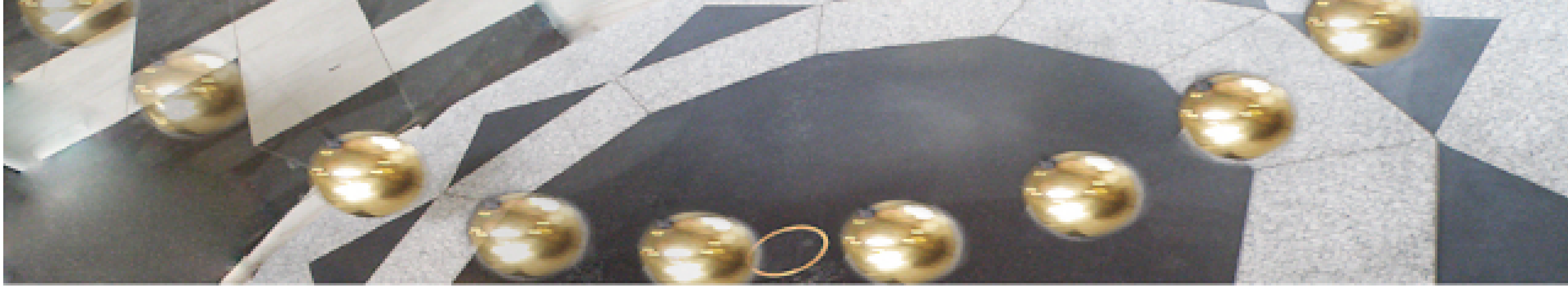

UiO : Fysisk institutt

Det matematisk-naturvitenskapelige fakultet

Lecture 4

This week

- **Monday:** Symmetries of systems (Section 2.3)
- **Wednesday:** Energy conservation, velocity dependent potentials. (Sections 2.3 and 2.4)
- **Problem session:** Problem set 2 (main topic: finding the e.o.m. from Lagrange's equation)

Recap

- The essence of Lagrange-Hamilton formalism is

Find generalized coordinates → Find K & V in terms of these → Find e.o.m. from K & V → Solve e.o.m. with initial conditions

- The Lagrange equation dealing with part 3 is

$$\frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right) - \frac{\partial L}{\partial q_i} = 0, \qquad j=1,2,\ldots,d$$

where the Lagrangian *L* is given by

$$L(q,\dot{q},t) = K(q,\dot{q},t) - V(q,t)$$

Plan for today

- Symmetries of systems (Section 2.3)
  - Conserved quantities (constants of motion)
  - Noether's theorem
  - Cyclic coordinates
  - Generalized momentum/conjugate momentum
  - More general symmetries of the Lagrangian
  - A proof of conservation of angular momentum! (If we have time)

Summary

- Cyclic coordinates are generalized coordinates q_i that do not appear in the Lagrangian
- The corresponding **conjugate momentum** p_i is conserved

$$p_i \equiv \frac{d}{dt}\left(\frac{\partial L}{\partial \dot{q}_i}\right)$$

- If Q is the parameter of a transformation leaving the Lagrangian invariant the conserved quantity K is

$$K = \sum_i \frac{\partial L}{\partial \dot{q}_i} Q_i$$