Phases of Venus

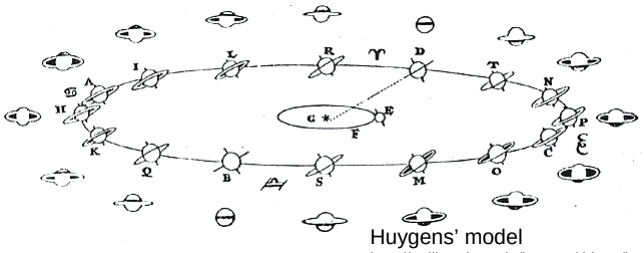
4. When Venus is very, very close to the sun in the sky (for example when Venus sets very shortly after the sun sets), what phases are possible?
   A. Crescent only
   B. Nearly full only
   C. Crescent and nearly full
5. When Venus is very, very close to the sun in the sky (for example when Venus sets very shortly after the sun sets), what phases are possible according to Ptolemy's model?
   A. Crescent only
   B. Nearly full only
   C. Crescent and nearly full

- Galileo in a letter to Castelli
  – "Know therefore that about 3 months ago I began to observe Venus with the instrument, and I saw her in a round shape and very small. Day by day she increased in size and maintained that round shape until finally, attaining a great distance from the Sun, the roundness of her eastern part began to diminish, and in a few days she was reduced to a semicircle. She maintained this shape for many days, all the while, however, growing in size. At present, she is becoming sickle-shaped…

1. Did Galileo disproved Ptolemy's model?
   A. Y
   B. N
2. Did Galileo prove Copernicus' model? Same foils.

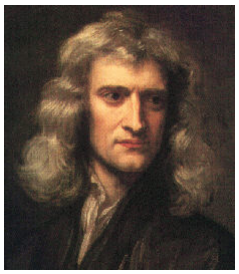
Saturn 1610

- I discovered another very strange wonder, which I should like to make known to their Highnesses . . . , keeping it secret, however, until the time when my work is published . . . . . the star of Saturn is not a single star, but is a composite of three, which almost touch each other, never change or move relative to each other, and are arranged in a row along the zodiac, the middle one being three times larger than the lateral ones, and they are situated in this form: oOo. —Letter to Medici
- Circulated an anagram: s m a i s m r m i l m e p o e t a l e u m i b u n e n u g t t a u i r a s.
  – *Altissimum planetam tergeminum observavi*, or "I have observed the highest planet tri-form."
- Tri-form disappeared in 1612.



Huygens' model
http://galileo.rice.edu/images/things/huygens_phases2.gif

Newton's Laws of Motion & Gravity—22 Sept

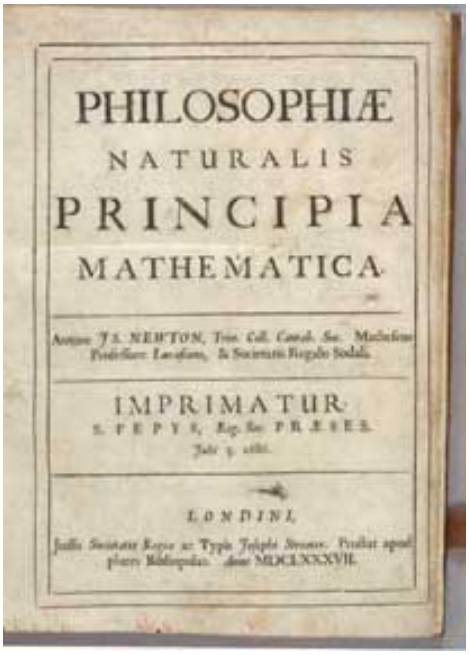


Isaac Newton (at 47) by Godfrey Kneller
Trustees of the Portsmouth Estate
www.huntington.org/LibraryDiv/Newton/Newtonexhibit.htm

- Astronomical Horizons Public Talk
  - Prof. Jack Baldwin
  - The Crab Nebula: a supernova baked in its shell
  - Thursday, September 23, at 7:30pm in Abrams Planetarium
- *De Revolutionibus Orbium Coelestium*, Copernicus, 1543
- *Astronomia Nova*, Kepler, 1609
- *Philosophiae Naturalis Principia Mathematica*, Newton, 1687
- Newton: Same laws apply to a falling apple & moving planet.
- Description of motion
- Newton's Law of Gravity (Force $\propto 1/R^2$) implies Kepler's 3rd Law

Copernicus	1473–1543
Columbus sails	1492
Tycho Brahe	1546–1601
Shakespeare	1564–1616
Johannes Kepler	1571–1630
Jamestown	1607
King James Bible	1611
Harvard College	1636
Isaac Newton	1642–1727
George Washington	1732-1799

- Nature and Nature's laws lay hid in night./ God said, Let Newton be! and all was light. —Newton's epitaph by Alexander Pope


PHILOSOPHIÆ
NATURALIS
PRINCIPIA
MATHEMATICA
IMPRIMATUR
LONDINI

"Natural" Motion for Newton & Aristotle

- Natural motion is motion that needs no explanation: the object naturally moves that way.
- Aristotle: For heavenly objects, natural motion is motion in a circle with the same speed. For base objects, natural motion is rest.
  - A book falls off the table and comes to rest on the floor. This needs no explanation because rest is the natural state.
- Newton: Natural motion is moving at the same speed in the same direction.
  - Newton's First Law: In the absence of a force, an object moves at the same speed in the same direction.

1. A book falls off the table and lands on the floor. For Newton, what is natural, needing no further explanation?
   a. The book is on the floor.
   b. The book is halfway to the floor.
   c. The book has fallen 1" from the table.

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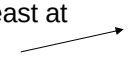
2. Venus moves around the sun in a circle at the same speed. Does Newton consider this motion natural?
   a. Yes, Venus is a heavenly object.
   b. Yes, the speed is the same.
   c. No, the direction is not always the same.
   d. No, Venus is not at rest.

Newton's Second Law

- Newton's First Law: In the absence of a force, an object moves at the same speed in the same direction.
- Velocity is the combination of speed and direction of motion
  - Specify speed and direction: I drive 10° north of east at 50mph.
  - Draw an arrow. Length specifies speed



Change in velocity

- Q The velocity changed in
  a. Case A only
  b. Case B only
  c. Neither cases A nor B
  d. Both cases A and B

- Case A
  - Velocity at start
  - Velocity after 1 s
- Case B
  - Velocity at start
  - Velocity after 1 s
- Case C
  - Velocity at start
  - Velocity after 1 s
- Case D
  - Velocity at start
  - Velocity after 2 s