

# Ch2\_SR\_in\_a\_Nutshell

## 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.

### 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.

### Lorentz Transform:

- Lorentz transform acts as a transform of the interval 4-vector, 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  $\beta$ , which just negate the velocity.