What is Classical Physics?

The usual answers.

→ Follows NLM, is macroscopic, EM-theory dictated, etc.

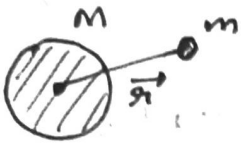
3rd Jan 2024

What is Classical physics?

→ Isaac Newton (1687)

→ Law of motion

→ Law of gravitation.

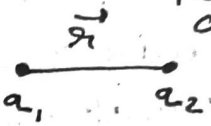


$$m\frac{d^2\vec{r}}{dt^2} = \vec{F} = -\frac{GMm}{r^2}\hat{r}$$

→ Charles Coulomb (1785) Static force? If there is accel there is motion. There is a conundrum.

→ Law of electrostatic force

$$\vec{F} = \frac{1}{4\pi\varepsilon_0}\frac{q_1 q_2}{r}\hat{r}$$



→ Ampere (1823)

→ Faraday (1831)

→ Gauss (1835)

→ Maxwell (1862)

→ Laws of Electrodynamics

(i) $\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\varepsilon_0}$

(ii) $\vec{\nabla}\cdot\vec{B} = 0$

(iii) $\vec{\nabla}\times\vec{E} = -\frac{\partial\vec{B}}{\partial t}$

(iv) $\vec{\nabla}\times\vec{B} = \mu_0\left(\vec{J} + \varepsilon_0\frac{\partial\vec{E}}{\partial t}\right)$

→ Lorentz (1895)

→ Law of electromagnetic force

$$\vec{F} = q(\vec{E} + \vec{v}\times\vec{B})$$

☐ Summary:

Law of motion → $\boxed{m\frac{d^2\vec{r}}{dt^2} = \vec{F}}$

Electromagnetic force — diff — **Gravitational force**

$\vec{F} = q(\vec{E} + \vec{v} \times \vec{B})$; $\vec{F} = m\vec{g}$, $\vec{g} = -\frac{GM\hat{r}}{r^2}$

In the static limit,

$\vec{F} = q\vec{E}$ ← Look Similar

- Why is speed of light an universal constant.
- Why is there no velocity dep term here for gravitation? — something like a magnetic component.

→ **Albert Einstein**

(STR) (GTR)

This is all of Classical physics

Ex: Consider a motion under a constant force: (in 1D)

$$m\frac{d^2x}{dt^2} = F = \text{const.}$$

Integrating,

$$\frac{dx}{dt} = u_0 + \int \left(\frac{F}{m}\right) dt = u_0 + \left(\frac{F}{m}\right)t$$

Integrating again,

$$x = x_0 + u_0 \int dt + \left(\frac{F}{m}\right)\int t\, dt$$

$$\Rightarrow x = x_0 + u_0 t + \frac{1}{2}\left(\frac{F}{m}\right)t^2$$

x_0, u_0 → const. of integration.

(NLM is silent about these — we guess / provide input)

physically, x_0 → Initial position

u_0 → Initial velocity.

Knowing these, the entire future of the particle is determined with certainty. → Classical physics is **deterministic**