UiO : Fysisk institutt

Det matematisk-naturvitenskapelige fakultet

Lecture 18

This week

- **Wednesday:** Newton's second law in relativistic form. (Section 8.1).
- **Thursday:** Problem set 9, more relativistic mechanics, lots of photons and the return of Compton scattering.
- **Friday:** The Lagrangian for a relativistic particle. (Section 8.2)
- **Next week:** No lectures or problem session. Mid-term exam will be posted Monday morning. To be handed in on Friday before 16.00.

Recap

- We can derive the Doppler effect by looking at Lorentz transformations of the four-momentum

$$\nu' = \gamma(1 - \beta\cos\theta)\nu$$

- Conservation of relativistic energy and momentum is given by the four-momenta

$$\sum_i p_i^\mu = \sum_f p_f^\mu$$

- The centre-of-mass reference frame is defined as the RF where

$$\vec{P} = \sum_i \vec{p}_i = 0$$

Today

- Newton's II law in a covariant form
  - Introduce a four-force and a relativistic force.
  - The zero-component of the four-force.
- The Lorentz force
  - Force on a charged particle from an electromagnetic field.
  - The electromagnetic field strength tensor.
  - Again(!) the example with a particle in a constant magnetic field.

Summary

- Relativistic four-force K^μ is defined as

$$K^\mu = \frac{dp^\mu}{d\tau} = \gamma\left(\frac{1}{c}\vec{c}\cdot\vec{F}\,,\,\vec{F}\right)$$

where the relativistic force F is

$$\vec{F} = \frac{d\vec{p}}{dt}, \qquad \vec{p} = \gamma m\vec{v}$$

- We can write the Lorentz force (force from electromagnetic field) on covariant form as

$$K^\mu = eF^{\mu\nu}U_\nu$$

where $F^{\mu\nu}$ is the electromagnetic field strength.