PHY3063 Spring 2017

HOMEWORK B

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Due: January 26, 2017

HW 1: Consider an inelastic collision in which two particles collide and scatter into two other particles: $A + B \rightarrow C + D$. m_A, m_B, m_C, and m_D represent the mass of each particle. In the laboratory frame (S), the linear momentum conservation will give

$$m_A\vec{v}_A + m_B\vec{v}_B = m_C\vec{v}_C + m_D\vec{v}_D.$$

The *classical* linear momentum should also be conserved in another inertial frame (S') moving with velocity $\vec{u}$ relative to S. Show that the law of conservation of *classical* linear momentum leads to conservation of the total mass: $m_A + m_B = m_C + m_D$. (*It is classical, i.e. non-relativistic. Use Galilean transformation.*)

HW 2: Suppose that A', B', and C' are at rest in frame S', which moves with respect to frame S at speed u in the $+x$ direction. The position of B' is exactly at the midpoint between A' and C'. At $t' = 0$, a light flash occurs at B' and expands spherically outwards.
(a) According to an observer in S', do the wave fronts arrive at A' and C' simultaneously?
(b) According to an observer in S, do the wave fronts arrive at A' and C' simultaneously?
(c) If your answer is no to (a) or (b), what is the difference in the arrival times?

HW 3: Harris 2-28 (*Work on Example 2.4 first.*)

HW 4: A rod of length ℓ_o lies in the $x'y'$ plane of its rest frame and makes an angle θ_o with the x' axis. What is the length and orientation of the rod in the lab frame (x, y) in which the rod moves to the positive x direction with a uniform speed u (see Fig. 1)?
The rod is moving with a constant speed u in the positive direction relative to (xy) frame (S frame). You can define the rod by the two end points. Any points between the points can be defined by the straight line (rod). Can you make an argument that Lorentz transformation would not change the rod shape (for example, no bending)? The it is just L.T of two points. Then the coordinates of the two points should be measured at the same time.

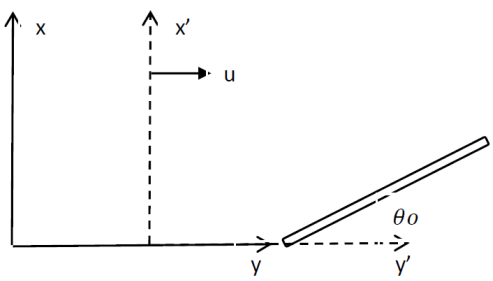

FIG. 1:

HW 5: Harris 2-34

Back-of-Envelop Physics How much of hydroelectric power could be generated from Niagara Falls? *Use your reasonable guess for the width, depth, height, and river flow speed of Niagara Falls. One way of estimating a quantity: set the range of your guess and take the geometric mean. e.g. The height of Niagara Falls: it should be in the range of 10 to 100 m. So* $\sqrt{10 \times 100} \approx 30$ *m. Or one my have a better guess of the range 30 to 100 m which will give about 60 m. The actual height is 57 m. Either guess would be perfectly fine for this purpose!*