

Assignment-II

2-8.1 A small object is in the form of a sphere of radius R in its proper frame. Determine the shape of the particle (a) as measured (observed) by a set of observers in the laboratory frame, and (b) as photographed by a photographer in the laboratory frame when the particle moves at $V = 0.5c$ in the $+x$ direction with respect to the laboratory. [(a) ellipsoidal: $4x^2/3 + y^2 + z^2 = R^2$ (b) spherical]

The average lifetime of a π meson in its own frame of reference is 26.0 ns. (This is its proper lifetime.)

- If the π meson moves with speed $0.95c$ with respect to the Earth, what is its lifetime as measured by an observer at rest on Earth?
- What is the average distance it travels before decaying as measured by an observer at rest on Earth?

Answers: 83.3 ns, 24 m

The muon is an unstable particle that spontaneously decays into an electron and two neutrinos. If the number of muons at $t = 0$ is N_0 , the number N at time t is

$$N = N_0 e^{-t/\tau} \quad (11)$$

where $\tau = 2.20\mu\text{s}$ is the mean lifetime of the muon. Suppose the muons move at speed $0.95c$.

- What is the observed lifetime of the muons?
- How many muons remain after traveling a distance of 3.0 km?

Answer: 7.046 microseconds, $0.225N_0$

A rod of length L_0 moves with speed v along the horizontal direction. The rod makes an angle θ_0 with respect to the x' axis.

- Determine the length of the rod as measured by a stationary observer.
- Determine the angle θ the rod makes with the x axis.

Answers: $L_0 (1 - \beta^2 \cos^2 \theta_0)^{1/2}$, $\gamma \tan \theta_0$