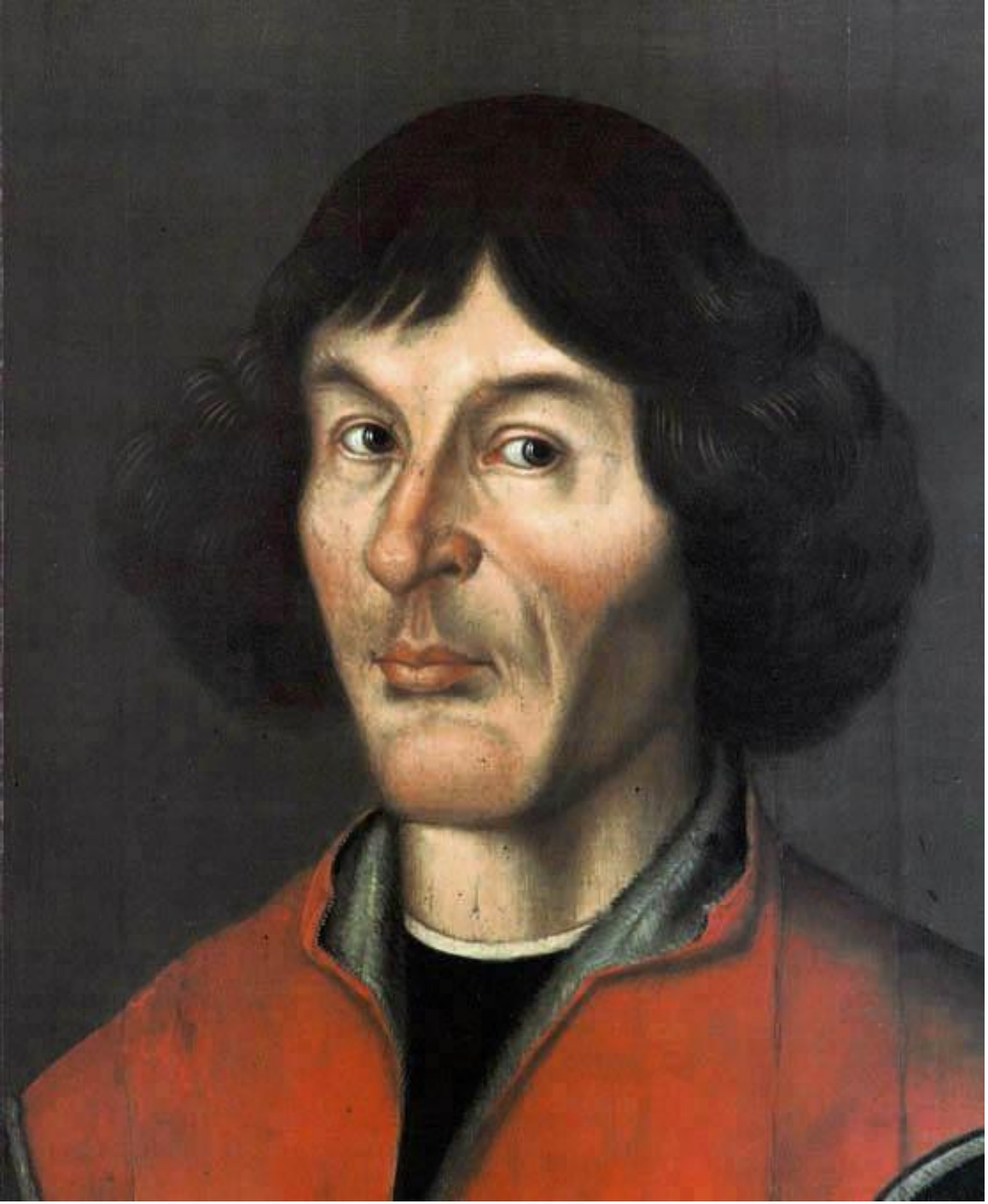


Deferent motion is in direction of point 1 to 7 but planet's epicycle carries it on cycloid path (points 1 through 7) so that from points 3 through 5 the planet moves backward (retrograde).

Wandering moment of planets view from earth surface



Wandering moment of planets view from earth surface



Nicholas Copernicus

- In 1543 Nicholas Copernicus broke with Aristotle's theory and advocated sun centered rotation. His theory neatly explained the retrograde motion of the planets as observed from earth.

- However measured position were so crude at that time that they fit Ptolemy's conception as well as Copernicus.

Italian scientist Galileo

- In about 1610 the Italian scientist Galileo Galilei made two observations that reinforced the theory of Copernicus.
- First, he observed the motion of the moons orbiting Jupiter, thus atleast some bodies that not orbit earth.
- He observed moon like phases of the sunlight on Venus that could not explained by Ptolemy theory.

Tycho Brahe

- He made the first accurate measurement of the position of planet as a function of time.
- He believed in Ptolemy's theory of universe.
- His careful observation helps kepler to describe mathematically the heliocentric motion of planet.

