Lecture 3: Introduction to Newton's theory of classical mechanics.

Science

- Natural science
  - Physical science
  - Life science
- Social science

Physical science

$\boxed{\text{Physics}}$, Chemistry, Geology, Astronomy, etc...

Examples of theories:

- Euclidean geometry
  - Sytem: static objects ("frozen in time")
  - Describes geometry of physical objects
  - Fundamental quantity: lenght.
- $\boxed{\text{Newton's theory of classical mechanics.}}$
  - Sytem: every physical object in the world and
  - Describes their motion
  - Fundamental quantities: lenght, time, mass.

| - Einstein's theory of relativity | at the end of the course.

- Galileo Galilei 1564-1642.

Contribution: "Law of inertia". Introduced the measurement of time into a theory of motion.

- Isaac Newton 1642-1726

$\sim$ 1700 books: "Principia Mathematica"

Newton's theory of classical mechanics became a scientific paradigm. For the next 200 years physicists tried to explain everything using Newton's theory.

Comment: Newton's theory includes Euclidean geometry into it. In fact, he used this theory extensively when developing classical mechanics.

But Newton also needed to develope new mathematical tools: "Calculus"

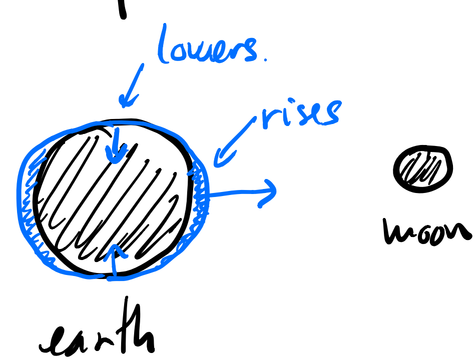
(e.g derivatives, integrals, limits, ...)

e.g Velocity is the derivative of the position w.r.t. time.

Succesful theory because it satisfied the 2 criteria necessary to consider it better than previous theories.

* It explains/predicts new phenomena
e.g tides, return of a comet.

* Unifies older independent theories into a simpler one.

