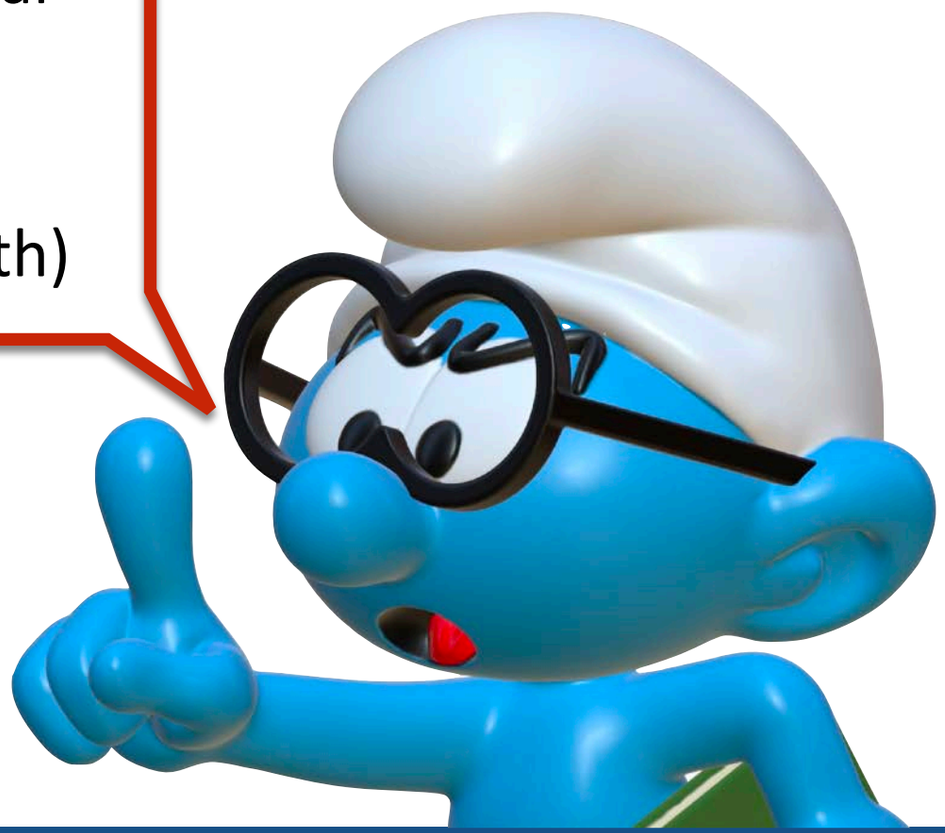
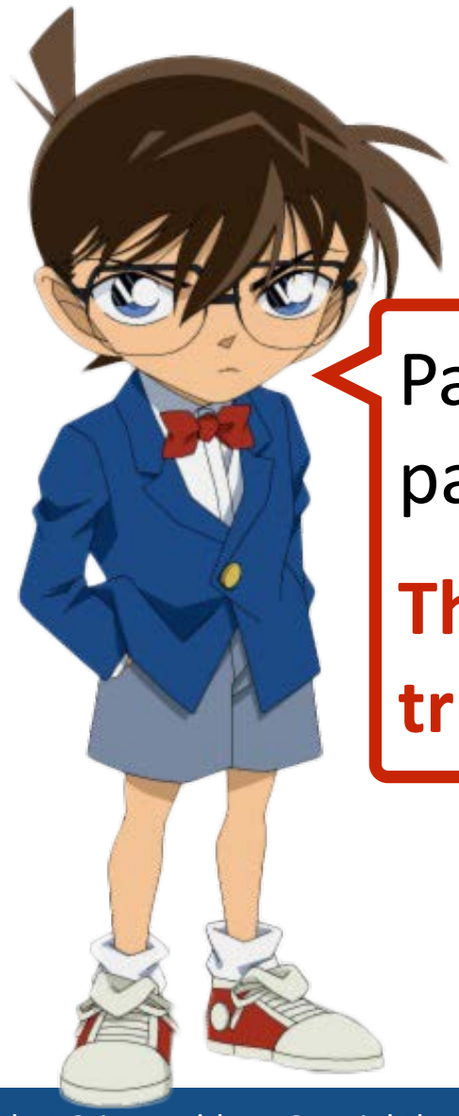
Summary: special theory of relativity (part-1)

