Scaling in ISiS Au multifragmentation data

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Evidence of thermal scaling was found in the ISiS Au multifragmentation data [1]. Thermal scaling is the feature that the fragment yields depend on temperature T via a Boltzmann factor: $n \propto \exp(-B/T)$; B is the fragment emission barrier. A plot of $\ln n$ vs. $1/T$ (Arrhenius plot) is linear if n is controlled by a Boltzmann factor. This is observed in a plot of the log of the fragment yield distributions $n(A)$ as a function of $1/\sqrt{E^*}$ ($\sqrt{E^*} \propto T$ in a Fermi gas) in Fig. 1a.

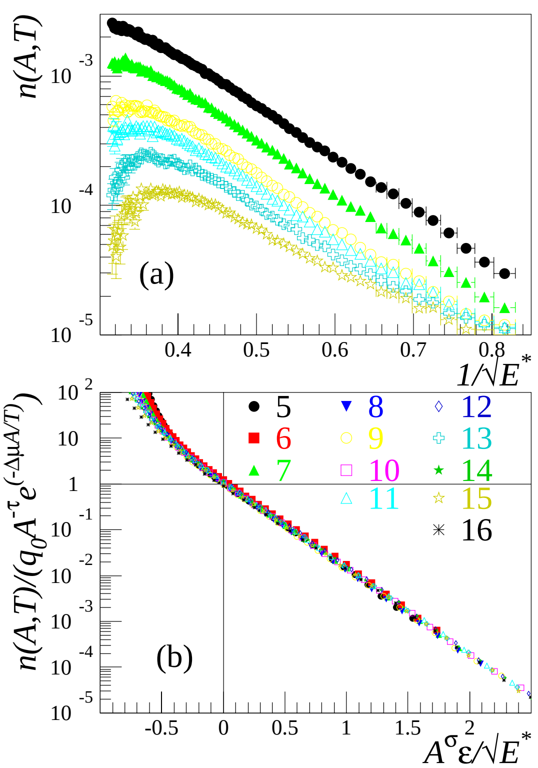

Figure 1: (a) Arrhenius plots. (b) Fisher's plot.

Similar behavior was observed in the EOS Au multifragmentation data [2] and the Boltzmann factors (slopes of Fig. 1a) were interprated via Fisher's droplet model [3]:

$$n(A,T) = q_0 A^{-\tau} \exp(A\Delta\mu/T - c_0\epsilon A^{\sigma}/T), \quad (1)$$

($\epsilon = (T_c - T)/T_c$) where it was assumed that the system was at coexistence ($\Delta\mu \approx 0$). This lead to a relation between B and fragment mass A: $B = c_0 A^{\sigma}$; c_0 is the surface energy coefficient. Within the modest statistics of the EOS data set ($\sim$ 27K events) the $\Delta\mu \approx 0$ assumption was difficult to test. Using the high statistics of the ISiS data set ($\sim$ 7.4M events) it is now possible.

The ISiS yields for $E^* \leq E^*_c$ and $5 \leq Z \leq 16$ were fit to Eq. (1) using A determined by multiplying the measured Z by the A-to-Z ratio of the fragmenting system and $T \propto \sqrt{E^*}$; τ, σ, c_0 and E^*_c were fit paramters and $\Delta\mu$ was parametrized by a polynomial in E^*. The results are: $\tau = 2.03 \pm 0.01$, $\sigma = 0.65 \pm 0.04$, $E^*_c = 3.70 \pm 0.05$ MeV/nucleon, $c_0\sqrt{a} \approx 4.25 \pm 0.05$ and $\Delta\mu$ decreased from ~ 1 MeV at low E^* to 0 at E^*_c.

Fisher's model predicts that a graph of the scaled fragment yields will collaspe the data from a wide range of mass and temperature collapse onto a single curve, thereby providing the best evidence yet for a liquid-vapor phase transition in nuclei (Fig. 1b).

References

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[2] J. B. Elliott *et al.*, Phys. Rev. Lett. **85**, 1194 (2000).

[3] M. E. Fisher, Physics **3**, 255 (1967).