UiO : **Fysisk institutt**
Det matematisk-naturvitenskapelige fakultet

Lecture 20

This week

- **Wednesday:** Maxwell's equations. (Sections 9.1-9.5).
- **Thursday:** No problem class. Next problem set is due Monday 24th of April, after Easter.
- **Friday:** Electromagnetic potentials, gauge transformations, electromagnetic four-potential and Maxwell’s equations on covariant form. (Sections 9.5.1-9.7)
- **Mid-term:** solution draft available, we hope to finish grading by the first week after Easter.

Recap

- We can write a relativistic action as

$$S = \int_{\tau_1}^{\tau_2} L\left(x^\mu(\tau), U^\mu(\tau), \tau\right) d\tau$$

which is a Lorentz (transformation) invariant scalar using a Lorentz invariant Lagrangian L.

- Lagrange's equations are then

$$\frac{d}{d\tau}\frac{\partial L}{\partial U^\mu} - \frac{\partial L}{\partial x^\mu} = 0$$

where τ is proper time and U is four-velocity.

Today

- Quick repetition of all of Maxwell, including:
  - Charge conservation
  - Gauss' law (on integral & differential form)
    - Given charge, what electric field do you get.
  - Ampère's law (on integral & differential form)
    - What magnetic field do you get from a current and a changing electric field.
  - Gauss' law for a magnetic field (on integral & differential form)
    - No monopoles.

Today

- Quick repetition of all of Maxwell, including:
  - Faraday's law (integral & differential form)
    - What electric field you get from a changing magnetic field.
  - Summary of Maxwell's equations.
    - The stuff above.

Summary

- Maxwell's equations (differential form):

$$\vec{\nabla}\cdot\vec{E} = \frac{\rho}{\epsilon_0}$$

$$\vec{\nabla}\times\vec{B} - \frac{1}{c^2}\frac{\partial\vec{E}}{\partial t} = \mu\,\vec{j}$$

$$\vec{\nabla}\cdot\vec{B} = 0$$

$$\vec{\nabla}\times\vec{E} + \frac{\partial\vec{B}}{\partial t} = 0$$