Nuclear Expansion and Symmetry Energy at Low Density

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In this report we try to obtain information on the density dependence of the symmetry energy by comparing the experimental isoscaling data with the Statistical Multifragmentation Model (SMM) calculation and the expanding Fermi gas relation. Fig. 1 (left) shows the symmetry energy as a function of excitation energy obtained by comparing the experimental isoscaling parameter with those of the statistical multifragmentation model calculation in Fe + Fe and Ni + Ni, and Fe + Ni and Ni + Ni pair of reactions. The temperature as a function of the excitation energy (caloric curve) obtained from the statistical multifragmentation model agrees very well with the vast body of data that exist in the literature for the caloric curve. Fig. 1 (right) shows the density as a function of the excitation energy obtained using the expanding Fermi gas relation (or assuming the break-up density in SMM to be evolving) that reproduces the Caloric curve obtained in this mass region. The correlation between the symmetry energy and the density as a function of excitation energy obtained is then used to plot the density dependence of the symmetry energy. Fig 2 shows the symmetry energy as a function of the density (solid circles). The solid square corresponds to the experimental data obtained by fitting the experimental differential cross-section data in a charge exchange reaction using the isospin dependent optical potential by Khoa *et al.* [1]. The solid curve corresponds to $E_{sym}(\rho) = 31.6(\rho/\rho_0)^{0.69}$ MeV, which was obtained by comparing the present data with the AMD calculation as discussed in Ref. [2, 3]. This dependence was obtained by comparing the experimentally determined isoscaling parameter with those predicted by the Anti-symmetrized Molecular Dynamic (AMD) calculation. The close agreement between the two different approaches for determining the density dependence of the symmetry energy as shown in fig. 3 is

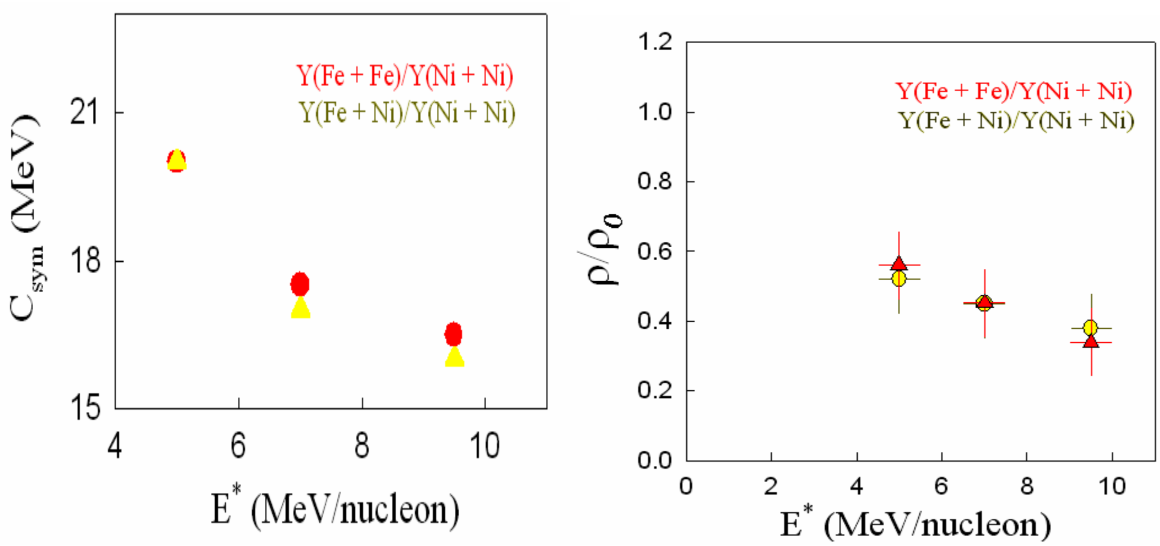

Figure 1. (left) Symmetry energy as a function of the excitation energy. (Right) Density as a function of excitation energy for the Fe + Fe and Ni + Ni, and Fe + Ni and Ni + Ni reaction pairs.

encouraging. The decrease in the symmetry energy therefore appears to be related to the decrease in density with increasing excitation.

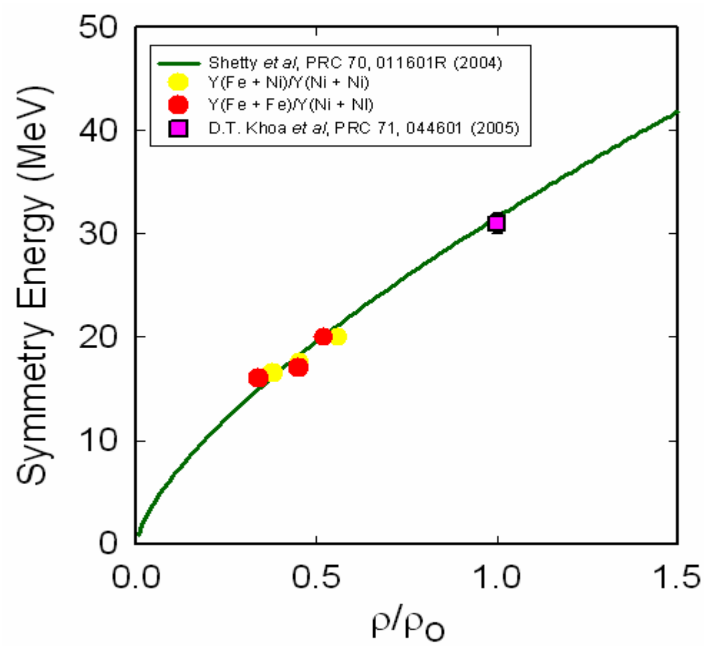

Figure 2. Comparison of the density dependence of the symmetry energy obtained from the dynamical model and the statistical model approach.

[1] D.T. Khoa *et al.*, Phys. Rev. C 71, 044601 (2005).
[2] D.V. Shetty *et al.*, Phys. Rev. C 70, 011601 (2004).
[3] D.V. Shetty *et al.*, nucl-ex/0512011 (2005).