"The Planets"

Astro/EPS C12 (CCN 17045 or 32505)

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LEC: 2 LeConte TWTh 2:30–5:00pm
Office Hours: 419 Campbell Hall

Astro/EPS C12

- requires only basic algebra and arithmetic
- C12 emphasizes CONCEPTS

- What is the origin of the solar system?
- How are solar system objects similar or different?
- How do they change over time?

POWERS OF TEN

- also called "orders of magnitude"

SCIENTIFIC NOTATION:

- $10^6 = 1000000.$
- $1.234 \times 10^6 = 1234000.$
- $300 \times 2000 = 600000.$
- $3\times10^2 \times 2\times10^3 = 6\times10^5$
- $1\times10^{-2} = 0.01$

MEASURING STUFF

- ounces vs. grams
- mm vs. cm vs. m vs. km

- 150 lb = 68 kg.
- 1000 mm = 1 m
  100 cm = 1 m

  1000 m = 1 km
- on homework...
  DON'T FORGET THE UNITS !!

DENSITY

Density is mass per unit volume.

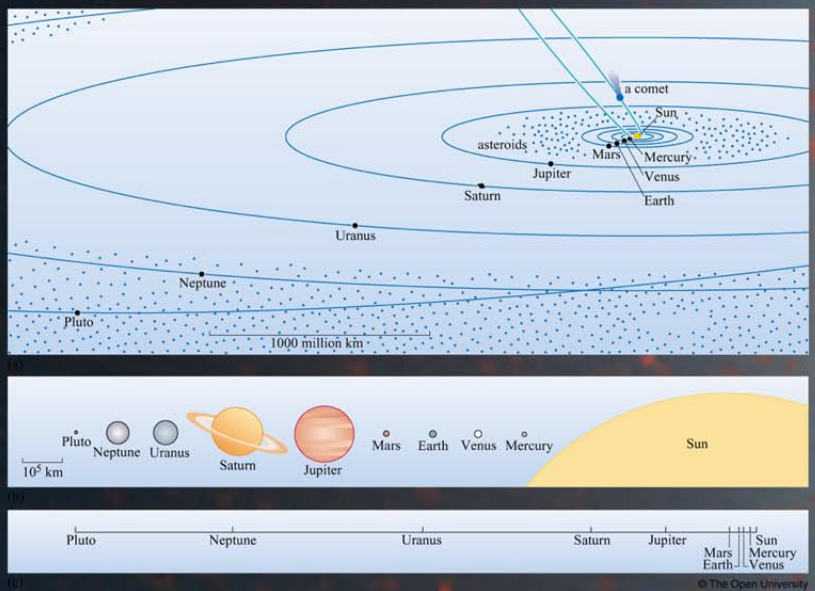
- $\rho = m / V$
- measured in kg/m^3 or g/cm^3

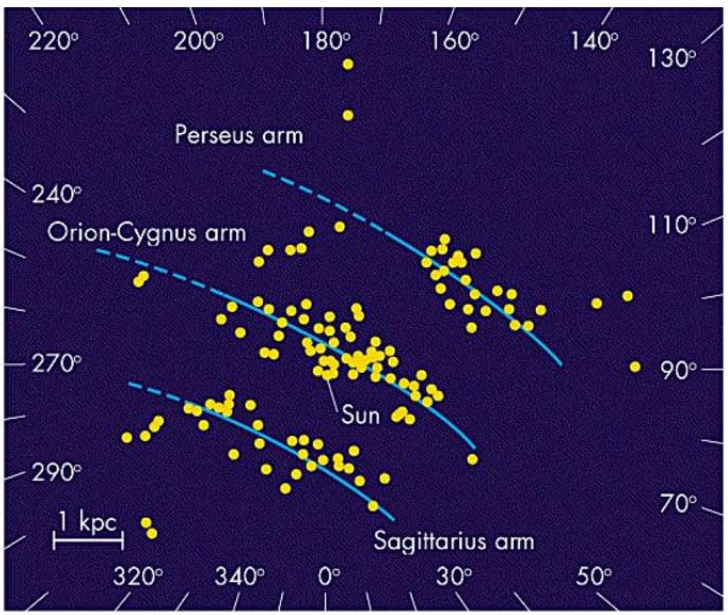
- water = 1 g/cm^3
- rock = 2700 kg/m^3
- iron = 7.9×10^3 kg/m^3

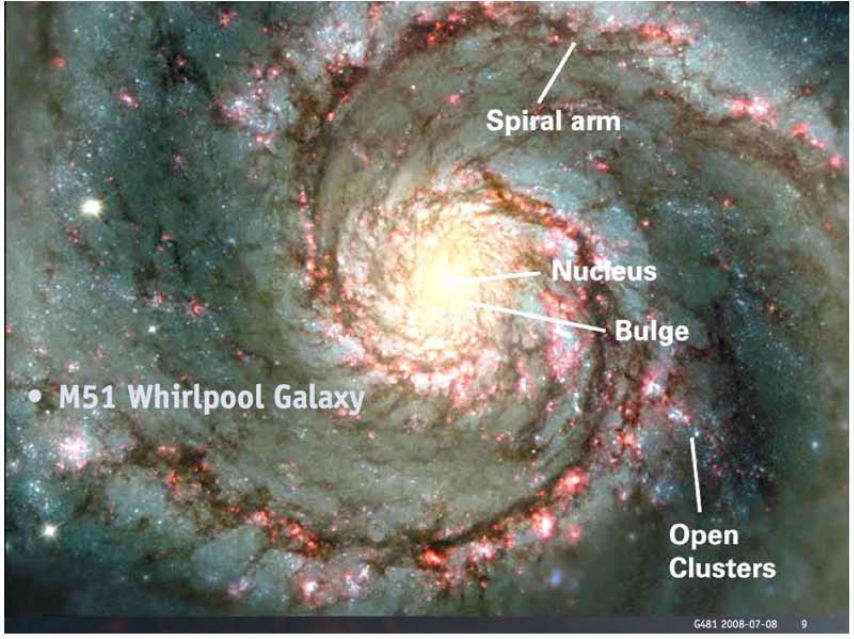
2006 IAU definition of "planet"

