UiO : Fysisk institutt

Det matematisk-naturvitenskapelige fakultet

Lecture 15

Recap

- We can generalize four-vectors to rank-n tensors with n indices, e.g. the rank-2 $F^{\mu\nu}$.
- We also have tensor fields, e.g. $\varphi(x)$, $A^\mu(x)$, $F^{\mu\nu}(x)$, that transform as relativistic tensors.
- We define a covariant derivative

$$\partial_\mu \equiv \frac{\partial}{\partial x^\mu}; \qquad \frac{\partial}{\partial x^\mu} = \left(\frac{1}{c}\frac{\partial}{\partial t}, \frac{\partial}{\partial x}, \frac{\partial}{\partial y}, \frac{\partial}{\partial z}\right)$$

- This can be used to define the d'Alembertian

$$\partial_\mu \partial^\mu = \frac{1}{c^2}\frac{\partial^2}{\partial t^2} - \vec{\nabla}^2$$

Today

- Four-velocity
  - A covariant (relativistic four-vector) velocity.
- Four-acceleration
  - A covariant (Lorentz vector) acceleration.
- Some practical advice on space travel (if time).

Summary

- We define four-velocity and four-acceleration in terms of the proper time τ

$$U^{\mu} \equiv \frac{dx^{\mu}}{d\tau}; \qquad A^{\mu} \equiv \frac{d^2x^{\mu}}{d\tau^2}$$

- The **proper acceleration** is defined as the acceleration in the instantaneous inertial RF (the rest frame where v = 0). This is the acceleration experienced by an object.