RELATIVITY MTH6132

PROBLEM SET 4

HAND IN ONLY THE STARRED QUESTIONS.

1) A stationary particle of rest mass M decays into two particles that both move along the x-axis. One has a rest-mass m_1 and a speed u_1 and the other has a rest-mass m_2 and a speed u_2. Prove that

$$M^2 = m_1^2 + m_2^2 + 2m_2^2 \frac{u_2}{1-u_2^2}\left(\frac{1}{u_1} + u_2\right)$$

2*) An atom of rest mass m_0 at rest in a laboratory absorbs a photon of frequency ν. Use the conservation law of 4-momentum to find the velocity and rest mass of the resulting particle.

3) A particle of rest mass m_1 moving with velocity u_1 along the x-axis collides with a stationary particle of rest mass m_2 stationary along the x-axis. If subsequently the particle with rest mass m_1 moves in the direction making an angle of 60^o relative to the x-axis (in the $x-y$ plane), show that

$$E_1 E_1{}'(u_1 u_1{}' - 2) = 2m_2(E_1{}' - E_1) - 2{m_1}^2,$$

where E_1 and $E_1{}'$ are the total energies of the particle m_1 before and after the collision respectively and $u_1{}'$ is its speed after the collision. [The total energy E of a particle of rest mass m and 3-velocity $\underline{\mathrm{v}}$ is $m\gamma(v)$.]

4*) A particle moving along the x–axis with speed v disintegrates into two photons (particles with zero rest mass) moving in directions making angles α and β with the x–axis and on opposite sides of it. Show that

$$v = \frac{\sin\beta\cos\alpha + \sin\alpha\cos\beta}{\sin\alpha + \sin\beta}$$

[**General hint**: *Proceed by writing down the 4–momenta for the particles and photons before and after and using the conservation law of of 4–momentum. See notes.*]

To be placed in the BLUE BOX on 2nd floor of the Maths building by Wednesday 2nd November, 6:00 pm.

Dr. Juan A. Valiente Kroon (G56)