Isoscaling Properties of the Fragments Pproduced in Multifragmentation of ^{40}Ar, ^{40}Ca + ^{58}Fe, ^{58}Ni Reactions at 25, 33, 45 and 53 MeV/nucleon

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In multifragmentation reactions, the ratio of fragment yields in two different systems, 1 and 2, $R_{21}(N,Z) = Y_2(N,Z)/Y_1(N,Z)$, are known to obey an exponential dependence on the neutron number (N) and the proton number (Z) of the fragments in an observation known as isoscaling. The dependence is given by a simple relation,

$$R_{21}(N,Z) = Y_2(N,Z)/Y_1(N,Z) = C \exp(\alpha N + \beta Z)$$

Where Y_2 and Y_1 are the yields from the neutron-rich and neutron-deficient systems, respectively. C is the overall normalization factor, and α and β are the parameters characterizing the isoscaling behavior.

The isoscaling parameters obtained in ^{40}Ar, ^{40}Ca + ^{58}Fe, ^{58}Ni reactions at 25, 33, 45 and 53 MeV/nucleon are presented in this report. Fig. 1 (left) shows the experimentally measured relative isotopic yield distributions for the Li, Be and C elements in ^{40}Ca + ^{58}Ni reactions (star symbols), ^{40}Ar + ^{58}Ni (circle symbols) and ^{40}Ar + ^{58}Fe (square symbols) for 25, 33 and 45 MeV/nucleon beam energies. The distributions for each element show higher fragment yield for the n-rich isotopes in ^{40}Ar + ^{58}Fe reaction (square), which has the largest neutron-proton ratio (N/Z), in comparison to the ^{40}Ca + ^{58}Ni

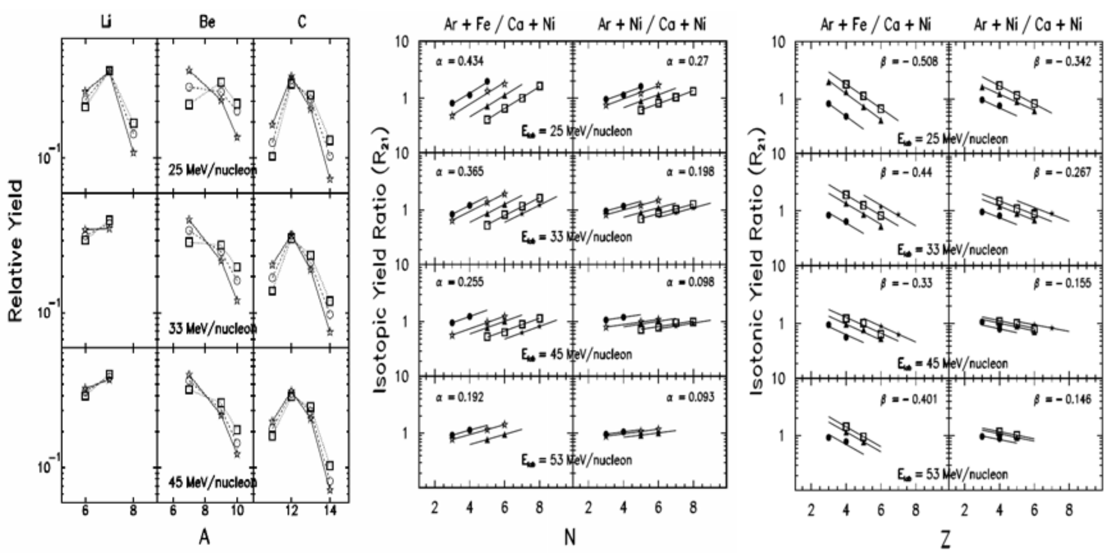

Figure 1. (Left) Relative isotopic yield distributions. (Center) Isotopic yield ratios as a function of neutron number N. (Right) Isotonic yield ratios as a function of proton number Z.

reaction (star), which has the smallest neutron-to-proton ratio. The yields for the reaction, ^{40}Ar + ^{58}Fe

(circles), which has an intermediate value of the neutron-to-proton ratio, are in between those of the other two reactions. It is observed from this figure that the isotopic composition of the fragments produced in multifragmentation reaction is sensitive to the isospin (N/Z) of the composite system. The relative difference in the yield distribution between the reactions is also observed to decrease with increasing beam energy.

