The Caloric Curve from 8 GeV/c Negative Pion, Anti-proton + Gold

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Hot nuclei formed in the reaction of 8 GeV/c negative pion, anti-proton + gold were studied with Indiana Silicon Sphere (ISiS) 4π detector array [1] at Brookhaven AGS accelerator. These reactions provide an excellent system for studying the thermodynamic properties of hot nuclei since the target nucleus is rapidly heated with little compression via collisions induced by a GeV hadron beam.

Last year, the caloric curve for hot nuclei formed in 8 GeV/c negative pion, anti-proton + gold was investigated using double isotope ratio thermometers and temperatures derived from the slope parameter. Now the investigation of the caloric curve is focusing on the dependence of the energy gate for selecting the particles to calculate the double-isotope ratio temperature.

According to Albergo et al. [1], the temperature of hot nuclei can be calculated from:

$$T = \frac{B}{\ln(aR)} \tag{1}$$

where B is the binding energy difference for the fragments, a is a factor that depends on statistical weights of the ground state nuclear spins, and R is double-isotope ratio of the ground-state population at freeze-out.

Since the apparent ratio R can be strongly influenced by secondary decay, Tsang et al. [2, 3] proposed an empirical correction factor, κ, for each double-isotope ratio to quantify the secondary decay effect. The temperature (T_0) can be determined from the expression:

$$\frac{1}{T_{app}} = \frac{1}{T_0} + \frac{\ln\kappa}{B} \tag{2}$$

Fig. 1 shows the sequence of caloric curves from the E900a experiment using the double-isotope ratio temperature (d/t-^{3}He/^{4}He) corrected for secondary decay feeding. Here the temperatures are calculated from four different energy selections. The lowest energy selection (represented by open circles symbols) is selecting Z = 1 particles with energy between 30 – 40 MeV and Z = 2 particles with energy between 38 – 48 MeV. Three higher energy selections (closed triangles, open triangles, and closed circles) were employed to study this effect.

The sequence of caloric curve shown in Fig. 1 can be interpreted as evidence for "cooling" of the hot residues as they evolve from the fast cascade stage of the collision toward equilibrium [4].

Due to the limit in the energy threshold for determining ^{4}He particles, the caloric curve cannot be constructed for lower energy particles. However, the caloric curve for lower energy gates can be extrapolated from this sequence of caloric curves. The solid and dash lines are extrapolated caloric curves (Z = 1: 20 – 30 MeV, Z = 2: 28 – 38 MeV (solid line), and Z = 1: 10 – 20 MeV, Z = 2: 18 – 28 MeV (dash line)). The extrapolated caloric curves are determined from the linear fit of the temperature from the four energy gates for each excitation energy.

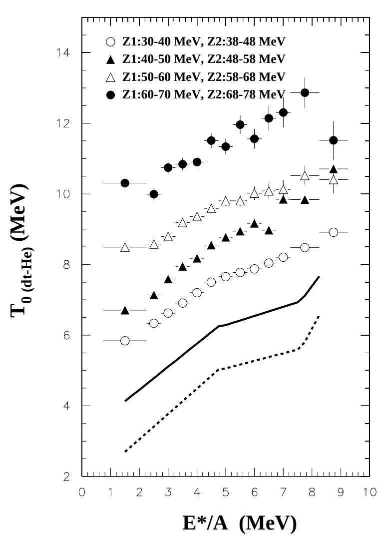

Figure 1: The sequence of caloric curves from E900a experiments using different energy ranges to select particle in double-isotope ratio calculation.

In Fig. 2, the caloric curve and the extrapolated caloric curves from the E900a experiment are compared with the caloric curves from the previous ISiS experiment [4], ALADIN group [5, 6], and EOS group [7]. The caloric curves from other experiments line between the two extrapolated curves.

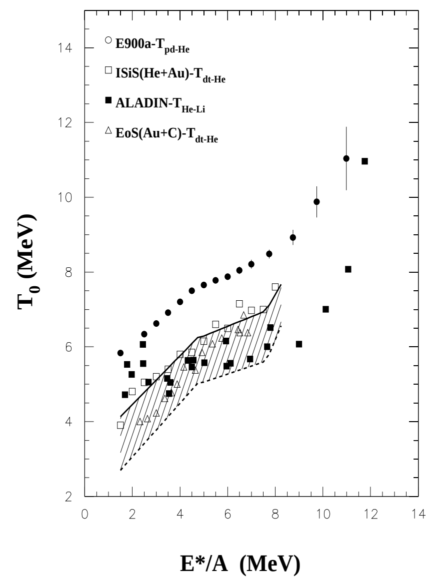

Figure 2: Comparison of caloric curves from various experiments.

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