Introductory Astronomy

Week 2: Newton's Universe

Clip 2: Brahe, Kepler and Galileo

Data Gathering

- Tycho Brahe (1580) makes observations of planetary motion with improved accuracy

- J. Kepler (1609) finds that these are consistent with heliocentric model governed by three laws

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Kepler's Laws

- 1. Orbit of a planet is an ellipse with Sun at one focus

- What's at other focus? Nothing, not even the same for all planets

- Eccentricity small: 0.017 for Earth, 0.2 for Mercury.

- 2. Line from Sun to planet sweeps out equal areas in equal times

- Planet moves faster near perihelion, slower near aphelion

- Comets in highly eccentric orbits – dramatic effect

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Kepler's Third

- 3. Square of sidereal period proportional to cube of semimajor axis

$$P^2 = Ka^3$$

Same K for all planets!

Galileo's Smoking Scope

- New technology: Galileo (1610) turns telescope up
- Finds
  - phases of Venus showing it orbits Sun
  - Galilean moons orbiting Jupiter
  - Mountains on Moon, spots on Sun, ears on Saturn

- Also studied mechanics (science of motion) and formulated principle of inertia: An object will retain its state of motion unless disturbed externally
- To really get mechanics, Newton had to invent calculus

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This is Progress

- Galileo studies heavens as a physical system to be observed
- Kepler's laws predict planetary motion with unprecedented accuracy from simple model
- They are universal. In fact, they govern orbiting systems from Solar System to Saturn's Moons to…electrons in an Atom (with different K)
- Such universality is a hint of underlying fundamental laws
- It took Newton and new math to find them

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Credits

- Sky Simulation: Starry Night http://www.starrynight.com/

- Astronomy Animations: University of Nebraska-Lincoln Astronomy Education Group http://astro.unl.edu/