The isotopic yield ratio as a function of neutron number N, is shown in Fig. 1 (center). The isoscaling parameter α for all the reactions were obtained by simultaneously fitting the ratio of the isotopic yields using the above equation. It is observed that α is larger for the ^{40}Ar + ^{58}Fe and ^{40}Ca + ^{58}Ni reactions, which has a larger difference in the N/Z of the systems in the pair, compared to the ^{40}Ar + ^{58}Ni and ^{40}Ca + ^{58}Ni reactions, which has a smaller difference in the corresponding N/Z. Fig. 1 (right) shows the isotonic yield ratio as a function of the proton number Z and parameter β obtained from them. Fig. 2 (left) shows the evolution of the isoscaling parameters α and β as a function of the beam energy and the isospin of the system. It is observed that α (β) decrease (increase) with increasing beam energy. The α (β) parameters are observed to be larger (smaller) for systems with higher isospin (N/Z).

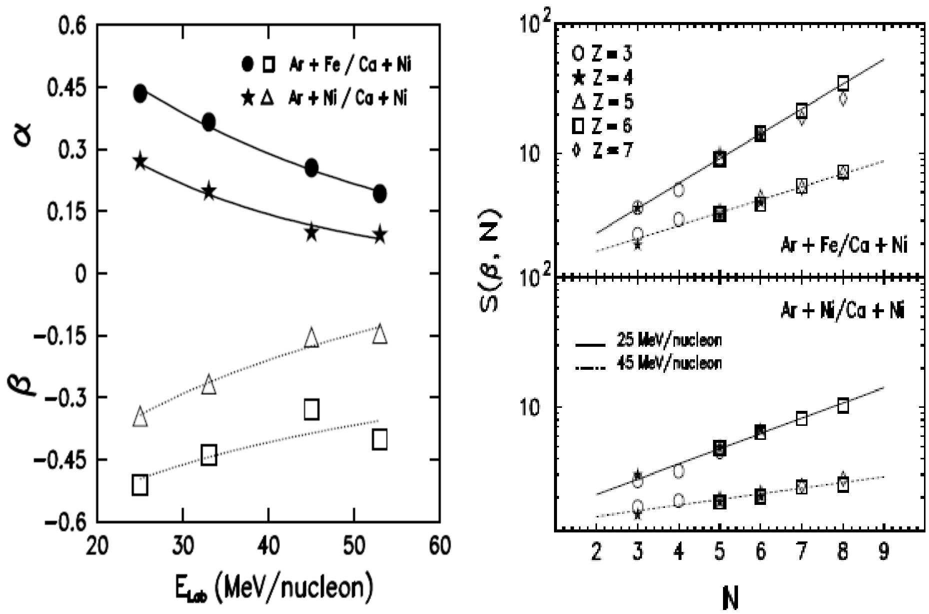

Figure 2. (Left) Isoscaling parameters α and β as a function of the beam energy. (Right) Scaled isotopic ratio S(β,N) as a function of neutron number N.

The isoscaling properties were also studied by constructing the scaling factor, S(β,N) = $R_{21}(N,Z)e^{-\beta Z}$. Fig. 2 (left) shows the S(β,N) from two different reaction pairs plotted as a function of neutron number N for beam energies of 25 and 45 MeV/nucleon. A significant difference in the scaling for the two beam energies are observed, indicating the influence of temperature on the isotopic yields of the light clusters. The present observation demonstrates the role played by the temperature in the distillation of nuclear matter into a neutron-rich gas and a symmetric liquid phase.

[1] J. Iglio *et al*., Phys. Rev. C (Submitted).