UiO : Fysisk institutt
Det matematisk-naturvitenskapelige fakultet

Lecture 17

Recap

- Relativistic four-momentum p^μ is defined as

$$p^\mu = mU^\mu = \left(\gamma mc, \gamma m\vec{v}\right) = \left(E/c, \vec{p}\right)$$

  where E and p is the relativistic energy and momentum. These reduce to ordinary kinetic energy plus rest energy, and to ordinary momentum in the non-relativistic limit.

- These lead to the energy-momentum relation

$$E^2 = p^2c^2 + m^2c^4$$

  which allows massless particles with E = pc.

Today

- Doppler effect for light
- Conservation of relativistic energy and momentum
  - Leads to mass non-conservation.
- Centre-of-mass reference frame
  - Just as in non-relativistic physics – the sum of momenta is zero.

Summary

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

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

- 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

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