1. Coordinates (x, t) in one frame are related to coordinates (x', t') in another frame by the Lorentz transformation formulas.
2. Similarly, space and time intervals $(\Delta x, \Delta t)$ in one frame are related to intervals $(\Delta x', \Delta t')$ in another frame by the same Lorentz transformation formulas.
3. Time dilation and length contraction are just special cases:
    1. It is time-dilation if $\Delta x = 0$ (proper time)
    2. It is length contraction if $\Delta t = 0$ (proper length)



Summary: consequences of the special theory of relativity and paradoxes

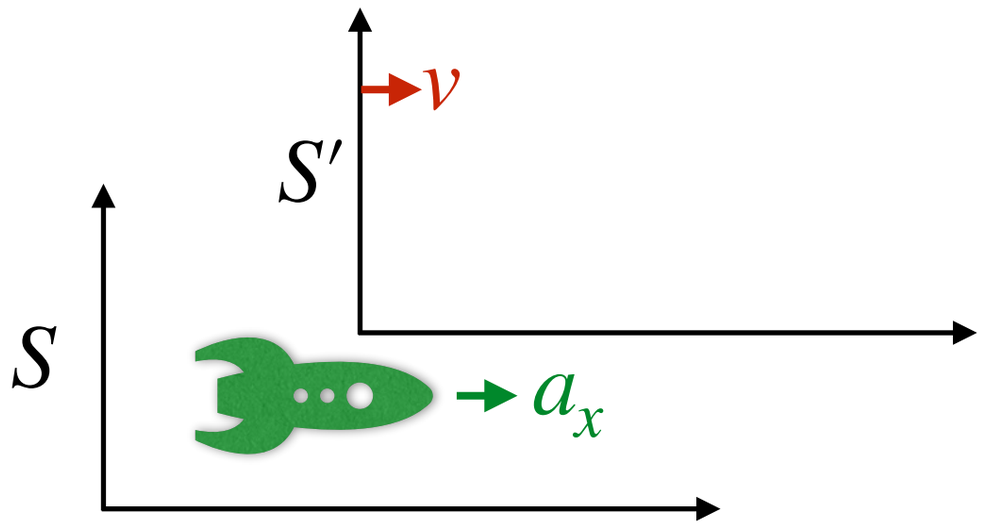


Paradoxes are just apparent paradoxes, they are not true.

There is always only one truth!

Acceleration in special theory of relativity

Let's discuss about how different initial observers will see an object under constant acceleration.



Space-Time interval & single particle 4-momentum

Relativistic linear momentum & relativistic energy

Exercise:

An unstable particle at rest spontaneously breaks into two fragments of unequal mass. The mass of the first fragment is 2.50×10^{-28} kg, and that of the other is 1.67×10^{-27} kg. If the lighter fragment has a speed of 0.893c after the breakup, what is the speed of the heavier fragment?

Electron volt

When dealing with subatomic particles, it is convenient to express their energy in electron volts because the particles are usually given this energy by acceleration through a potential difference.

The conversion factor is

$$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$$

For example, the mass of an electron is 9.11×10^{-31} kg. Hence, the rest energy of the electron is

Exercise:

Determine the energy required to accelerate an electron from (a) 0.500c to 0.900c and (b) 0.900c to 0.990c.

Exercise:

A pion at rest ($m_\pi = 273m_e$) decays to a muon ($m_\mu = 207m_e$) and an antineutrino ($m_\nu \approx 0$). The reaction is written $\pi^- \rightarrow \mu^- + \bar{\nu}$. Find (a) the kinetic energy of the muon and (b) the energy of the antineutrino in electron volts.

Exercise: