CMSpring02A

A beam of deuterons (^{2}H) with kinetic energy 1.808 MeV is incident on a stationary target also made of deuterons. The collisions of the beam with the target produce both protons (^{1}H) and tritons (^{3}H). Protons emerging from the reaction perpendicular to the incident beam in the laboratory frame are measured to have a kinetic energy of 3.467MeV. You may assume that the dynamics occurs in the *xy*-plane in the laboratory frame.

(1) We can compute the velocity of a particle from its kinetic energy by non-relativistic mechanics or by relativistic mechanics. Which is larger? Demonstrate the inequality between the two estimates analytically or geometrically.

(2) If the speed of the particle is 3% of the speed of light, calculate the relative error of the non-relativistic estimate.

(3) What is the speed of the proton produced in the above scattering experiment?

Now we wish to calculate the triton mass within an error of 0.01%.

(4) Write down the conservation laws for the collision of pointlike particles in the *xy*-plane.

(5) Find the triton mass, knowing the proton and deuteron masses are:
$m_p = 938.768$ MeV/ c^2,
$m_d = 1876.09$ MeV/ c^2,
where c is the speed of light.