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: 
  \{ 
  \begin{align*}
  & \text{Kepler’s 3 laws of planetary motion} \\
  & \text{Galileo’s laws of motion on Earth}
  \end{align*}
  \}

- Disagreement on: 
  \{ 
  \begin{align*}
  & \text{Nature of force moving planets} \\
  & \text{What would a body do if left alone}
  \end{align*}
  \}

- The problems:
  I. Problem of weight: Why do things fall?
    * Galileo and Aristotle: 2 physics (even Galileo…)
      \begin{align*}
      & \text{Aristotle: on earth -- natural and violent motion} \\
      & \text{on heavens -- circular motion}
      \end{align*}
      * 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 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:
   \[ F = ma \]  (m=mass, a= 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
- $F \approx 1/R^2$
- $F \approx M_1 M_2$
- $F = G \frac{M_1 M_2}{R^2}$  \[G=6.7\times10^{-8}\text{cm}^3/\text{g}.\text{sec}^2\ - \text{Cavendish 1798}\]
• Weight is not the same as mass!!

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

\( g \): acceleration due to gravity is same for all bodies
  (Galileo)

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

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

Your weight depends on where you are:

\[ g_{\text{moon}} \neq g_{\text{earth}} \]
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