UiO : Fysisk institutt
Det matematisk-naturvitenskapelige fakultet

Lecture 12

Recap

- We can write **Lorentz transformations** as the matrix multiplication (note index system!)

$$x'^{\mu} = L^{\mu}{}_{\nu} x^{\nu}$$

or x’ = Lx, where, for a boost in the x-direction,

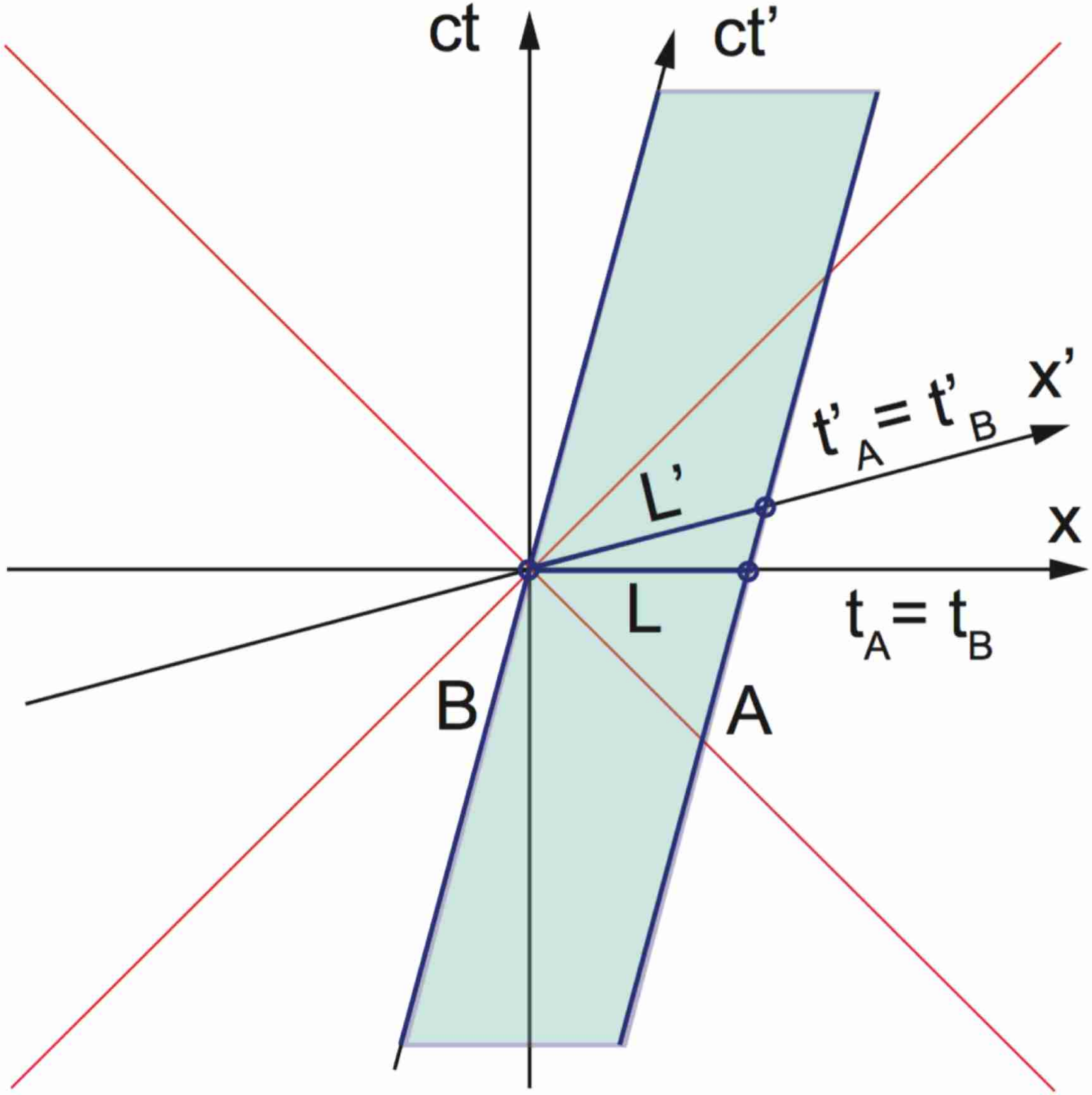
$$L = \begin{bmatrix} \gamma & -\beta\gamma & 0 & 0 \\ -\beta\gamma & \gamma & 0 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

- Adding translations we have the **Poincaré transformation** x’ = Lx+a.