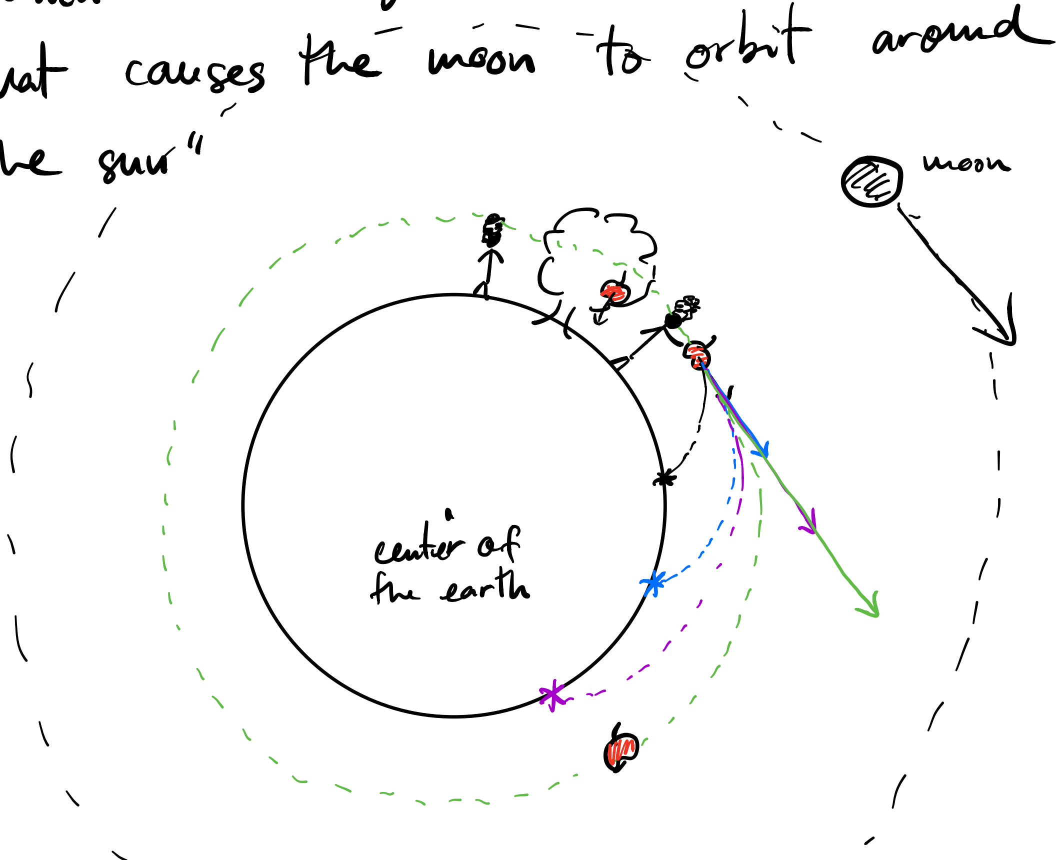


- Newton's unification:

Before Newton
- Theory for the motion of the objects in sky (planets, stars, ...)
- Theory for the motion of objects on earth. (Galileo)

With Newton these two phenomena are explained by the same theory (his theory)

" What cause an apple to fall from a branch into the ground is the same as what causes the moon to orbit around the sun"



"falling apple" = "apple orbiting the earth"
(like the moo does)

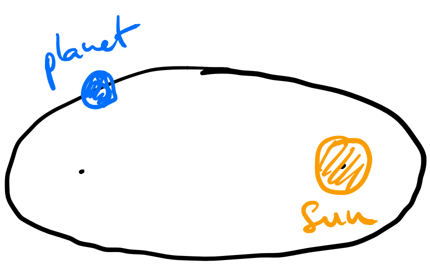
Unification : • free fall • planetary motion

Newton's theory.

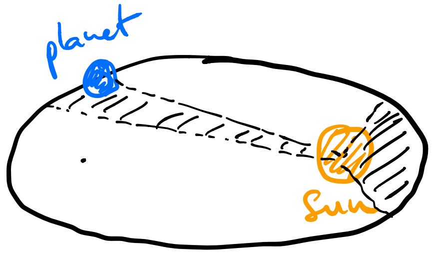
Another example of unification by Newton:

Before Newton, german astronomer Johannes Kepler, developed a theory to explain the motion of the planets in the solar system.

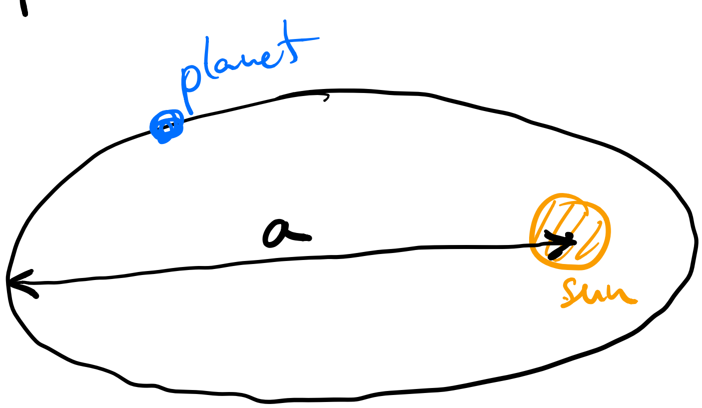
1) Orbit of a planet is an ellipse where the sun is at one of its focus.



2) A line joining a planet and the sun sweeps out equal areas in equal time intervals.



3) The square of the orbital period T of a planet is directly proportional to the cube of the semi-major axis a of the ellipse.



$T^2 \propto a^3$

directly proportional

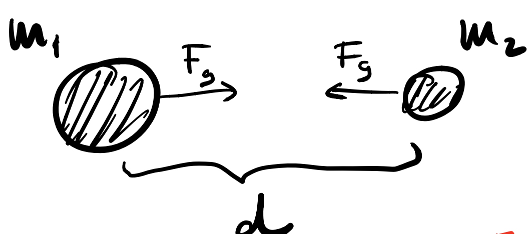
which is equivalent to write

$T^2 = K a^3$

(constant of proportionality
doesn't change in time &
is the same for all planets
in the solar system)

Newton is able to derive this 3 postulates from just one: the law of gravitation.

" the force between two massive bodies is proportional to the inverse of the distance between the two squared"



$$\boxed{F_g = G\frac{m_1 \cdot m_2}{d^2}}$$

force of gravity

This formula also applies to the objects on earth.