Heavy-Ion Collisions & Equation of State: Homework Set 1

1. Show that rapidity y for a particle at momentum $(p_\perp, p_\parallel)$ can be obtained from

$$y = \frac{1}{2} \ln \frac{E + p_\parallel}{E - p_\parallel} = \ln \frac{E + p_\parallel}{m_\perp} \; .$$

2. Consider a symmetric system, where the projectile is incident on a target nucleus identical to the projectile. Let T_{lab} denote the kinetic energy per nucleon for the projectile, excluding the rest energy. Let T_{cm} represent the kinetic energy per nucleon in the center of mass for the system, excluding the rest energy.

   (a) Show that relativistically the two energies are related with

   $$T_{\text{cm}} + \frac{T_{\text{cm}}^2}{2m} = \frac{T_{\text{lab}}}{4} \; .$$

   (b) Is T_{cm} larger or smaller relativistically than nonrelativistically? Calculate T_{cm} for the case of $T_{\text{lab}} = 1\,\text{GeV}$.