Johannes Kepler

- In 1600 kepler presented his three law of planetry motion, which are the basis of our understanding of planetary and spacecraft motion.
- First Law: The orbit of planet is an ellipse, with the sun at one focus.
- Second Law: The line joining the planet to the sun sweeps out equal area in equal times.

- Third law: The square of the period of a planetary orbit is proportional to the cube of its mean radius.

- In addition, Kepler’s contributed keplers equation, which relates position and time. Keplers equation is the most famous transcendental equation ever discovered.

Isaac Newton

- The underlying cause of planet motion was described by Newton.
- The postulated that all masses are attracted to one another with a force proportional to their mass and inversely proportional to square of the distance.
- He further postulated that mass of the symmetric body could be concentrated at their center.

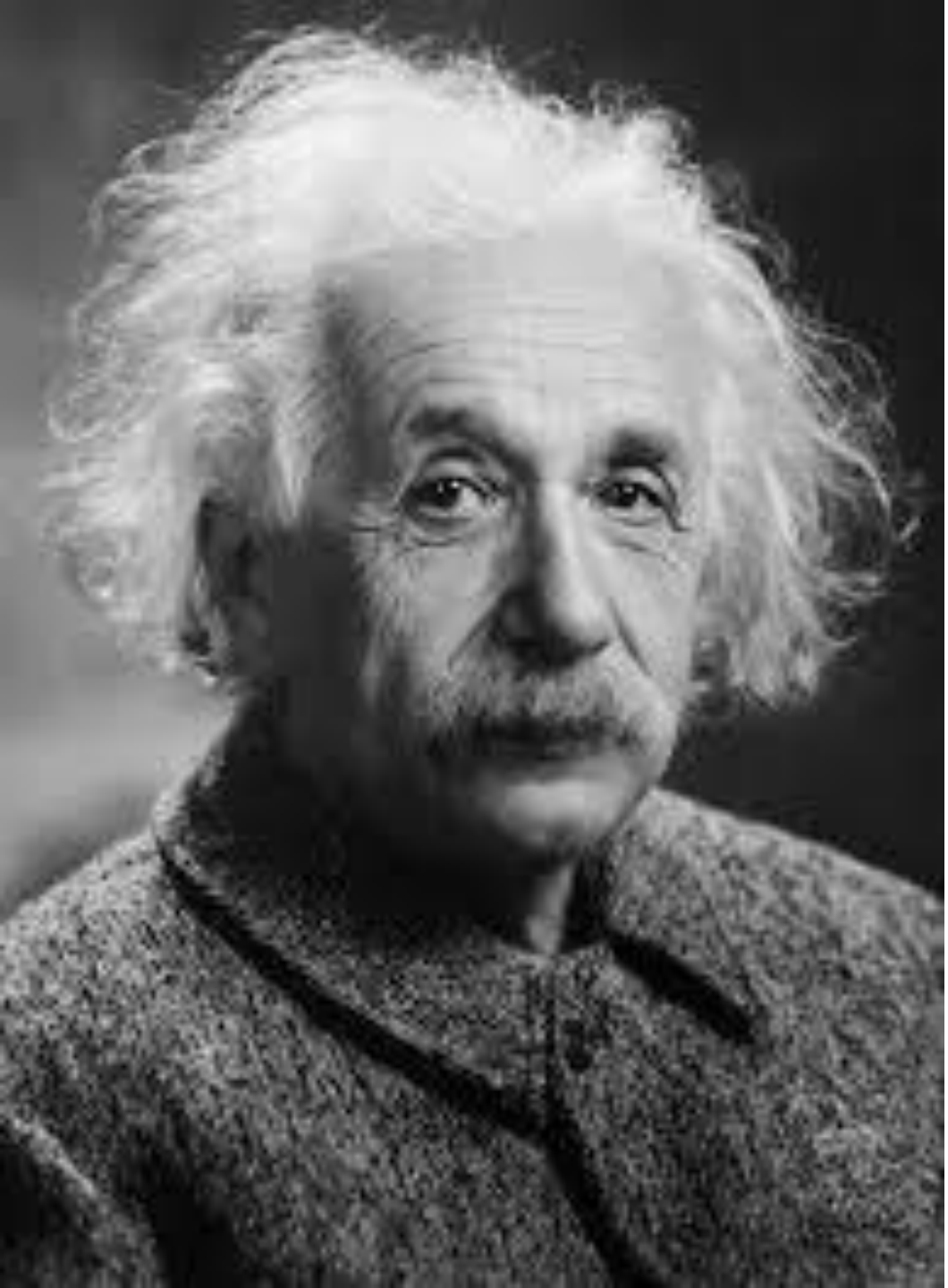
- To test the assumptions, he formulated the differential equation of motion for the planets and invented calculus to solve them.

- The result confirmed by kepler’s law.

- By 1666 one man understand planetary motion, but in would be another 20years before the world had the news.