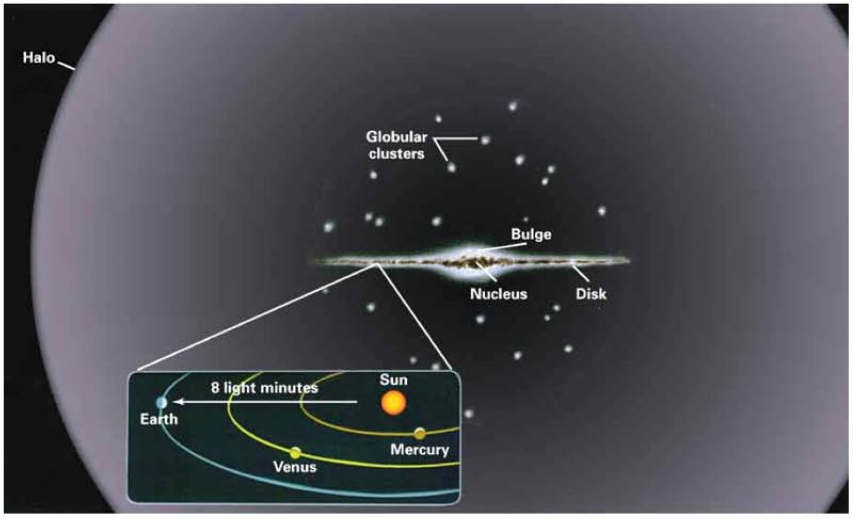
A planet is a celestial body that

- is in orbit around the Sun,
- has sufficient mass for its self-gravity to overcome rigid body forces so that it assumes a hydrostatic equilibrium (nearly round) shape, and
- has cleared the neighbourhood around its orbit.

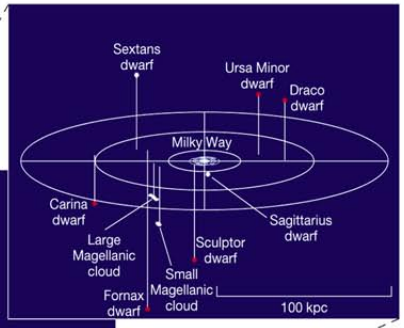


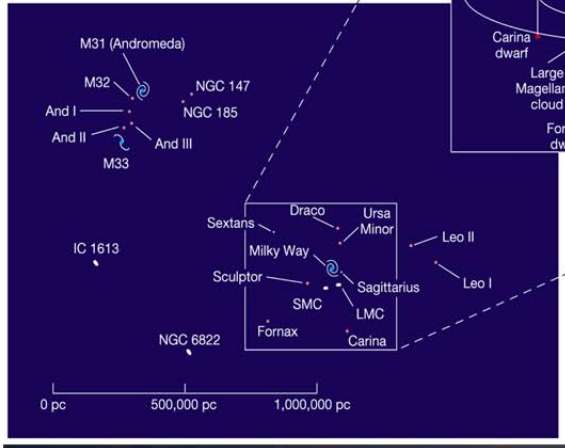






LOCAL GROUP





CHINESE ORACLE BONES

- Shang dynasty (1500-1000 BCE)
- supernova records
- sunspot records
- aurorae
- Jupiter
- solar / lunar eclipses

CHINESE SUNSPOT/ AURORA RECORDS

- sunspots and low-latitude aurorae linked to solar activity
- extensive records allow studies of variability of the solar activity

CHINESE COMET RECORDS

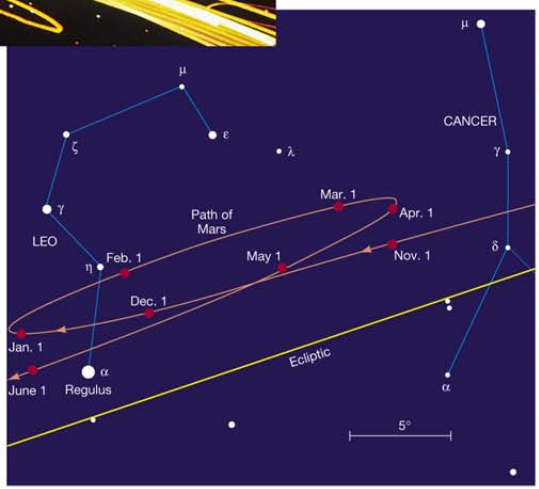
silk with comet drawings, 168 BCE

HALLEY'S COMET

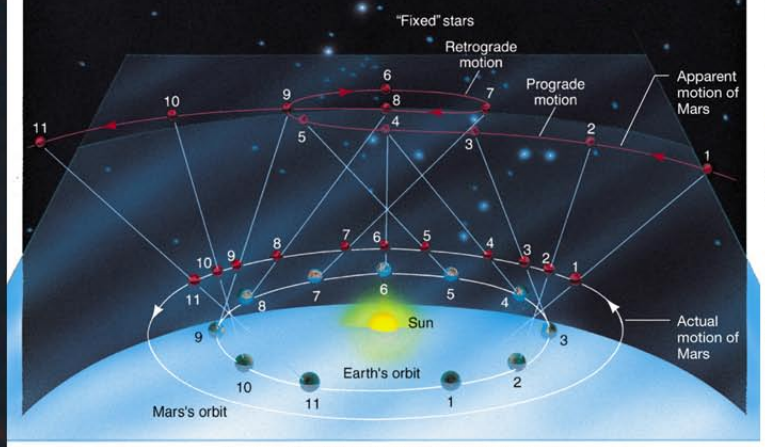
Bayeux tapestry (1070-1080)