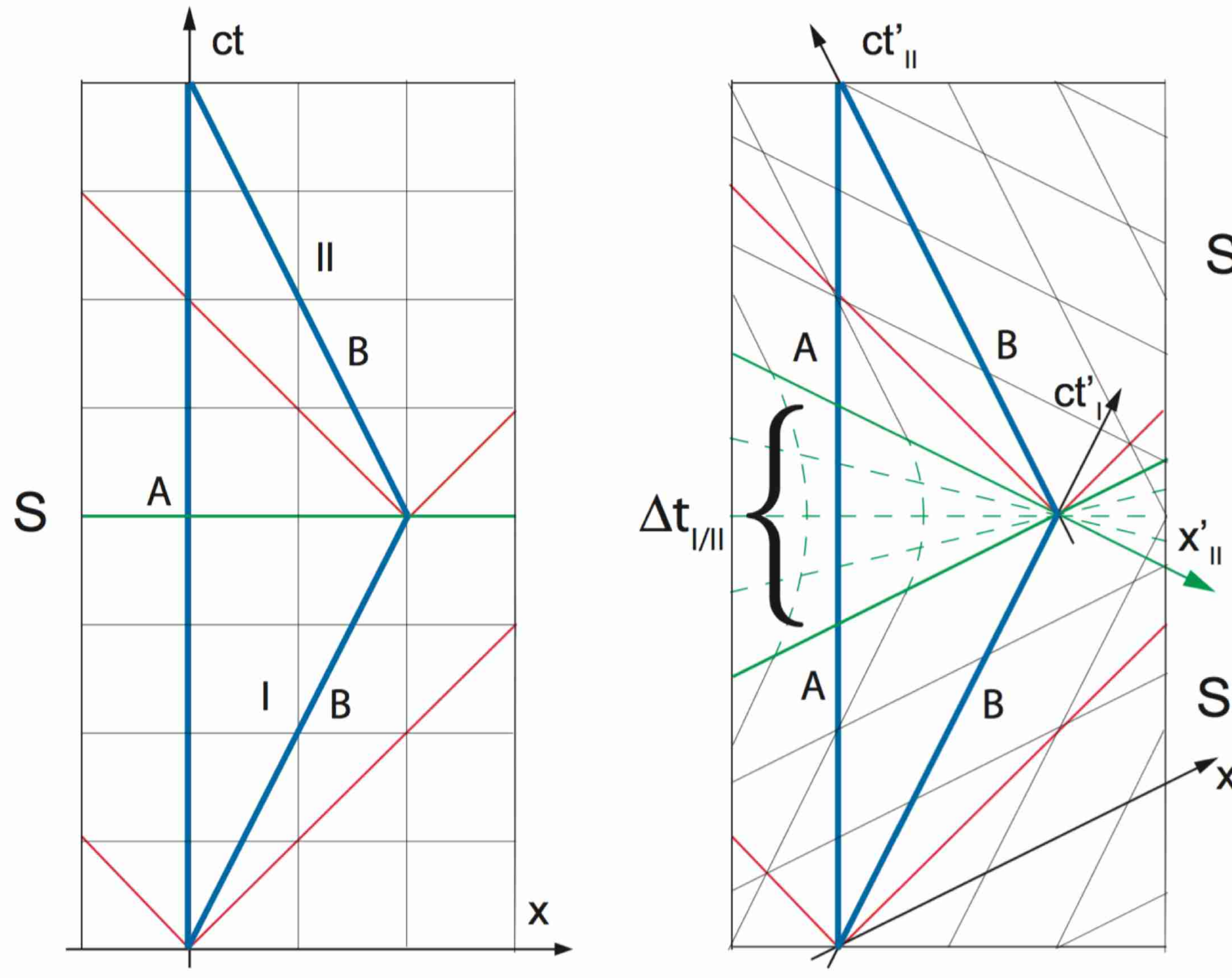
Plan for today

- Length contraction
  - The length of objects is different in different RFs!
- Time dilatation
  - Time moves differently in different RFs!
- Proper time
  - How to get a good definition of time even when accelerating.
- The twin paradox (*sigh*)
  - A completely bloody annoying useless example of nothing.

Length contraction



Twin paradox



Summary

- A body of length L_0 at rest in RF S' moving with velocity v w.r.t. RF S has length L in S given by

  $$L = \frac{1}{\gamma} L_0 \leq L_0$$

  A time interval τ in S' is the interval t in S

  $$t = \gamma \tau \geq \tau$$

  This is **length contraction** and **time dilation**.

- The **proper time** is given as

  $$\tau_{AB} \equiv \int_{t_A}^{t_B} \sqrt{1 - \frac{v^2(t)}{c^2}}\, dt$$