

PHZ 6607 Fall 2016

Homework #2, Due Friday, September 9

1. Express the mass of the sun as a length in kilometers. Express the angular momentum per mass of the sun as a length in kilometers.
2. A cart rolls on a long table with velocity v . A smaller cart rolls on the first cart in the same direction with velocity v relative to the first cart. A third cart rolls on the second cart in the same direction with relative velocity v , and so on, up to n carts. What is the velocity v_n of the n th cart in the frame of the table? What does v_n tend to as $n \rightarrow \infty$?
3. (a) Observer \mathcal{O} sees a photon with energy $E = \hbar\omega$ and momentum $\mathbf{p} = \hbar\mathbf{k}$ approaching at an angle θ with respect to the z -axis. Observer \mathcal{O}' moves with (possibly relativistic) velocity in the z -direction with respect to \mathcal{O} . What frequency does \mathcal{O}' measure? What is θ' measured by \mathcal{O}' ?
(b) Observer \mathcal{O} sees the universe filled with isotropic blackbody radiation with temperature T_0 . What is the temperature $T'(\theta')$ seen by \mathcal{O}' ?
(c) Observer \mathcal{O} sees an isotropic angular distribution of stars, $dN/d\Omega = \mathcal{N}_0$ independent of direction. What is the angular distribution $\mathcal{N}' = dN/d\Omega'$ measured by \mathcal{O}' ?
4. (a) In a high energy collision, the energy available to create new particles is the energy in the center of mass frame. A proton with momentum $10 \text{ TeV}/c$ is incident on a target proton at rest. What is the available center-of-mass energy? A 10 TeV proton heading east collides with a 10 TeV proton headed west. What is the available energy in the center of mass frame now? What energy/momentum would be needed in a fixed-target experiment to achieve the same available energy? (This has something to do with why large accelerators are now colliders.)
(b) A Λ^0 baryon ($m_\Lambda = 1115.7 \text{ MeV}$) decays into a proton ($m_p = 938.3 \text{ MeV}$) and a negative pion ($m_\pi = 139.6 \text{ MeV}$). What is the momentum of the proton or pion in the center of mass frame?
(c) The decaying Λ^0 has momentum $28.5 \text{ GeV}/c$ in the lab frame. What is the maximum angle between the proton and the pion in the lab?