Ch2_SR_in_a_Nutshell

The 2 Fundamental postulates

- ⚖ **The Principle of Relativity:** The physics laws are the same inside all inertial reference frame
    - They physical values might be different (velocity, energy...), but these values obey the same law.
- ⚖ **Constant of light speed**: The speed of light is constant in every frame (for all observers)

Core Concepts

- 🄰 **An observer** is the set of synchronized grid of clocks that records all events
- 🄰 **A frame is inertial** in a region of spacetime where, throughout that region, Newton's 1st law apply.
    - The need for a region is due to the harsh reality that there is no place in the universe that is truly inertial, with flat spacetime.
    - For example, a spacelab in near earth orbit is not inertial if expanded to include earth. (because it would be accelerating towards you at $8ms^{-2}$) This frame would only be inertial in the vicinity of spacelab, in a short time.

Lorentz Transform matrix

- Lorentz transform acts as a **linear transform** of 4-vectors, while also a coordinate transform between two frames that shares origin

$$\begin{pmatrix} t \\ x \\ y \\ z \end{pmatrix} = \begin{pmatrix} \gamma & -\beta\gamma & 0 & 0 \\ -\beta\gamma & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} t' \\ x' \\ y' \\ z' \end{pmatrix}$$

- Lorentz transform is a hyperbolic 'rotation'

$$\begin{pmatrix} cosh & -sinh \\ -sinh & cosh \end{pmatrix}$$

- The inverse transformation is acquired by reversing the sign of β, which just negate the velocity.

Velocity addition

Imaging reference frame S_1, S_2, S_3. Velocity addition calculates: known v_{S_2,S_1} and v_{S_3,S_2}, the speed of S_3 viewed in S_1 is:

$$v_{3,2} = \frac{v_{3,1} - v_{2,1}}{1 - v_{3,1}v_{2,1}}, \quad v_{3,1} = \frac{v_{3,2} + v_{2,1}}{1 + v_{3,2}v_{2,1}}$$