Isoscaling studies from the Z and N distributions of intermediate mass fragments

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Introduction

Understanding the production mechanism and properties of intermediate mass fragments (IMFs) emitted in multifragmentation reactions is one of the key areas of research in the intermediate energy domain [1]. Over the last one decade, such studies have been extended to explore the isoscaling phenomenon in those reactions [2, 3]. Parameters obtained from isoscaling are considered as vital tools to calculate the symmetry term of the nuclear equation of state. Isoscaling is obtained using the yield ratios of fragments from reactions with isotopically different projectiles and/or targets at similar temperatures. The ratio R_{21}(N, Z), of yields for a given fragment type produced from two different sources has an exponential dependence on neutron (N) and proton (Z) numbers of the fragment and the relation is described as,

$$\begin{aligned} R_{21}(N,Z) &= Y_2(N,Z)/Y_1(N,Z) \quad (1) \\ &= Cexp(\alpha N + \beta Z), \end{aligned}$$

where three parameters, C, α & β describe the overall isoscaling behaviour [2]. However, in the present study an attempt has been made to calculate the values of slope parameters (α & β) using the microcanonical approach as proposed by Ad.R. Raduta [4].

1. Experimental Details

The experiment was carried out using the K800 cyclotron at Laboratori Nazionali del Sud (LNS), Catania, Italy. Isotopically enriched, self supporting targets of ^{124}Sn and ^{112}Sn having thicknesses of 689 μg/cm^2 and 627 μg/cm^2 respectively, were placed inside the Charged Heavy Ion Mass and Energy Resolving Array (CHIMERA). Pulsed with a repitition rate of 120 ns, ^{48}Ca beam of energy 45 AMeV was used to bombard the targets. The IMFs were detected using the 1192 ΔE-E (Si-CsI(Tl)) telescopes of the CHIMERA array. More details about the array can be found in Refs. [5, 6].

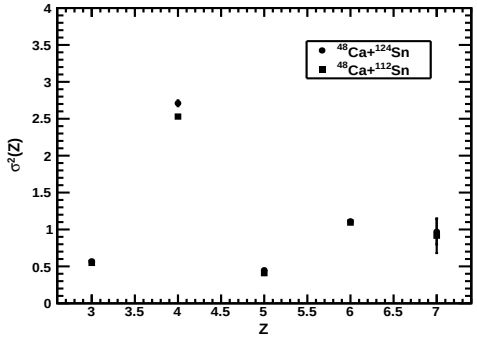

FIG. 1: Variance values calculated from the two isotopic distributions of IMFs from the ^{48}Ca+^{124,112}Sn reactions.

Results and Discussion

According to the microcanonical model, it is assumed that isotopic as well as isotonic distributions of fragments can reasonably be reproduced by the Gaussian functions. The variance of such distributions should be nearly same for different reactions having similar sizes and temperatures. This is one of the prerequisite to obtain the slope parameters from the isotopic/isotonic distributions of IMFs [4]. The variance obtained from isotopic distributions of IMFs in the present study is shown in Fig. (1) . It is clear from this figure that the above said assumption holds true for all

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the IMFs except for a small mismatch in the case of Be. With the already discussed assumptions, slope parameters (α & β) of the isoscaling eq. (1) can be expressed in terms of mean and variances of the isotopic/isotonic distributions as,

$$\alpha(Z) = \frac{1}{\sigma(Z)^2}(N_2(Z) - N_1(Z)),$$
$$\beta(N) = \frac{1}{\sigma(N^2)}(Z_2(N) - Z_1(N).$$

Here, σ(Z)/σ(N) represents the variance of

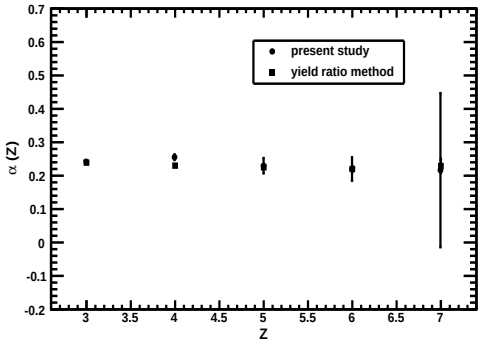

FIG. 2: A comparison of the slope values (α) obtained from the two approaches.

isotopic/isotonic distributions. N(i)/Z(i) represents the mean of isotopic/isotonic distributions of IMFs from the neutron rich (i=2) and neutron poor (i=1) sources. The variation of slope parameter, α, obtained using the above said formalism is plotted in Fig. (2). The second data set in this graph corresponds to the values obtained using eq. (1). It is clear from this figure that, the values of slope parameters obtained using current approach are matching reasonably well with the one calculated using yield ratios method. Due to lack of sufficient isotonic distributions data, a trend for β values could not be obtained in the present analysis.

Acknowledgments

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