B.Sc Part - I

RELATIVISTIC DOPPLER EFFECT

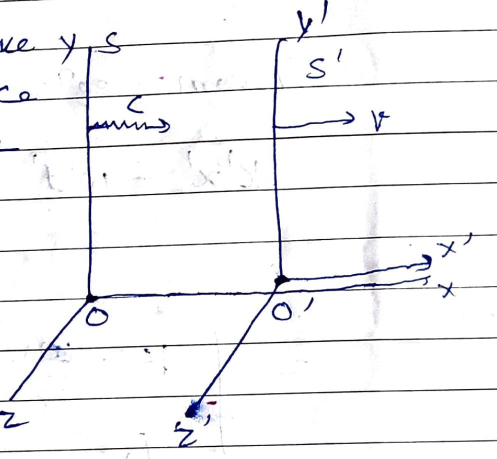
It is the phenomenon of apparent change in frequency or wavelength of light due to the relative motion between source of light and the observer.

When the velocity of observer is comparable to $c \rightarrow$ relativistic Doppler effect

1. Longitudinal RDE
2. Transverse RDE

1) Longitudinal RDE →

Equation of plane wave emitted by source of light in S frame of reference.



$$\xi = \xi_0 \sin(Kx - \omega t)$$

where $\omega = 2\pi\nu$

$$K = \frac{2\pi}{\lambda}$$

Phase associated with wave

$$\phi = Kx - \omega t$$

Phase associated with wave as observed in S'

$$\phi' = K'x' - \omega' t'$$

Ajanta Officer

But for a wave Phase should be constant.

so $\phi' = \phi$

$$k'x' - \omega't' = kx - \omega t \quad \text{——— (1)}$$

According to inverse Lorentz transformation equation

$$\left.\begin{aligned} x &= \frac{x' + vt'}{\sqrt{1 - v^2/c^2}} \\ t &= \frac{t' + \frac{vx'}{c^2}}{\sqrt{1 - v^2/c^2}} \end{aligned}\right\} \quad \text{——— (2)}$$

From eqn (1) and (2)

$$k'x' - \omega't' = k\left[\frac{x' + vt'}{\sqrt{1 - v^2/c^2}}\right] - \omega\left[\frac{t' + \frac{vx'}{c^2}}{\sqrt{1 - v^2/c^2}}\right]$$

$$= \left[\frac{k - \frac{\omega v}{c^2}}{\sqrt{1 - v^2/c^2}}\right]x' - \left[\frac{\omega - kv}{\sqrt{1 - v^2/c^2}}\right]t'$$

comparing both sides

$$k' = \frac{k - \frac{\omega v}{c^2}}{\sqrt{1 - v^2/c^2}}$$

& $$\omega' = \frac{\omega - kv}{\sqrt{1 - v^2/c^2}}$$