- Halley determined the comet's 75-yr period in 1705, with records back to 1682
- Chinese astronomers recorded almost all sightings back to 12 BCE, but they didn't recognize the periodicity

RETROGRADE MOTION

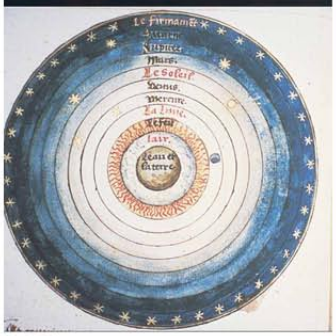


RETROGRADE MOTION

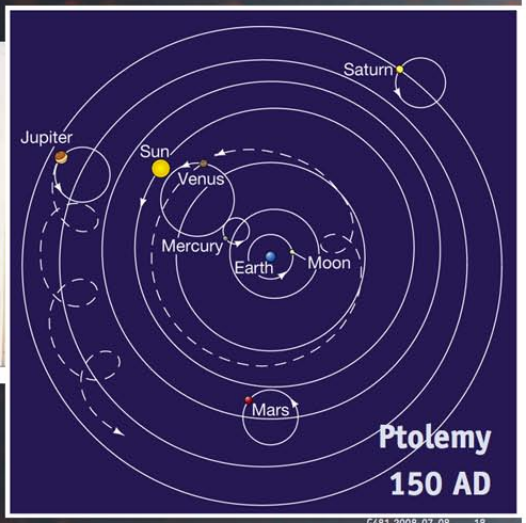


GREEKS

Aristotle
350 BCE



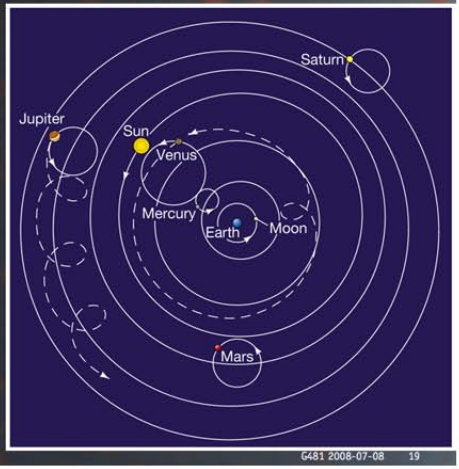
Aristarchus -
310–230 BCE



Ptolemy
150 AD

PTOLEMY

- planets move along little epicycles
- epicycles move along deferents
- explained some retrograde motion
- Ptolemy's "Almagest" included a catalog of 850 stars
- Moon size problem



PERSIAN ASTRONOMY

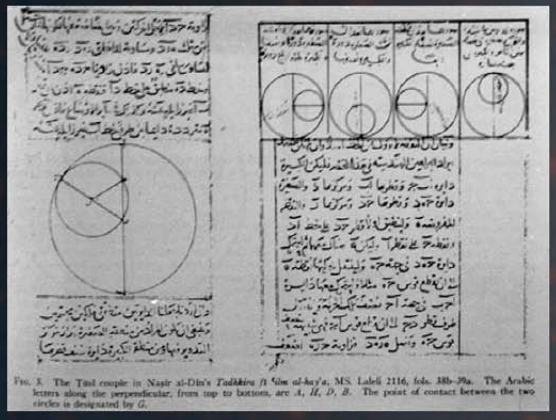
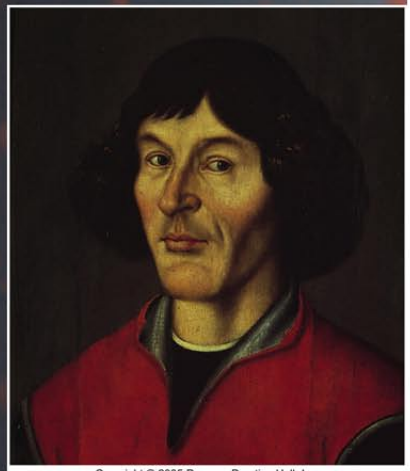


FIG. 3. The Tūsī couple in Naṣīr al-Dīn's *Tadhkira fī ʿilm al-hayʾa*, MS. Laleli 2116, fols. 38b–39a. The Arabic letters along the perpendicular, from top to bottom, are *A, H, D, B*. The point of contact between the two circles is designated by *G*.

- Tusi couples allowed planets to move along circles at constant velocities, a more "perfect" solution than Ptolemy's

