

PYL127 -2020

Problem Set 7

Lorentz transformations

1. Show, by explicit substitutions, that the hypotheses of Lorentz and Larmor regarding lengths of rods and rates of clocks in frames moving with respect to aether can account for the null result in Michelson Morley experiment.
2. An event takes place at $(x, y, z, ct) = (3, 0, 0, 8)$ in a frame S . A frame S_1 is moving with respect to S with a velocity $\frac{c}{2}\hat{i}$. Another frame S_2 moves with respect to S_1 with a velocity $\frac{c}{2}\hat{j}$. Find the space time coordinates of the event in S_2
3. Repeat the exercise if a particle has a velocity $\vec{v} = 0.1c\hat{j}$ in the frame S .
4. Light of some wavelength moves in a medium with a speed given by $v = \frac{c}{n}$ where n is the refractive index at that wavelength. Suppose the medium is moving with a velocity $V = 10m/s$ in the same direction in the lab. Then find its speed as observed in the lab frame.
5. Two particles are moving towards with equal and opposite speeds towards each other. Then determine the speed of a particle, as observed in the rest frame of the other.
6. Two events $(x, ct) = (2, 3)$ and $(4, 5)$ occur in a frame S .
 - (a) Show that they can be causally connected
 - (b) Show that you can enter a frame where both the events take place at the same position.
7. Now consider the events $(1, 2)$ and $(8, 5)$.
 - (a) Show that they cannot be causally connected.
 - (b) Show that there are frames in which the first event occurs later than the second.