

B.Sc Part-I

SIMULTANEITY

Any two events are said to be simultaneous if they occur at the same time.

Consider two frames of reference S and S' . S' is moving with velocity V along x -axis. Also let two events occur simultaneously in S at two different points $P_1 (x_1, y_1, z_1, t_1)$ and $P_2 (x_2, y_2, z_2, t_2)$ so that

$$x_1 \neq x_2, t_1 = t_2$$

The events are simultaneous in

$$S \Rightarrow t_1 = t_2$$

Let t_1' and t_2' be time in S' corresponding to the time t_1 and t_2 in S .
By Lorentz transformation,

$$t_1' = \beta \left(t_1 - \frac{Vx_1}{c^2} \right), t_2' = \beta \left(t_2 - \frac{Vx_2}{c^2} \right)$$

$$\begin{aligned} t_2' - t_1' &= \beta (t_2 - t_1) + \beta \frac{V}{c^2} (x_1 - x_2) \\ &= \beta \frac{V}{c^2} (x_1 - x_2). \text{ For } t_1 = t_2 \end{aligned}$$

But $x_1 \neq x_2$ so that the last says that $t_1' \neq t_2'$. This means that the same two events are not simultaneous in S' .

Two events at different places P_1 and P_2 which are simultaneous for an observer at rest in S , are no longer simultaneous to an observer S' which is moving with velocity v relative to S along x -axis. It shows that simultaneity is not absolute, but it is relative.