COPERNICUS

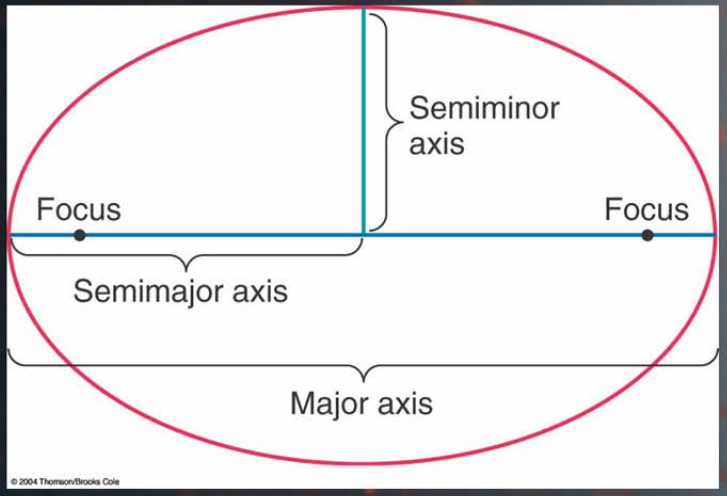
De Revolutionibus, 1543



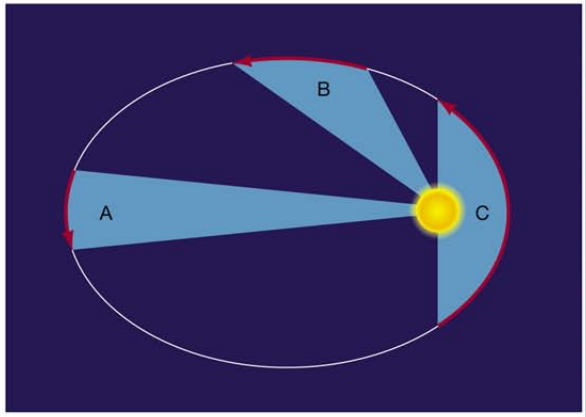
JOHANNES KEPLER

- German, 1571–1630
- worked as Tycho Brahe's assistant
- his goal was to explain planetary motion in the heliocentric system

THE ELLIPSE

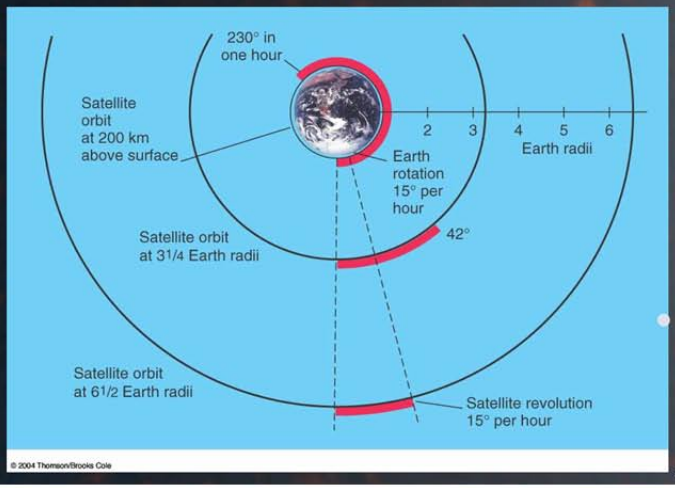


KEPLER'S 2nd LAW



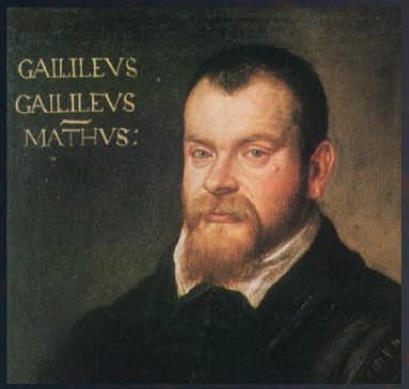
- law of equal areas
- planets move faster at perihelion

KEPLER'S 3rd LAW



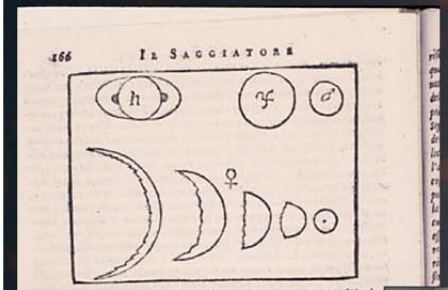
- $P^2 \propto R^3$

GALILEO GALILEI

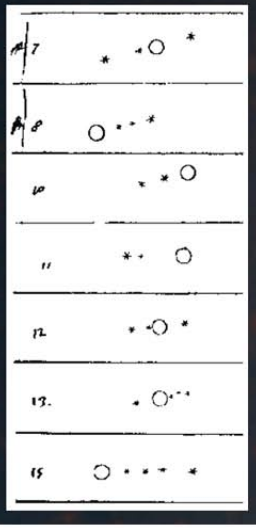


- Italian, 1564–1642
- used the telescope for astronomy
- *Siderius Nuncius*, 1610
  - lunar terrain
  - sunspots
  - phases of Venus
  - rings of Saturn
  - moons of Jupiter
- received a "warning" in 1615

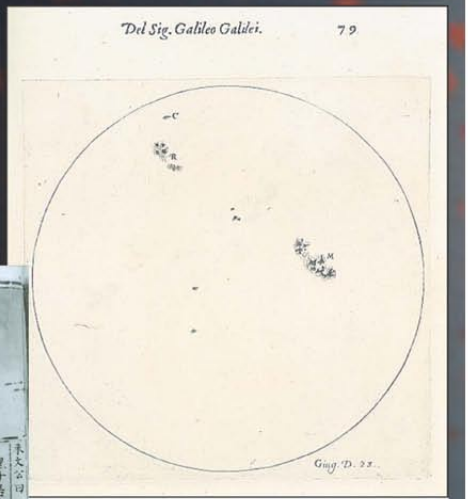
GALILEO GALILEI



GALILEAN MOONS



DISCS OF THE SUN AND MOON



GALILEO'S "DIALOGUE"

- *Dialogue Concerning the Two Chief World Systems*
- pub. 1632
- in Italian (not Latin)
- house arrest in 1633

GALILEO'S MIDDLE FINGER

- in the Institute and Museum of the History of Science, Florence, Italy
- Galileo acknowledged to be correct by the Pope, 1992

