相对论

2019年10月8日 21:28

洛伦兹变换: $x^2+y^2+z^2-c^2t^2 = x'^2+y'^2+z'^2-c^2t'^2$ $\quad y'=y \quad z'=z$.

$$\begin{cases} x' = ax + b(ct) \\ ct' = dx + e(ct) \end{cases} \Rightarrow \begin{cases} a=e = \frac{1}{\cos\theta} \\ b=d = \tan\theta \\ a^2-d^2=1 \end{cases}$$

引入 $\beta = \frac{b}{a} = \sin\beta$. $\quad \begin{cases} a = \frac{1}{\sqrt{1-\beta^2}} \\ b = \frac{\beta}{\sqrt{1-\beta^2}} \end{cases}$

$$\frac{dx'}{dt} \Big/ \frac{dt'}{dt} = -v \Rightarrow \beta = -\frac{v}{c}$$

$$\begin{cases} x' = \frac{x - vt}{\sqrt{1-v^2/c^2}} \\ y'=y \quad z'=z \\ t' = \frac{t - \frac{v}{c^2}x}{\sqrt{1-v^2/c^2}} \end{cases} \quad \text{或者} \quad \begin{cases} x = \frac{x'+vt'}{\sqrt{1-v^2/c^2}} \\ y=y' \quad z=z' \\ t = \frac{t' + \frac{v}{c^2}x}{\sqrt{1-v^2/c^2}} \end{cases}$$

钟慢效应: $\Delta t = \frac{\Delta t'}{\sqrt{1-v^2/c^2}}$

"同时" K'系中同时. $t_1 = \frac{t' + \frac{v}{c^2}x_1'}{\sqrt{1-v^2/c^2}}$ $\quad t_2 = \frac{t' + \frac{v}{c^2}x_2'}{\sqrt{1-v^2/c^2}}$ $\quad \Delta t = \frac{v}{c^2}\frac{x_2'-x_1'}{\sqrt{1-v^2/c^2}}$

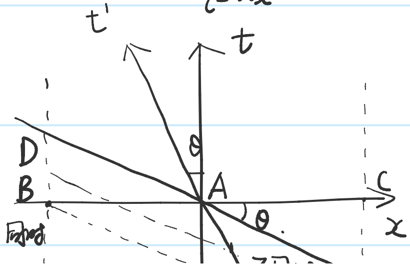
尺缩效应: $x_1' = \frac{x_1 - vt}{\sqrt{1-v^2/c^2}}$ $\quad x_2' = \frac{x_2 - vt}{\sqrt{1-v^2/c^2}}$ $\quad L = L'\sqrt{1-\frac{v^2}{c^2}}$

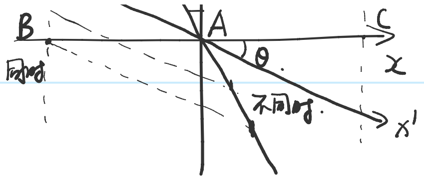
时空间隔: $\Delta s = \sqrt{c^2(t_1-t_2)^2-(x_1-x_2)^2+(y_1-y_2)^2+(z_1-z_2)^2}$ $\quad d\tau = \frac{1}{c}ds = dt\sqrt{1-\frac{u^2}{c^2}} = dt'\sqrt{1-\frac{u'^2}{c^2}}$

速度变换: $\begin{cases} dx = \frac{dx'+v\,dt'}{\sqrt{1-v^2/c^2}} \\ dy = dy' \quad dz = dz' \\ dt = \frac{dt' + \frac{v}{c^2}dx'}{\sqrt{1-v^2/c^2}} \end{cases}$ $\quad \begin{cases} u_x = \frac{dx}{dt} \\ u_y = \frac{dy}{dt} \\ u_z = \frac{dz}{dt} \end{cases}$ $\quad \begin{cases} u_x' = \frac{dx'}{dt'} \\ u_y' = \frac{dy'}{dt'} \\ u_z' = \frac{dz'}{dt'} \end{cases}$

$u_x = \frac{u_x'+v}{1+\frac{v}{c^2}u_x'}$ $\quad u_y = \frac{u_y'\sqrt{1-v^2/c^2}}{1+\frac{v}{c^2}u_x'}$ $\quad u_z = \frac{u_z'\sqrt{1-v^2/c^2}}{1+\frac{v}{c^2}u_x'}$ $\quad$ 两速度只要有一个为c 合速度为c

逆: $u_x' = \frac{u_x - v}{1-\frac{v}{c^2}u_x'}$ $\quad u_y' = \frac{u_y\sqrt{1-v^2/c^2}}{1-\frac{v}{c^2}u_x'}$ $\quad u_z' = \frac{u_z\sqrt{1-v^2/c^2}}{1-\frac{v}{c^2}u_x'}$ $\quad$ 两速度均小于c 合速度<c.





质量 $= m(u) = \dfrac{m_0}{\sqrt{1-u^2/c^2}}$ $\vec{p} = \dfrac{m_0}{\sqrt{1-u^2/c^2}}\vec{u}$

质能公式：$E = mc^2 = \dfrac{m_0 c^2}{\sqrt{1-u^2/c^2}} \approx m_0 c^2 + \dfrac{1}{2} m_0 v_0^2$

$$E^2 = p^2c^2 + m_0^2 c^4$$

静质量为零：$E = pc$.