Physics of the solar system—10 Jan

- Announcements
- Phenomena in the solar system and the physics to understand them.
  - Orbits of the planets
  - Orbits of the asteroids
  - Density of the planets
  - Volcanoes on Io, a moon of Jupiter

Class & observing

- Ast208, Planets and Telescopes, has two parts
  - Phenomena and physics of the solar system, for the most part, excluding the sun
    - Ed Loh, MF 11:30am-12:20pm
    - 60% of final grade
  - Observing techniques and projects
    - Horace Smith, Tues, 8:00-9:50pm
   - 40% of final grade

Syllabus

- The up-to-date syllabus is on angel.
- Slides will be put on angel soon after class. Link is the date.
- Office hours: Is MWF 10:00-11:00 OK?
- Reference, Carroll & Ostlie, will be on reserve in Business Library
- Clicker questions start on Fri.
  - Register your i-clicker at iclicker.com
  - You may turn in paper answers twice.
  - Lowest two will be dropped.
- Pre-class questions start on Fri.
  - Due at 8:00am on the day of the class.
- Homework (once a week)
- Midterm test
- Final exam

Phenomena

- Orbits of the planets. Kepler's Laws
- Orbits of the asteroids
- Density of the planets
- Volcanoes on Io, a moon of Jupiter

Kepler discovers Kepler's First Law of Planetary Motion

- "… I was wondering why and how a sickle of just that thickness (0.00429) came into being. While this thought was driving me around, while I was considering again and again… that my apparent triumph over Mars has been in vain, I stumbled entirely by chance on the secant of the angle 5° 18′, which is the measure of the greatest optical elongation. When I realized that this secant equals 1.00429, I felt as if I had been awakened from a sleep…" —Ch. 45 (a year's work later)
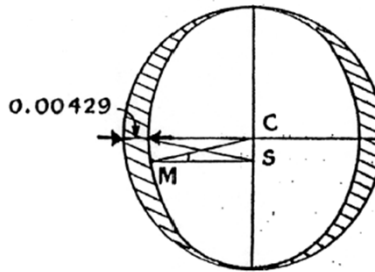
Kepler's First Law of Planetary Motion 1605

- The path of a planet is an ellipse.
  - Ellipse is figure for which D1+D2 does not change
  - The sun is at one focus.
  - Eccentricity = (dist between foci)/(major axis)
1. For this ellipse, the eccentricity is approximately
   A. 0
   B. 0.1
   C. 0.3
   D. 0.7
   E. 0.9
2. Same question for
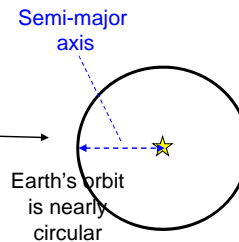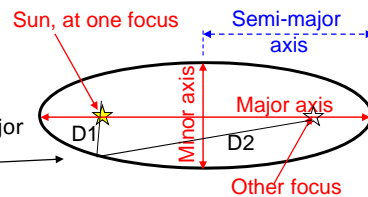
Kepler's Second Law 1602

- The line joining the planet and the sun sweeps out equal areas in equal amounts of time
  - Planet moves slowly when it is far from sun
  - Planet moves rapidly when close to sun

Kepler2ndLaw

Third Law 1618

- The size and periods of the planetary orbits are related by

  $P^2 = a^3$

  - where P is the period in years and
  - a is the half of the major axis in astronomical units

1. A 10th object (planet?) was found beyond the orbit of Pluto. ___ has the shorter period.

   A. Pluto

   B. 10th object

   C. Not enough information to answer

3rd Law
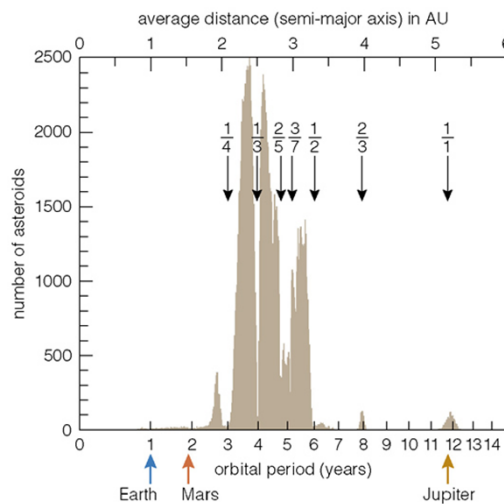http://web.cuug.ab.ca/~kmcclary/fastsolar.html

Physics of planetary orbits

- What physics is needed to explain the orbits of the planets?
  - Gravity
  - F=ma & Newton's other laws
  - Interaction is between sun & planet

Orbits of the asteroids

- Asteroids lie between the orbits of Mars and Jupiter.
- There are orbital radii that do not occur or are very infrequent.