ISAAC NEWTON

- English, 1642–1727
- went to Cambridge, returned home during plague in 1665
- published *Principia* in 1687 with funding from Sir Edmund Halley

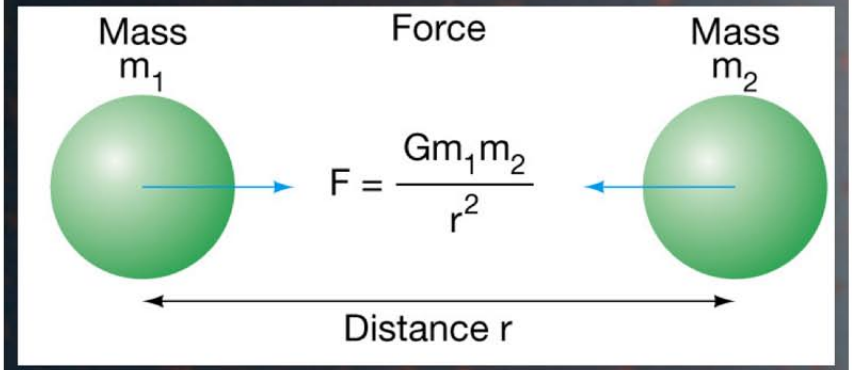
ISAAC NEWTON

- Law of Gravitation
- Newton's version of Kepler's 3rd law
- observed the spectrum

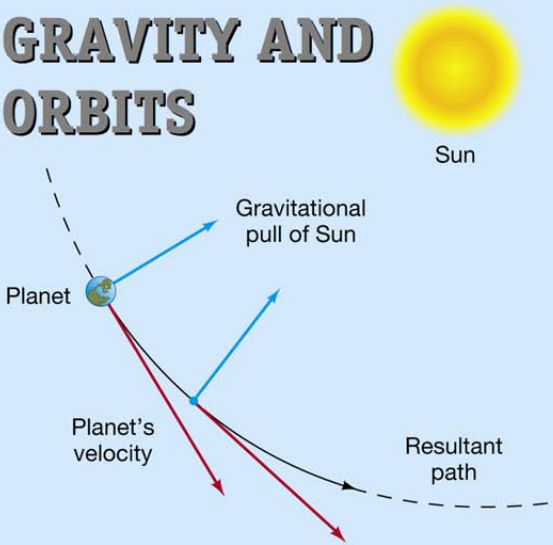
LAWS OF MOTION

- 1st law: inertia
- 2nd law: F = ma
- 3rd law: equal and opposite

NEWTON'S LAW OF GRAVITATION

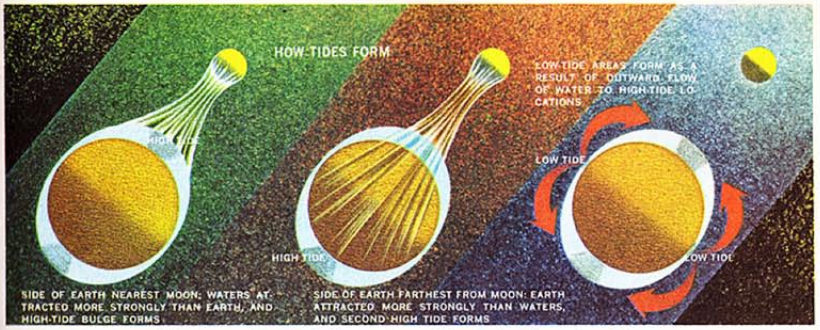


GRAVITY AND ORBITS



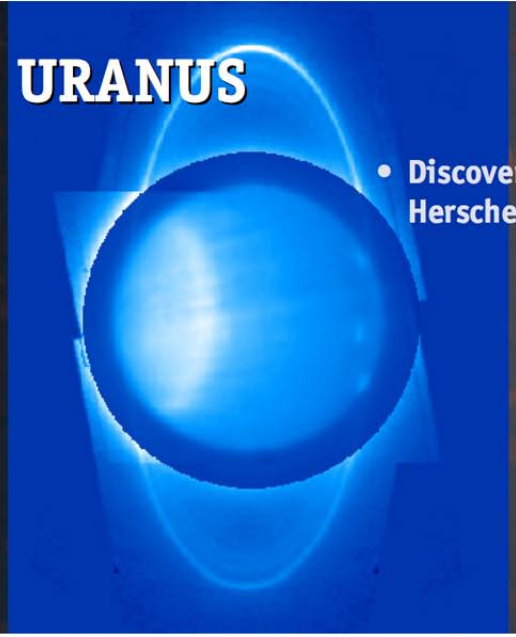
NEWTON'S LAW OF GRAVITATION

$F = G (m_1 m_2) / r^2$



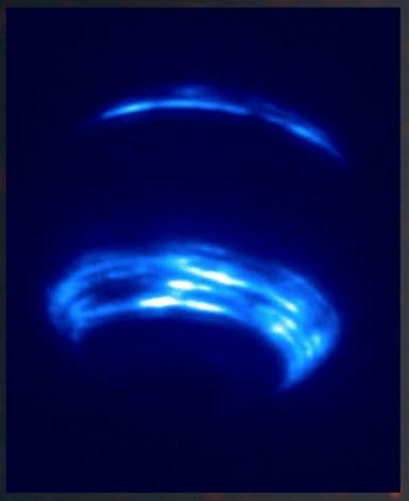
Tides are caused mainly by the moon's gravitational pull on the earth and its waters. For example, on the side of the earth nearest the moon, the waters are attracted more strongly than the earth, so a bulge of water—the high tide—forms.

