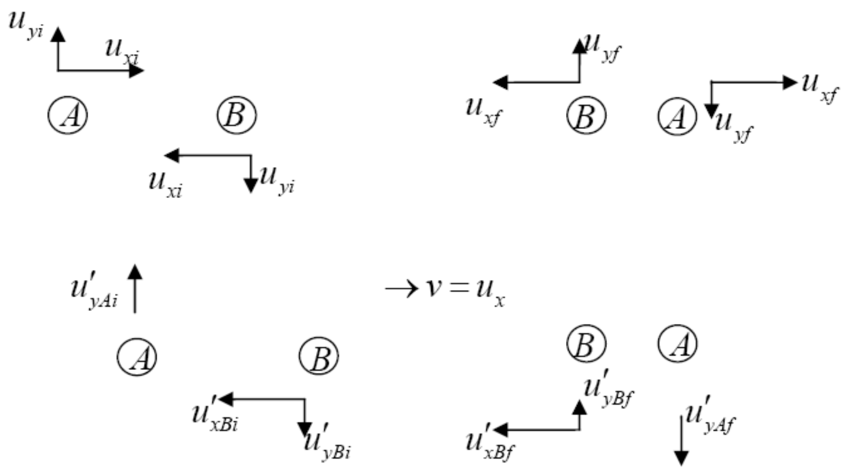
1. Hw13-6

Show that with the relativity momentum formula, if the momentum is conserved in the frame of ground than it is conserved in the frame travelling with A, in the example of elastic collision at the beginning of my notes section 13.1.



图表 1 习题 1

2. Hw 14-1 (KK13.9)

The solar constant, the average energy per unit area falling on the earth, is 1.4 X 10^3 W /m^2. How does the total force of sunlight compare with the sun's gravitational force on the earth?

Sufficiently small particles can be ejected from the solar system by the radiation pressure of sunlight. Assuming a specific gravity of 5, what is the radius of the largest particle which can be ejected?

3. Hw 14-4

A particle of mass m and energy E collide with an identical stationary particle. What is the threshold energy (the minimum value of E) for a final state that containing N particles with mass m?

4. Hw 14-8

For a number of material particles (rest mass m_i>0), each has (E_i/c,P_i) is S frame:

(a) Prove that we can find one frame in which the total momentum P=0. (Hint: 1) You can prove that the energy-momentum 4-vector is time-like for one material particle, and for two particles, the total-energy-momentum can also be proved time-like: so for any number particles the total energy-momentum is also time-like. 2) Minkowski diagram can be used to easily show that you can find a frame in which total momentum is zero)

(b) Prove the zero-momentum frame moves relative to S by: $\beta = \sum \vec{p}_i c \Big/ \sum E_i$

(c) Use the conclusion in this problem to show that it is impossible for a single photon to create a positron + electron pair.

(d) If someone claims that he could create two identical particles each with mass m out of a single particle whose M<2m, because he can make arbitrary large energy by accelerating the M, is the claim correct or wrong and why?

5. Hw 14-11 (KK 14.4)

A particle of rest mass M spontaneously decays from rest into two particles with rest masses m_1 and m_2. Show that the energies of the particles are

$E_1 = (M^2 + m_1^2 - m_2^2)c^2/2M$ $E_2 = (M^2 - m_1^2 + m_2^2)c^2/2M$.

6. Morin's 12.6

A ball of mass M and energy E collides head-on elastically with a stationary ball of mass m. Show that the final energy of mass M is

$$E' = \frac{2mM^2 + E(m^2 + M^2)}{2Em + m^2 + M^2} .$$

Hint: This problem is a little messy, but you can save yourself a lot of trouble by noting that E' = E must be a root of the equation you get for E'. (Why?) As a reward for trudging through the mess, there are lots of interesting limits you can take.

7. Morin's 12.22

A mass m travels at speed 3c/5, and another mass m sits at rest.

(a) Find the energy and momentum of the two particles in the lab frame.

(b) Find the speed of the CM of the system, by using a velocity-addition argument.

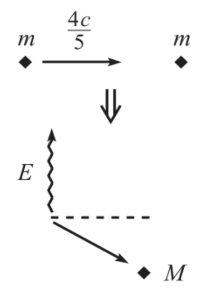
(c) Find the energy and momentum of the two particles in the CM frame, without using the Lorentz transformations.

(d) Verify that the E's and p's are related by the relevant Lorentz transformations.

(e)Verify that $E^2 - p^2c^2$ for each mass is the same in both frames. Likewise for $E^2_{total} - p^2_{total}c^2$.

8. Morin's 12.28

A mass m moving at speed 4c/5 collides with another mass m at rest. The collision produces a photon with energy E traveling perpendicular to the original direction, and a mass M traveling in another direction, as shown in Fig.2. In terms of E and m, what is M? What is the largest value of E (in terms of m) for which this setup is possible?



图表 2 习题 8

9. Hw 14-14

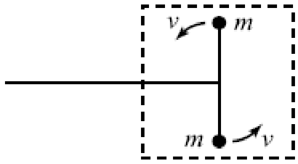
For a particle with charge q moves in an uniform magnetic field B, and the initial velocity is perpendicular to the B, the force is Lorentz force=q|v||B| perpendicular to the motion. Show that the motion is a circular motion with radius: $r = |P|/q|B|$ even in the relativistic domain.

10. Hw14-15

A particle m is moving initially with momentum (3-momentum)P_0 along x direction, a constant force with magnitude F_0 is applied along x direction. Find the velocity of the m at later time, and also the trajectory x(t). (You can leave any integral as it is).

11. Hw14-16

Considering a “black box” inside which a dumbbell like object is rotating as shown in the figure:



图表 3 习题 11

(a) What is the rest mass M of the black box as viewed by someone knowing nothing inside?

(b) Suppose the black box is initially at stationary, and you apply a force on the horizontal stick (the stick can be treated as massless), convince that by using F=dP/dt=Ma (which is correct when the black box at low velocity), the inertial mass M is indeed the one in a).