Length Contraction: B.Sc. Part-1, Hons. & Sub.

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LENGTH CONTRACTION

Let S and S' be inertial systems moving with relative velocity v along the xx' axes. Consider a rod at rest in the inertial system S' lying parallel to the x'-axis. Though the system S' is moving with a relative velocity, to the observer in S' the rod is at rest. The length in an inertial frame in which the rod is at rest is called its **proper length**. The length of the rod $L_0 = x_2' - x_1'$, where x_1' and x_2' are the co-ordinates of its two ends measured at the same instant of time. To an observer in S, the length of the rod $L = x_2 - x_1$ where x_1 and x_2 are the co-ordinates of its two ends measured at the same time; therefore, $t_2 = t_1 = t$. Using Lorentz transformation

$$x'_2 = \gamma(x_2 - vt_2) \qquad x'_1 = \gamma(x_1 - vt_1)$$

Using above in $L_0 = x'_2 - x'_1$ gives

$$L_0 = \gamma(x_2 - x_1) = \gamma L$$

$$L = L_0\sqrt{1-\beta^2}$$

Since $\sqrt{1-\beta^2}$ is always less than unity, the length $L < L_0$. That is, to an observer in *S* the rod looks as though it is contracted parallel to the direction of motion.

The effect is reciprocal. If a rod has a length L_0. in *S*, to an observer in *S* which is in relative motion, it will appear to be of length $L_0\sqrt{1-\beta^2}$. The phenomenon of length contraction is referred to as **Lorentz-Fitzgerald contraction.** Thus, the space which is reduced to the measurement of length in physics and the geometrical shapes of objects cannot be absolute but only relative.