NEWTON, MOTION & GOD

1. Brief Biography (1642-1727)

2. Physics Around 1600

3. The Laws of Motion

4. Final Synthesis

5. God is Necessary
1. Brief Biography of a “silent, thinking lad”

• Born Xmas day 1642, year of Galileo’s death
  * father dies 3 months before birth
  * at 3 mother remarries

• 1665: Graduates from Cambridge
  * Plague: 2 years at home ➞ calculus
    mechanics
    gravitation
    optics

• 1667: Fellow at Cambridge; ‘69 Professor
• 1684: Halley asks about inverse square law
• 1687: Publishes the ‘Principia’
  Mathematical Principles of Natural Philosophy
• 1703: Publishes ‘Optics’
2. **Physics Around 1660**

- **2 pieces:**
  - Kepler’s 3 laws of planetary motion
  - Galileo’s laws of motion on Earth

- **Disagreement on:**
  - Nature of force moving planets
  - What would a body do if left alone

- **The problems:**
  I. Problem of weight: Why do things fall?
     * Galileo and Aristotle: 2 physics (even Galileo…)
       Aristotle: on earth -- natural and violent motion
       on heavens -- circular motion
     * Kepler: mutual attraction (a force!)
  II. Action at a Distance: Magnetism -- W. Gilbert
  III. Descartes and his vortices: no action at a distance!
3. The 3 Laws of Motion

• Foundations:
  * absolute space
  * absolute time
  * acceleration: measure of \textbf{CHANGE} in state of motion
  * force: measures the strength of agent of change
  * mass: measures resistance to change

I. Every body continues in its state of rest or uniform motion in a straight line, unless it is compelled to change that state by a force impressed on it. [Law of Inertia]

II. The change in motion is proportional to force impressed:
   \[ F = ma \quad (m=\text{mass}, \ a=\text{acceleration}) \]

III. To every action there is an equal and opposite reaction.
4. The Final Synthesis

- Newton brings Kepler and Galileo together!!
  The moon (and the apple) is falling!
- Physics of heavens is unified with physics of Earth

**GRAVITY!**

- Force points to the centers of objects
- \( F \approx \frac{1}{R^2} \)
- \( F \approx M_1 M_2 \)
- \( F = G \frac{M_1 M_2}{R^2} \) \([G=6.7 \times 10^{-8} \text{cm}^3/\text{g.sec}^2 - \text{Cavendish 1798}]\)
• Weight is not the same as mass!!

- Weight is gravitational force on mass m:
  \[ F_g = mg \]

\[ g: \text{ acceleration due to gravity is same for all bodies} \] (Galileu)

\[ F_g = mg = \frac{mGM}{R^2} \]

\[ \Rightarrow g = \frac{GM}{R^2} \]

Your weight depends on where you are:

\[ g_{\oplus} \neq g_{\text{earth}} \]
5. God is Necessary

- Action at a distance:
  “it is inconceivable that inanimate brute matter should, without the mediation of something else, which is NOT material, operate upon, and affect other matter without mutual contact…”

- God is prime mover

- Infinite Universe: A consequence of gravity (Bentley) God’s interference provides stability to planetary orbits

- Newton’s alchemical view and biblical chronology