Z-dependence of isoscaling parameter in central heavy ion collisions at intermediate energy

Z. Chen, R. Wada, T. Keutgen, K. Hagel, J. Wang, L. May, L. Qin,
J. B. Natowitz, T. Materna, S. Kowalski, and P.K. Sahu

The isoscaling of intermediate mass fragments (IMFs) has been studied in reactions between ^{64,70}Zn, ^{64}Ni projectiles and ^{58,64}Ni , ^{112,124}Sn, , ^{197}Au, ^{232}Th targets at 40MeV/nucleon. IMFs were detected by a telescope at 20°. The telescope consisted of four Si detectors and a CsI crystal. Each Si detector had 5cm x 5cm area. The thicknesses were 129, 300, 1000, 1000 micron, and each Si was segmented into four sections. Each quadrant section of Si was backed by a 3 cm thick CsI(Tl) crystal read by a photo multiplier tube. Isotopes of IMFs were clearly identified from Z=3 up to Z=12 with energy thresholds of 4-8 MeV/nucleon, depending on Z of the IMFs. In order to minimize the effect of the missing yields below the threshold, which becomes significant for heavier IMFs, the isotope yield ratios for two different reactions were examined as a function of IMF energy and the yield ratios were evaluated as an averaged value over the measured energy range of the given IMFs.

In Fig. 1, the results of isoscaling parameters α, obtained by fitting yield ratios for different combinations of two reactions, are plotted as a function of $\Delta(Z/A)^2$. $\Delta(Z/A)^2$ is given by

$$\Delta(Z/A)^2 = ((Z/A)_1^2 - (Z/A)_2^2).$$

Where $(Z/A)_i$ is the charge to mass ratio of the source of IMF in a given reaction system i . In the plot

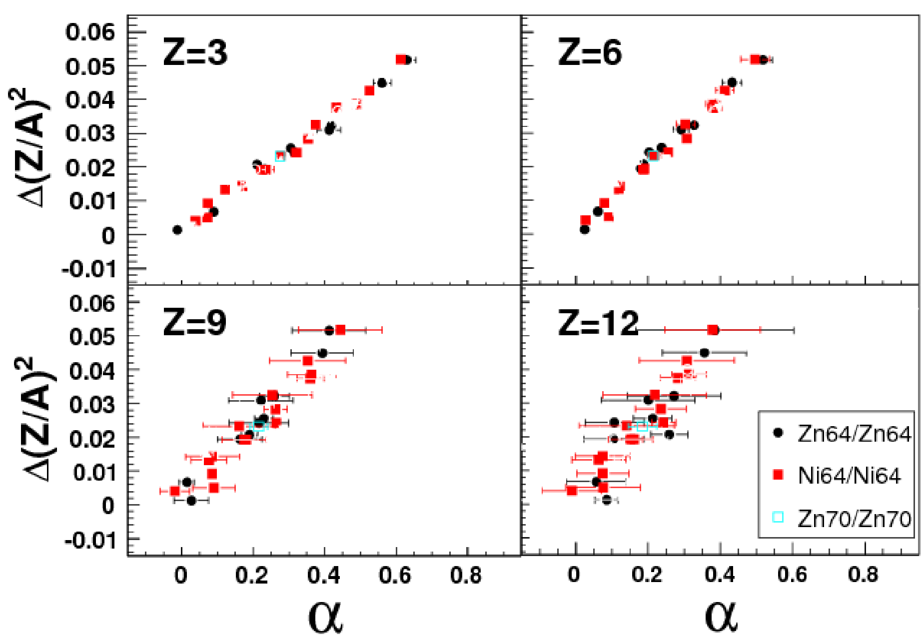

Figure 1. α is plotted as a function of $\Delta(Z/A)^2$ for different combinations of two reactions.

$\Delta(Z/A)^2$ is calculated from the Z/A of the compound system. One can clearly see that α and $\Delta(Z/A)^2$ are linearly correlated. In general α can be represented as

$$\alpha = 4C(Z)/T \times \Delta(Z/A)^2 .$$

C(Z) is the symmetry energy coefficient and T is the temperature of the source. In Fig.1 it is also observed that the slope increases with the increase of Z. In order to study this Z dependence of α , α is expressed by a linear function of Z as $\alpha = a1 * Z + a0$.

In Fig. 2, a1 is plotted as a function of $\Delta(Z/A)^2$. It is found that the slope a1 is also linearly correlated to $\Delta(Z/A)^2$. In order to understand the linear correlation of α and a1 as a function of $\Delta(Z/A)^2$, calculations of an anti-symmetrized molecular dynamics model (AMD) are being performed. Further detailed study is now underway.

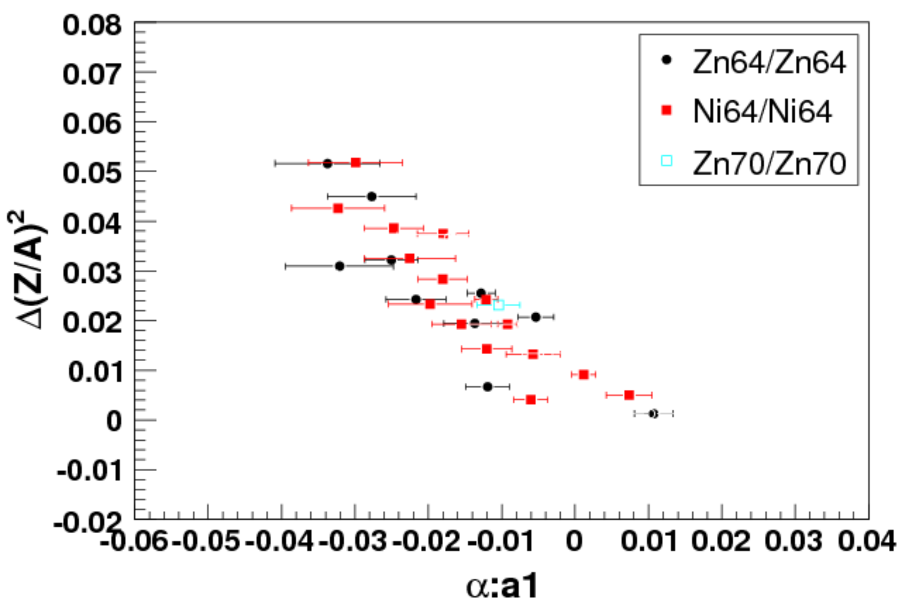

Figure 2. Linear coefficient a1 is plotted as a function of Δ(Z/A)2, see detail in the text.