URANUS



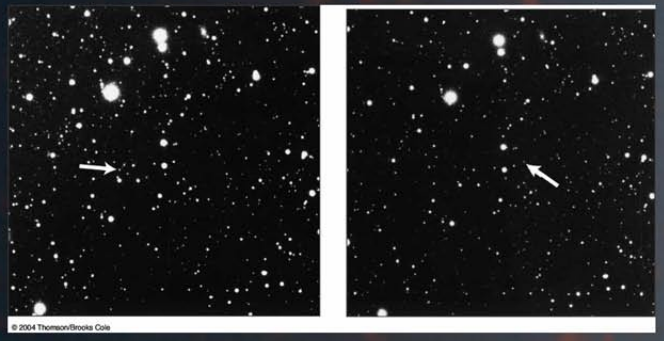
- Discovery: William Herschel, 1781

NEPTUNE

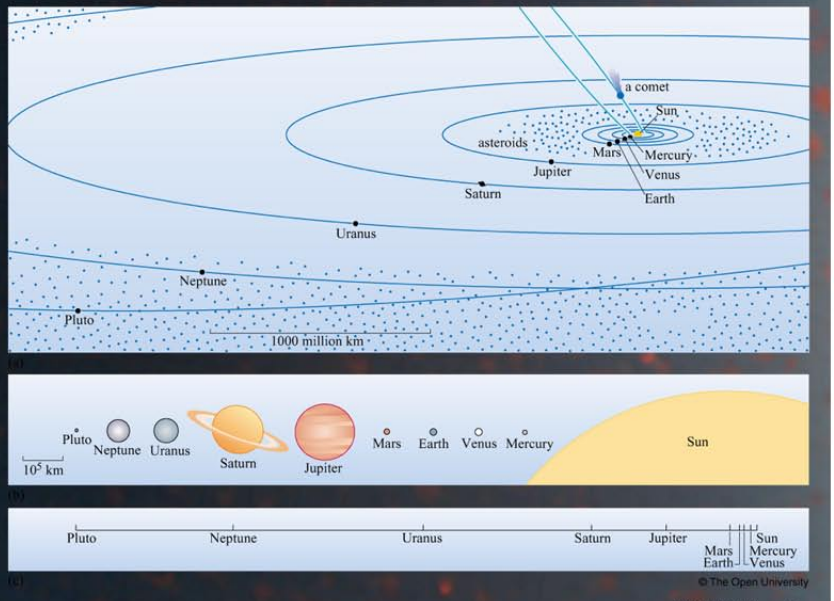


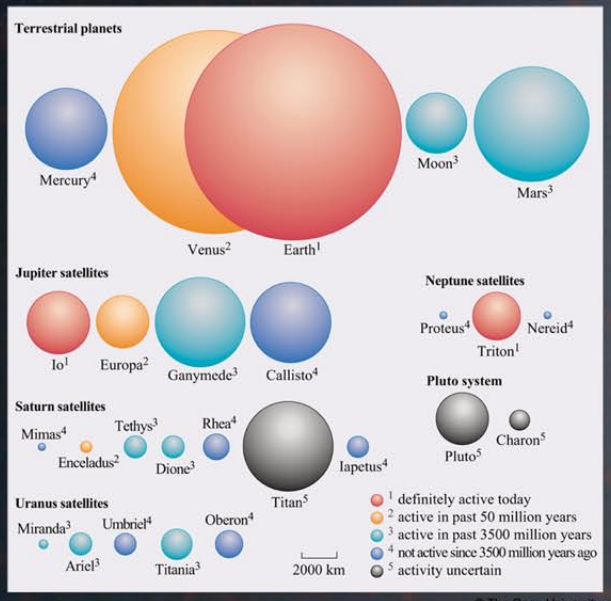
- John C. Adams, England (1845), predicted position
- Urbain Leverrier, France (1846), predicted position
- Johann Galle , Germany (1846), verified Neptune
- Galileo's notes show an unrecognized Neptune sighting (1613)

PLUTO

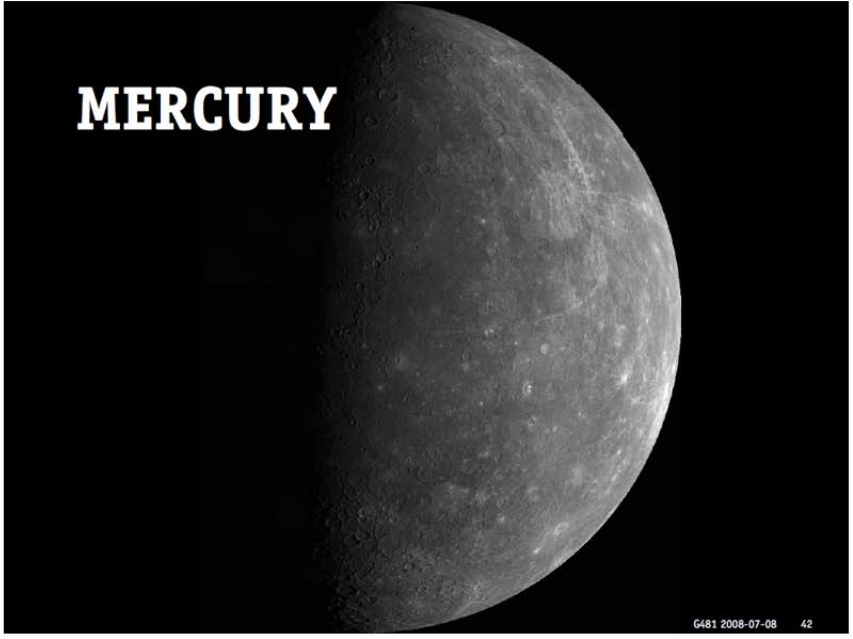


- Discovery: Clyde Tombaugh (1930)
- at Lowell Observatory
- symbol for Pluto includes Percival Lowell's initials

