A Power Law for Clusterization at the Energy of Vanishing Flow in Heavy-Ion Collisions

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The vanishing of flow occurs at an incident energy termed as *balance energy* (E_{bal}) where attractive scatterings balance the repulsive scatterings [1]. Though, large efforts have been made to understand the nature of balance energy, no attention is paid to study the fragment structure at the energy of vanishing flow. Since the formation of the fragments is associated with the amount of excitation energy, the study of fragmentation at the balance point will be very useful. We plan to address this question using the Quantum Molecular Dynamics (QMD) model [2]. The QMD model is based on a molecular dynamics picture where nucleons interact via two- and three-body interactions. Each nucleon in the QMD model propagates according to classical equations of motion [2].

For the present study, we simulated the central collisions of Ar+Al, Ar+Sc, Ar+V, Zn+Ni, Ni+Ni, Zn+Ti, Kr+Nb, Nb+Nb, La+La and Au+Au at their corresponding theoretical balance energies [3]. The fragments are constructed using the MST method where nucleons share the same fragment if they are within a distance of 4 fm.

In fig.1 (a), we display the preliminary normalized multiplicity of the fragments with masses A = 2 and $2 \leq A \leq 4$, whereas in fig. 1(b), we display the fragments with $2 \leq A \leq 30\%$ and $3 \leq A \leq 30\%$ (of the largest nucleus). Interestingly, the trend is same in all the cases including LMF's and IMF's. A significant mass dependence with negative slope can be seen in all the cases. This dependence can be parameterized by a power law of the form $c \cdot A^{\tau}$; τ being -0.30 ± 0.03, -0.37 ± 0.02, -0.32 ±0.01, -0.33 ± 0.03, respectively, for the fragments with A =2, $2 \leq A \leq 4$, $2 \leq A \leq 30\%$ and $3 \leq A \leq 30\%$ (of the largest nucleus). This slope, which is quite close to the one obtained for the energy of vanishing flow [3], suggests that there is an interplay between the attractive surface forces and repulsive nucleon-nucleon scatterings which gives us $A^{1/3}$ dependence for the emission of fragments of all sizes [4].

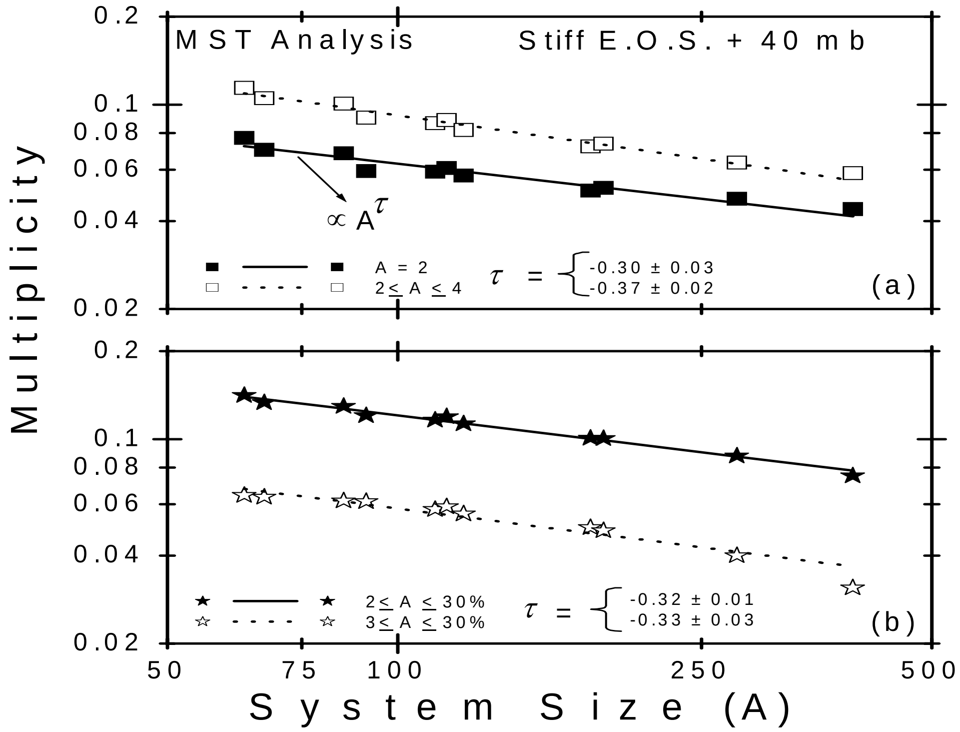

Figure 1: The Normalized Multiplicities as a Function of the System Size.

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