UiO : Fysisk institutt
Det matematisk-naturvitenskapelige fakultet

Lecture 9

This week

- **Wednesday:** Hamilton's principle and calculus of variations. (Section 3.6)
- **Thursday:** Problem set 4 (main topic: Lagrangian and Hamiltonian, phase space). Includes mid-term exam question form 2014.
- **Friday:** Relativity: fundamental principles. (Sections 4.1 and 4.2)

Today

- Hamilton's principle
  - The action and the principle of least (no?) action.
  - Equivalence to Lagrange's equations.
  - Use of variational calculus outside of mechanics.
  - The real power of the action (if time – not strictly part of the learning outcome).
  - Poisson brackets (if time – not strictly part of the learning outcome).

Learning outcomes

- Part I: Analytical Mechanics
  - Generalized coordinates and conjugate momenta
  - Lagrange’s equations
  - Symmetries and constants of motion
  - Hamiltonian dynamics
  - Calculus of variations

Summary

- **Hamilton's principle** or **the principle of least action** says that the action

$$S[q(t)] = \int_{t_1}^{t_2} L(q(t), \dot{q}(t), t)\, dt$$

as a function of the path q(t) is unchanged for small variations

$$q(t) \rightarrow q(t) + \delta q \quad \text{with} \quad \delta q(t_1) = \delta q(t_2) = 0$$

around the trajectory that fulfils the e.o.m.

- This is equivalent to Lagrange's equations.