1 Two Particles Collide

A particle of mass m_1 elastically collides with a particle of mass m_2 which was at rest (in the lab frame). Find the maximum fraction of the kinetic energy loss for m_1,

$$\left.\frac{T_0 - T_1}{T_0}\right|_{\max}, \tag{1.1}$$

with respect to the deflected angles (in the lab frame). Describe the trajectories in the collision (in the lab frame).

Hints: You may maximize with respect to either deflected angle, ψ or ζ, since they are interdependent. Use results from the text.

1.0 solution

$$\frac{T_0 - T_1}{T_0} = 1 - \frac{T_1}{T_0} \tag{1.2}$$

Thorton and Marion equation **9.88** is

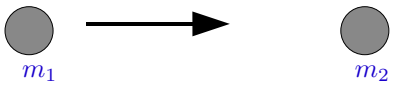
$$\frac{T_2}{T_0} = 1 - \frac{T_1}{T_0} = \frac{4m_1m_2}{(m_1+m_2)^2}\cos^2\zeta\,, \qquad \zeta \le \frac{\pi}{2}\,.$$

So we will maximize this with respect to ζ. The ζ dependence has just a $\cos^2\zeta$ which has a maximum at $\zeta = 0$. So

$$\boxed{\left.\frac{T_0 - T_1}{T_0}\right|_{\max} = \frac{4m_1m_2}{(m_1+m_2)^2}}\,. \tag{1.3}$$

With the deflected angle of m_2 $\zeta = 0$ the deflected angle of m_1 will be $\psi = 0$ or π, because, from conservation of momentum, it cannot have any momentum component that is transverse to the motion of m_2. So the trajectories in the collision in the lab frame look like

Before collision:



After collision: