L00 Introduction

Monday, August 26, 2019 07:04

Introduction - about me

around the room: name, interests, why physics [or not!], goals

Read course website/syllabus

text: Mason (download) first month, Taylor after that

schedule: vector calculus-> Lagrange's equations

{ballistic, damped, harmonic, driven} motion -> many body: 2, n,∞, 6

pre-class online: reading, video lecture/notes Lxx, multiple choice quiz: Qxx

in-class/online: demo, group assignments Hxx

office hours online: help finishing homework

introduce Q01, H01 (numerical mechanics: Matlab/Octave)

What is classical mechanics - the laws of motion? (basis for all physics PHY 231)

- Aristotle wrong -> Galileo experimented acceleration -> 1 law (kinematics)
- Kepler condensed Tycho Brahe's experimental data -> 3 laws ($1/r^2$)
- Hooke Cavendish, Coulomb, experimental data: spring, gravity, electricity ($1/r^2$)
- Newton combined terrestrial and celestial mechanics -> 3 laws (dynamics)

How do you solve classical mechanics? What is the math? (ODE vs E&M PDE)

$$\vec{F}(\vec{x},t) = m\vec{a} = m\frac{d^2\vec{x}}{dt^2} \qquad d\vec{x} = \vec{v}\,dt \qquad d\vec{v} = \vec{F}/m\,dt$$

for different force laws.
(particles vs. fields.)

- Lagrange, Hamilton, Poisson, Euler, Gauss et al -> 3-body problem, new formalism

Lagrange's equations: conservation of momentum, Hamilton's equations symmetric

$$\frac{\partial T}{\partial \vec{v}} = \frac{\partial}{\partial \vec{v}}\left(\tfrac{1}{2}m\vec{v}^2\right) = m\vec{v} \equiv \vec{p} \qquad \vec{F} = \frac{d}{dt}m\vec{v} = \dot{\vec{p}} \qquad \vec{F} = -\nabla V$$

$$\Rightarrow \underbrace{\frac{d}{dt}}_{\text{cons.}}\frac{\partial T}{\partial \vec{v}} = -\underbrace{\frac{\partial V}{\partial \vec{r}}}_{\text{sym}} \qquad \left(\frac{d}{dt}\frac{\partial}{\partial \vec{v}} - \frac{\partial}{\partial \vec{r}}\right)(T-V) \equiv \boxed{\frac{\delta}{\delta \vec{r}}\mathcal{L}(\vec{r},\vec{v},t) = 0}$$

$$\Rightarrow H = T + V \qquad T = \frac{\vec{p}^2}{2m} \qquad \boxed{\frac{\partial H}{\partial \vec{p}} = \frac{\vec{p}}{m} = \dot{\vec{x}} \qquad \frac{\partial H}{\partial \vec{x}} = \nabla V = \dot{\vec{p}}}$$

Euler-Lagrange eq.

Noether's thm.

Hamilton's eq.

Laid the theoretical framework to extend mechanics (quantized particles, fields)

- Poincaré (maps), Einstein (clocks) -> extend mechanics (relativistic frame, inertia)

Group activity: map out classical mechanics (entities, relations)

example for E&M: $\chi \to A \to F \to 0,\ U \to G \to J$