# Relativity : Notes/W.S.-40

Length Contraction

Two observers that move at a constant speed with respect to each other, disagree on the time that it takes for an event to occur. They also disagree on the length of an object or the distance between two points.

Suppose that a spaceship travels from planet A to planet B. Observers on A and B both measure the distance between the planets as L_o. We shall show that the astronaut measures a different distance between the planets.
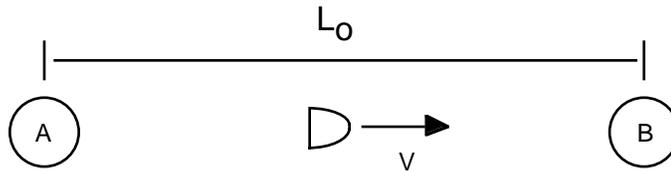
The time measured for the trip by an observer on planet A or B is;

$$t = \frac{L_o}{v}$$

An astronaut on the spaceship measures a time of t_o for the trip.

$$t_o = t \cdot \sqrt{1 - \frac{v^2}{c^2}}$$

The astronaut measures the distance between the planets as:

$$L = v \cdot t_o$$

So we have:

$$L = L_o \cdot \sqrt{1 - \frac{v^2}{c^2}}$$

This equation shows that the distance between the planets as measured by the astronaut is smaller than the distance measured by the observers.

From the observers' point of view, the spacecraft, or anything else that is moving, also contracts.

Problems:

1)a) A spaceship passes an observer with a speed of 0.750 c. If the spaceship is measured to be 18.0 m long by the astronaut, what is the length of the ship as measured by the observer?

b) The astronaut sees a similar ship parked near the observer. What length does the astronaut measure for the ship?

c) What is the speed that the spaceship must be moving, so that its length is 9.0 m according to the observer?

2) An advanced spaceship travels with a speed of $v = 1.80 \times 10^8$ m/s (0.600 c) from a planet to its moon. The distance (L_o) between the planet and the moon is measured to be 1.20×10^{10} m by an observer on the planet.

a) Find the time (t) which the observer measures for the trip.

b) Find the time (t_o) which the astronaut measures for the trip.

c) Find the distance (L) from the planet to the moon as measured by the astronaut.

3) A meter stick (length = 100. cm) moves past an observer at a speed of 0.950 c. What is the length of the meter stick as measured by the observer?

Answers: 1)a) 11.9 m, b) 11.9m, c) 0.87 c, 2)a) 66.7 s, b) 53.4 s, c) 9.60×10^9 m, 3) 31.2 cm.