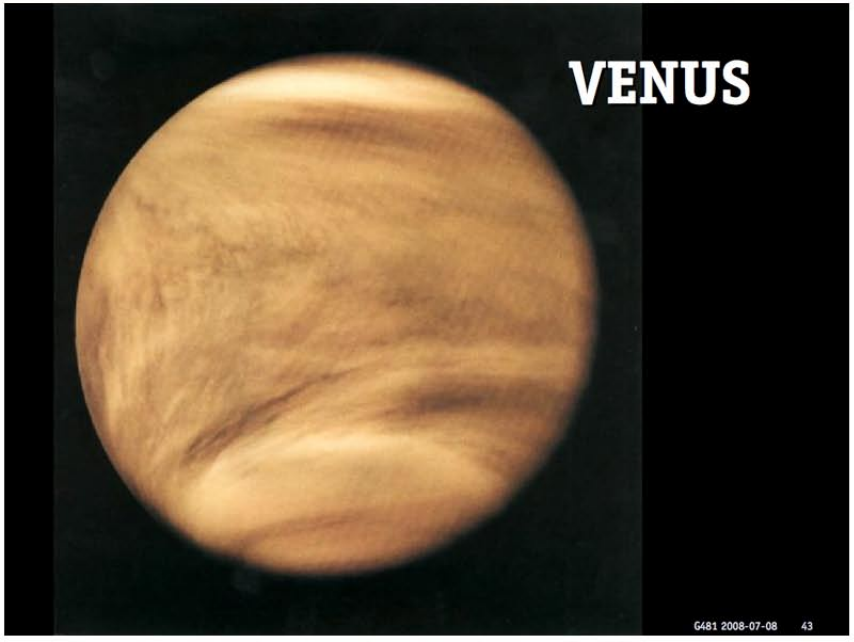




MERCURY



VENUS



EARTH


MARS
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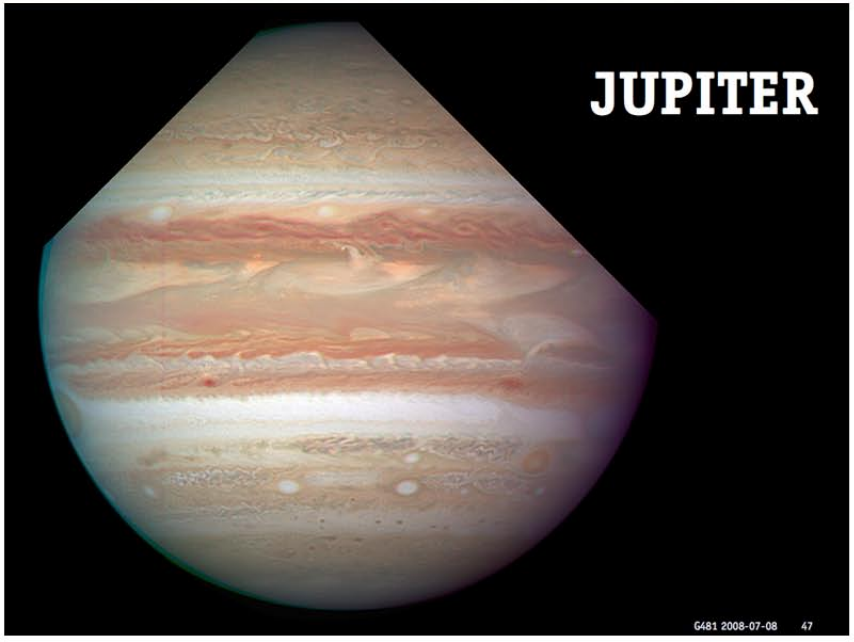
ASTEROIDS
G481 2008-07-08 46


JUPITER
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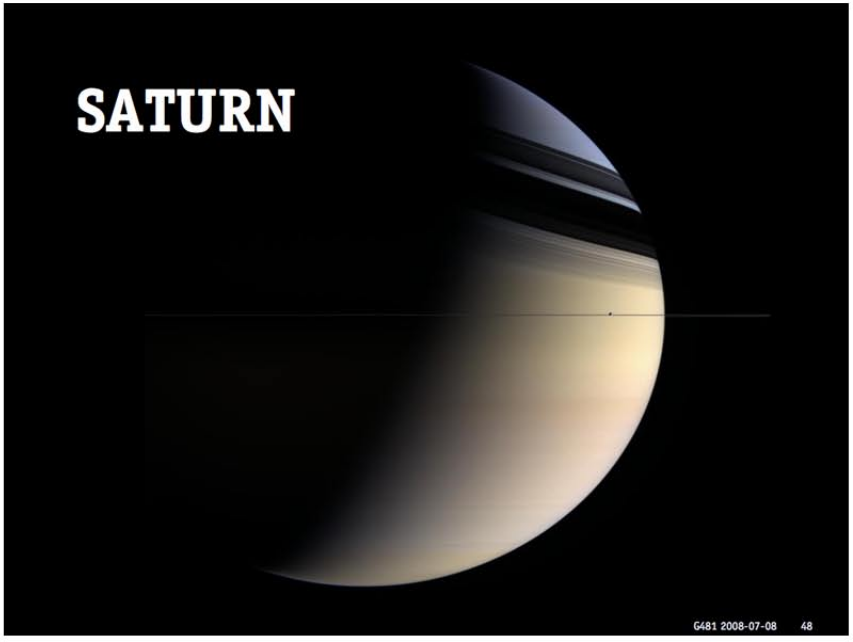
SATURN
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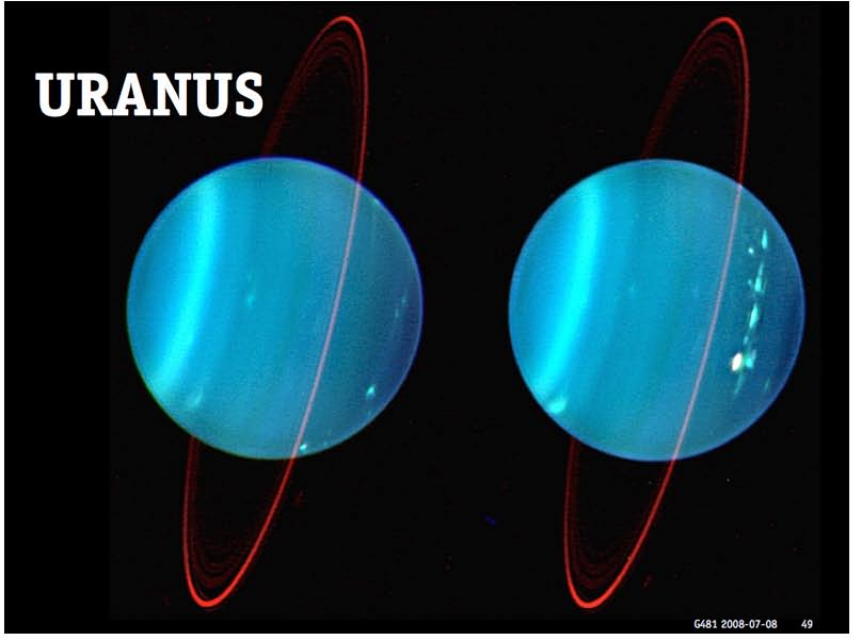
URANUS
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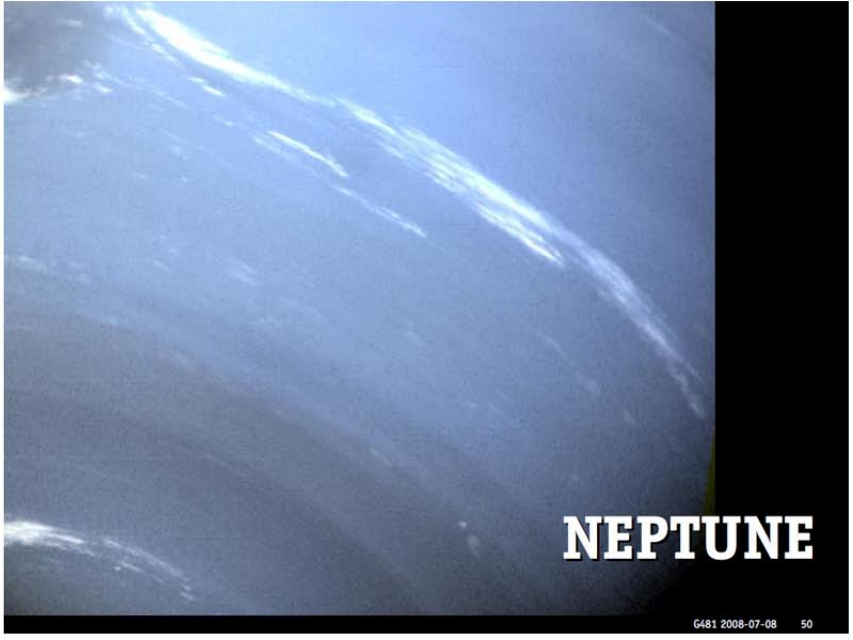
NEPTUNE
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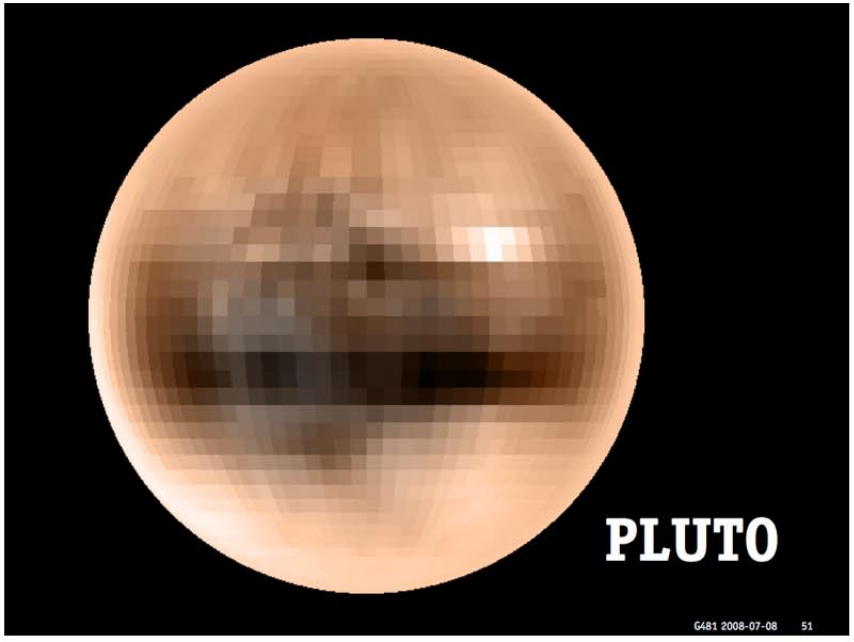
PLUTO
G481 2008-07-08 51


COMETS
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