Physics of the orbits of asteroids

- What physics is needed to explain the orbits of the asteroids?
  - Gravity
  - Newton's laws of motion
  - Must also consider interaction of 3rd body.
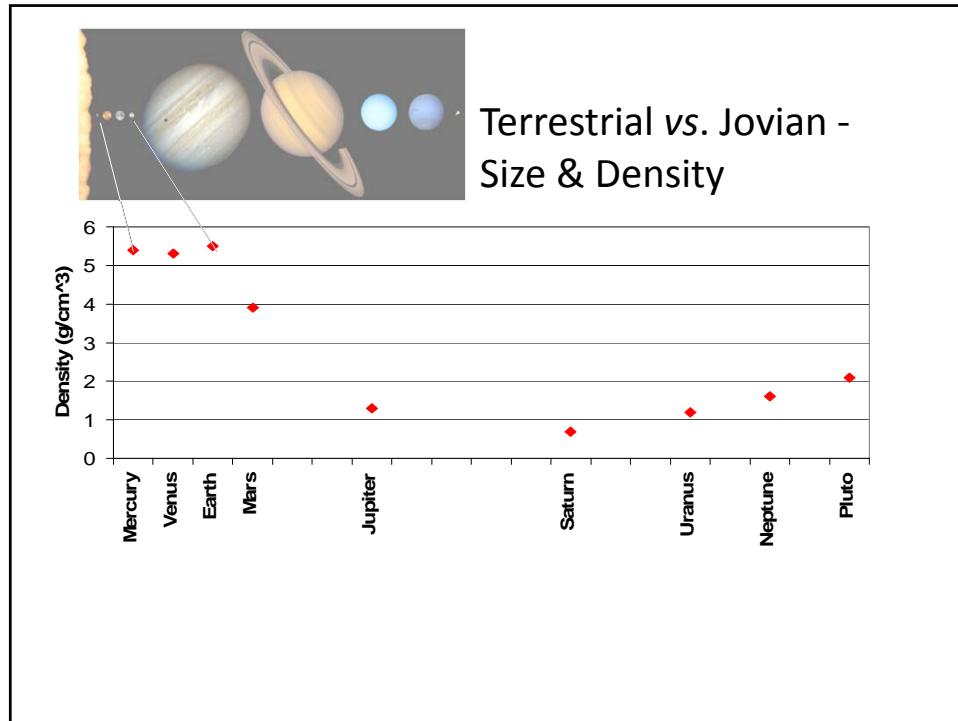
Density of the planets

- The planets near the sun are dense (like rock) and the farther planets less dense (like water).
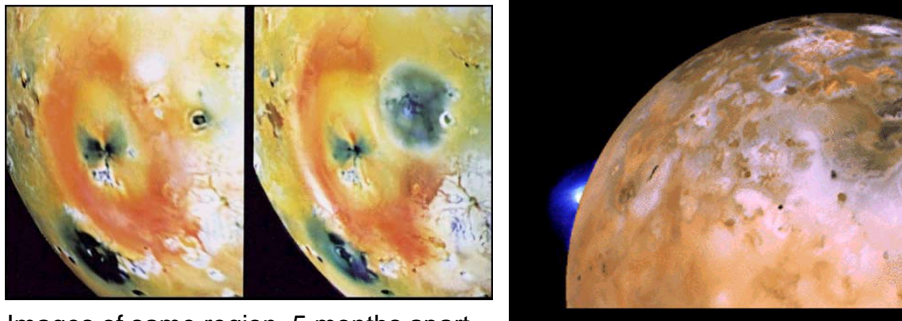

Jupiter; 1.3 gm/cm3

Mercury; 5.4 gm/cm3

Terrestrial *vs.* Jovian - Size & Density

Physics to account for the density of planets

- What physics is needed to explain the density of the planets?
  - Gravity
  - Temperature
  - History

Volcanoes on Io

Images of same region, 5 months apart.

Physics of Io's volcanoes

- What physics is needed to explain why Io is hot, so that it has volcanoes?
  - The moon is not so different in size from Io, and yet it has no volcanoes.