The production of entropy in central Ca+Ca and Nb+Nb collisions

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The Gaussian wave packet has fixed width $\sqrt{L}$ which equals 1.08 fm. The centroid of these Gaussians wave packets move in phase space according to classical equations of motion [4]:

$$\ddot{r}_i = \nabla_{p_i} \langle \mathcal{H} \rangle, \quad \dot{p}_i = -\nabla_{r_i} \langle \mathcal{H} \rangle, \quad i = 1, \ldots, N.$$  (2)

Here $\mathcal{H}$ is the total Hamiltonian of the system of N-nucleons. To estimate the entropy, we use the generalized formula [3]:

$$S_N = 3.945 - \ell n\left(\frac{d_{\text{like}}}{p_{\text{like}}}\right).$$  (3)

Following Ref. [5], we define the yield ratio $d_{\text{like}}/p_{\text{like}}$ in the following way:

$$\frac{d_{\text{like}}}{p_{\text{like}}} = \frac{Y(A = 2) + \frac{3}{2}Y(A = 3) + 3Y(A = 4)}{N_p},$$  (4)

where $Y(A=n)$ stands for the yield of fragments with mass ‘n’ in one event. Analogous to experimental results, we calculate the total participant proton multiplicity $N_p$ as:

$$N_p = \frac{Z_P + Z_T}{A_P + A_T} \left[ Y(A = 1) + 2Y(A = 2) + 3Y(A = 3) + 4Y(A = 4) \right],$$  (5)

where $Z_P + Z_T$ and $A_P + A_T$ define the total charge and mass of the colliding system.

Results and Discussion

Turning to model calculations, we simulated the central collisions of $^{40}\text{Ca} + ^{40}\text{Ca}$ (at 400 and 1050 AMeV) and $^{93}\text{Nb} + ^{93}\text{Nb}$ (at 400 and 650 AMeV). The entropy is then estimated via Eq.(3), for unfiltered events. Figure 1 shows the model calculations for entropy $S_N$ along with experimental data taken with Plastic Ball/Wall detector [6]. Clearly, one sees that calculated entropies are in nice agreement with experimental data at all incident energies. Further, the magnitude...
FIG. 1: The baryonic entropy $S_N$ vs beam energy $E_{lab}$ for the central collisions of $^{40}\text{Ca} + ^{40}\text{Ca}$ and $^{93}\text{Nb} + ^{93}\text{Nb}$. Also shown are entropy values extracted by the Plastic Ball group [6] at maximum baryon charge number $\left(\frac{d_{like}}{p_{like}}\right)_{\text{max}}$ (Preliminary results).

of entropy produced is almost independent of beam energy as well as system size. These preliminary results suggest that QMD model contains necessary ingredients to describe the physics of fireball formation and dynamical emission of light clusters [7].

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References