

Problems Week 7

1. Consider the sum of two light waves

$$\psi = \cos((\vec{K} - \vec{L}) \cdot R) + \cos((\vec{K} + \vec{L}) \cdot R),$$

with \vec{K}, \vec{L} linearly independent. Write this as a wave $A \cos(\vec{K} \cdot \vec{R})$ with modulated amplitude. Show that

$$\vec{K}^2 + \vec{L}^2 = \vec{K} \cdot \vec{L} = 0.$$

Show also that one of \vec{K}, \vec{L} must be timelike and the other spacelike. Let \vec{K} be timelike and pick an observer with four-velocity \hat{K} . What does the wave look like as measured by him?

2. Show that a photon (massless particle) cannot decay into an electron and a positron (both with mass $m > 0$). Show that the reverse process is also impossible. Show also that an electron cannot go into an electron and a photon.
3. A particle of mass M decays into two particles with masses m_1, m_2 . What are the energies of the three particles as measured by an observer at rest with respect to the decaying particle?