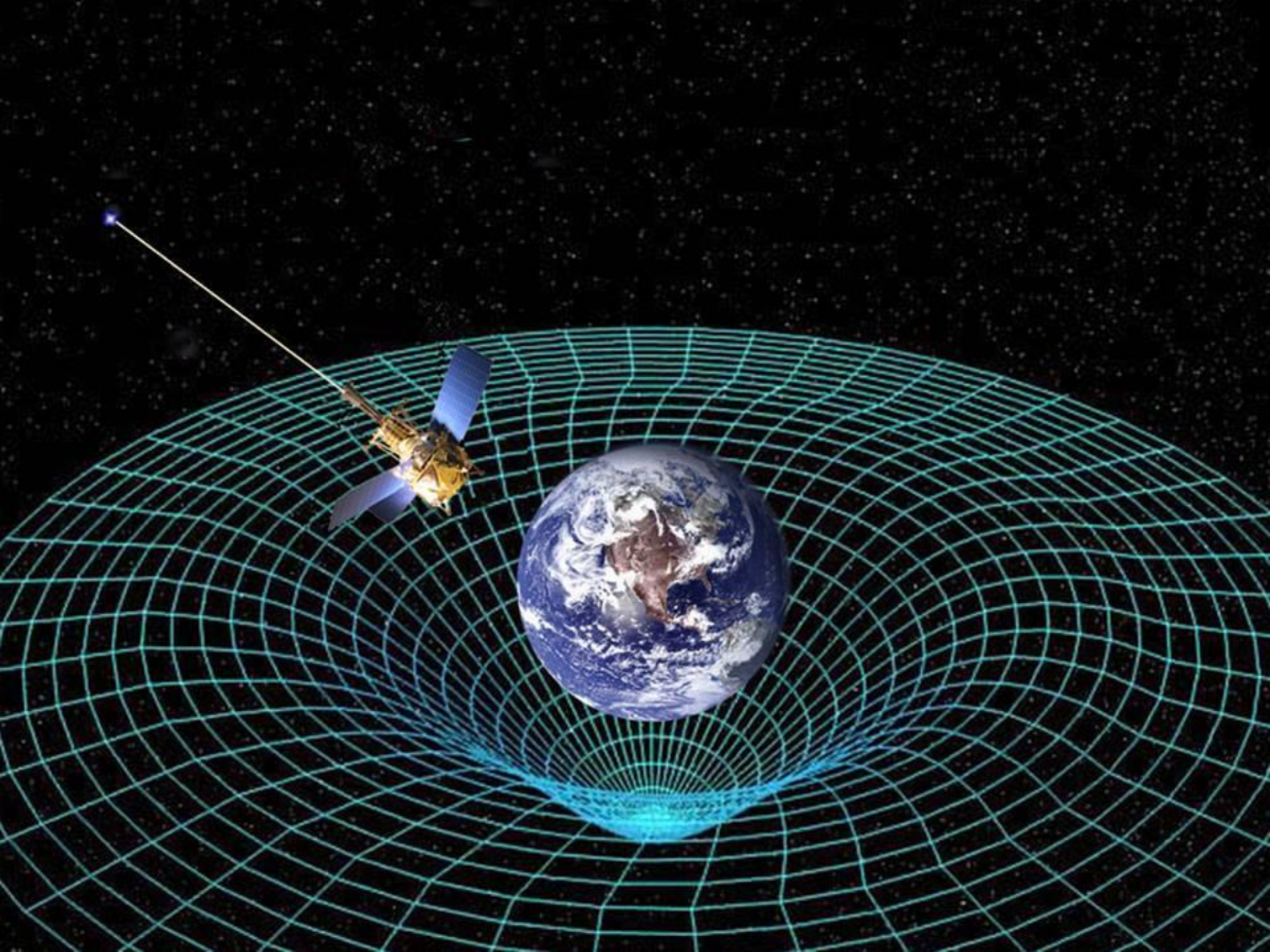
- Newton put his incredible piece of work aside and neither published nor discussed it until 20years, later, when he was questioned by his friend Edmund Halley about planetary motion. Newton causally replied that he had already worked it out and had it somewhere among his papers.

- At the urging of an astonished Halley, Newton published his work in Principia.



Albert Einstein

- Space and time exist absolutely, but are not independent.
- They are interwoven into a single fabric called “Space Time”.
- Massive rotating bodies like sun earth and other planets, wrap and twist their local space time.
- Space time tells the matter how to move and matter tells the space time how to curve and twist.



- According to Einstein theory gravity is a “space time curvature”.

- Where as Newton Space theory, space and time exist absolutely and independent, they are unaffected by the presence of heavy massive objects like sun, earth or other planets.

- Newton conception of space-time https://youtu.be/8AE_n4q41Z4
- Einstein's conception of space-time https://youtu.be/ni1N-A-Fnyo
- Gravity explained neatly https://www.youtube.com/watch?v=OKXVRu6JL54

Thank you…..