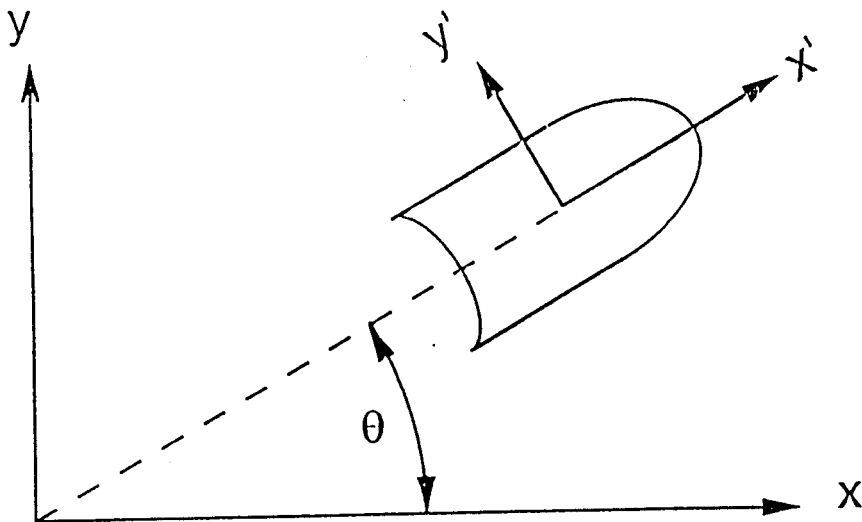


A rocket ship travels at a relativistic velocity $\vec{v} = v_0 \begin{pmatrix} \cos\theta \\ \sin\theta \\ 0 \end{pmatrix}$ with respect to an observer O in the x-y coordinate frame. A photon of frequency ω' is emitted from the rocket along the y' axis in the rocket's frame of reference.

- (a) Calculate the angle, α with respect to the x-axis, of the photon in the observer's frame of reference.
- (b) Calculate the frequency ω of the photon in the observer's frame of reference.



The Lorentz transformation of a four-vector (A_x, A_y, A_z, A_4) with velocity $v = \beta c$ with respect to a stationary observer's x-axis is:

$$B_x = \gamma(A_x + \beta A_4), \quad B_y = A_y, \quad B_z = A_z, \quad B_4 = \gamma(A_4 + \beta A_x)$$

where $\gamma = 1/\sqrt{1-\beta^2}$.