Variance of the isotope yield distribution and symmetry energy

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The ratio of symmetry energy coefficient relative to the temperature, a_{sym}/T , has been extracted as a function of Z from the variance of the observed isotope distributions from the experiments described in Ref.[1]. In order to explore the relation between the symmetry energy term in the free energy and the variance of the isotope distribution, Ono *et al.* introduced a generalized function K(N,Z) for the free energy in Ref. [2] as given below.

$$K(N,Z) = \sum_{i=1}^{n} w_i(N,Z)\left[-\ln Y_i(N,Z) + \alpha_i(Z)N + \gamma_i(Z)\right] \qquad (1)$$

Here i represents each reaction. The summation is taken over i for the reaction systems of different N/Z in order to get isotope multiplicity distributions over a wide range from proton rich to neutron rich isotopes. The average weights, $w_i(N,Z)$, are determined by minimizing the statistical errors in K(N,Z) for a given (N,Z). The isoscaling parameter, $\alpha_i(Z)$, is the isoscaling parameter value obtained by the method described in Ref. [1]. The K(N,Z) distribution from the experiment is shown in Fig. 1.

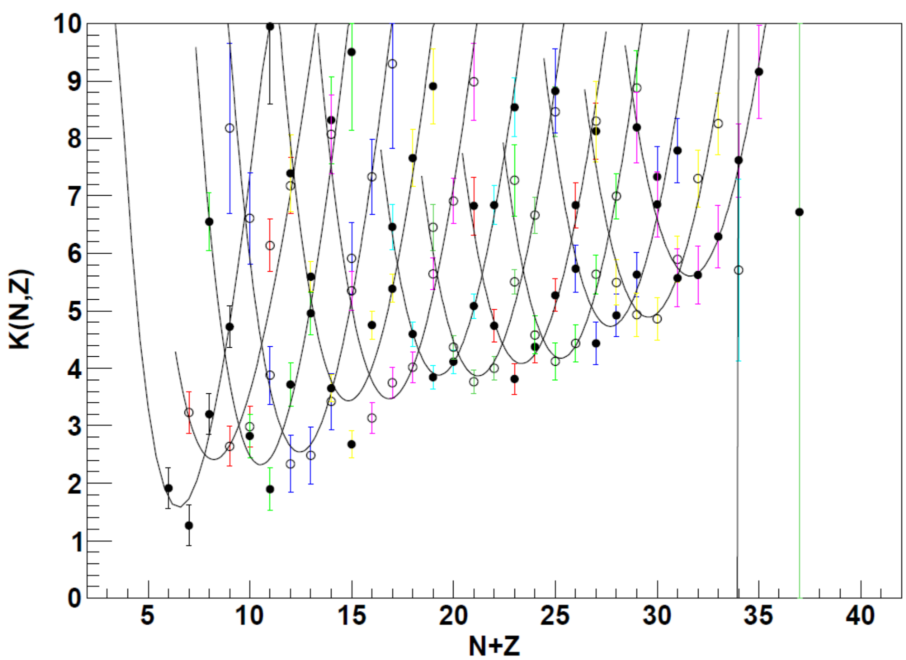

FIG. 1. K(N,Z) distribution from five reaction systems, ^{64}Ni+^{58}Ni, ^{64}Ni,^{112}Sn, ^{197}Au, ^{232}Th.

The isotope distributions for a given Z exhibit a smooth quadratic distribution and they can be fit by a function:

$$K(N,Z) = \xi(Z)N + \eta(Z) + \varsigma(Z)\frac{(N-A)^2}{A} \qquad (2)$$

where ξ(Z), η(Z), ζ(Z) are the fitting parameters. The functional form, ζ(Z) is related to the symmetry energy coefficient as:

$$\varsigma(Z) = a_{sym} / T \qquad (3)$$

In order to explore the experimental observation, the dynamical simulations have been made, using an Antisymmetrized Molecular Dynamics (AMD) model [3,4] with a statistical decay code, Gemini [5] , as an afterburner. All calculations shown in this report have been performed in a newly installed computer cluster in the Cyclotron Institute [6]. Using the same analysis as for the experimental data, the ratio a_{sym}/T has been obtained from the calculations.

The experimental values of a_{sym}/T obtained by the isoscaling technique is shown by solid circles in Fig. 2 [1], the values of ζ(Z) extracted using the technique described in this report are shown by solid squares. A comparisons between the experimentally extracted ratios of symmetry energy coefficient to temperature with those from the AMD model (open circles) is also presented in Fig. 2.

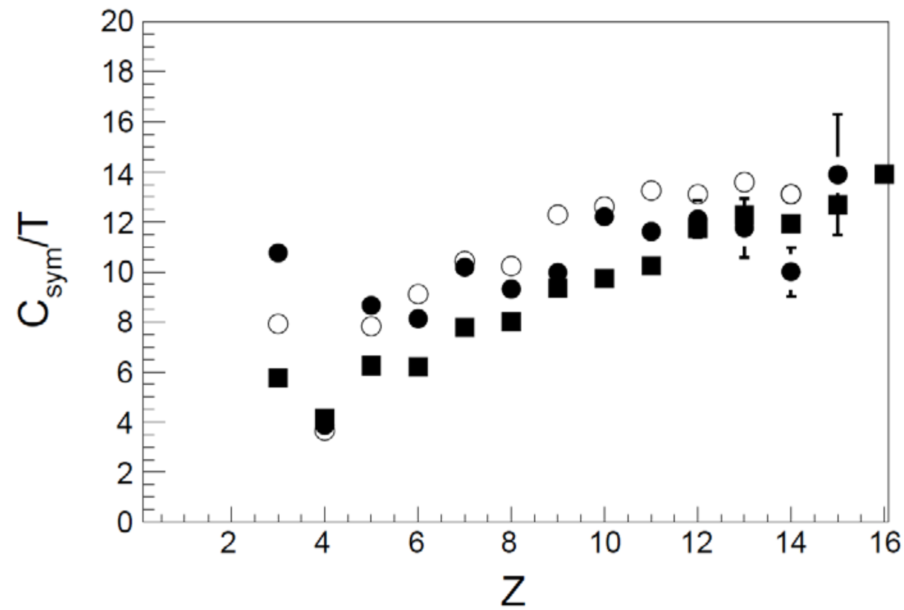

FIG. 2. Experimental and theoretical a_{sym}/T values as the function of Z. The values obtained by isoscaling technique is presented by solid circles. Squares are results of technique described in this report, open circles show values from AMD-Gemini calculations.

The results from the two experimental techniques are in reasonable agreement. The values and trends observed for the final fragments are well reproduced by the AMD plus Gemini model simulations.

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