LORENTZ TRANSFORMATIONS AND SIMULTANEITY

Link to: physicspages home page.

To leave a comment or report an error, please use the auxiliary blog.

References: Griffiths, David J. (2007), Introduction to Electrodynamics, 3rd Edition; Pearson Education - Chapter 12, Post 13.

Here's a simple example of using the Lorentz transformations. Suppose that two events occur simultaneously in the Earth frame, a distance 500 km apart. An observer in a (very fast) plane travelling at $\frac{12}{13}c$ along the line joining the events passes the first event A such that their respective coordinate origins coincide at that event. At what time does the plane observer think event B occurs?

The Lorentz transformations are

$$\begin{aligned} \bar{x} &= \gamma(x - vt) && (1)\\ \bar{t} &= \gamma\left(t - \frac{xv}{c^2}\right) && (2) \end{aligned}$$

Event A occurs at the same time $t = \bar{t} = 0$ in both systems. For event B, $x = 500$ km and $t = 0$, so

$$\begin{aligned} \bar{t} &= \gamma\left(-\frac{500v}{c^2}\right) && (3)\\ \gamma &= \frac{13}{5} && (4)\\ \bar{t} &= -\frac{13}{5}\left(\frac{12c}{13}\frac{500}{c^2}\right) && (5)\\ &= -\frac{1200}{c} && (6)\\ &= -\frac{1200 \text{ km}}{3 \times 10^5 \text{ km s}^{-1}} && (7)\\ &= -4 \times 10^{-3} \text{ s} && (8) \end{aligned}$$

Thus the plane observer thinks that B occurs 4 milliseconds before A.