

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: $\left\{ \begin{array}{l} \text{Kepler's 3 laws of planetary motion} \\ \text{Galileo's laws of motion on Earth} \end{array} \right\}$
- Disagreement on: $\left\{ \begin{array}{l} \text{Nature of force moving planets} \\ \text{What would a body do if left alone} \end{array} \right\}$
- 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 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:
$$F = ma \quad (m=\text{mass}, a= \text{acceleration})$$

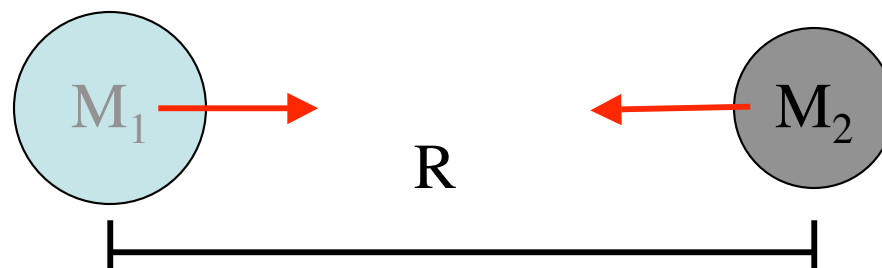
III. To every action there is an equal and opposite reaction.

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
- $F \approx 1/R^2$
- $F \approx M_1 M_2$
- $F = G M_1 M_2 / R^2$ [$G=6.7 \times 10^{-8} \text{cm}^3/\text{g} \cdot \text{sec}^2$ - 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)

$$F_g = mg = mGM/R^2$$

$$\Rightarrow g = GM/R^2$$

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