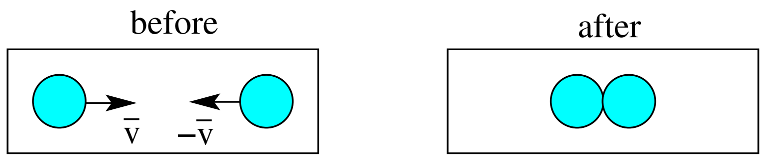
Relativistic Energy I [mln64]

The two colliding particles of equal mass viewed from the frame in which the total momentum is zero.



Relativistic mass before and after the collision (inferred from momentum conservation):

$$M = m(\bar{v}) + m(-\bar{v}) = 2m(\bar{v}) = \frac{2m_0}{\sqrt{1 - \bar{v}^2/c^2}}.$$

Increase in rest mass (after collision):

$$\Delta M = M - 2m_0 = 2m_0 \left(\frac{1}{\sqrt{1 - \bar{v}^2/c^2}} - 1 \right) \simeq \frac{m_0 \bar{v}^2}{c^2}.$$

Relativistic energy (in general):

$$E \doteq m(v)c^2 = \frac{m_0 c^2}{\sqrt{1 - v^2/c^2}}.$$

Conservation of relativistic energy (in collision):

$$\Delta E = Mc^2 - 2m(\bar{v})c^2 = 0.$$

Relativistic kinetic energy (in general):

$$T \doteq E - m_0 c^2 = m_0 c^2 \left(\frac{1}{\sqrt{1 - v^2/c^2}} - 1 \right) \simeq \frac{1}{2} m_0 v^2.$$

Kinetic energy converted into thermal energy (during collision):

$$\Delta Q = -\Delta T = \Delta M c^2 \simeq 2 \left(\frac{1}{2} m_0 \bar{v}^2 \right).$$