Density slope of nuclear symmetry energy from a novel correlation analysis

L. W. Chen,[1] C. M. Ko, B. A. Li,[2] and J. Xu

[1]*Department of Physics, Shanghai Jiao Tong University, Shanghai and Center of Theoretical Nuclear Physics, National Laboratory of Heavy Ion Accelerator, Lanzhou, , China*

[2]*Department of physics and Astronomy, Texas A&M University-Commerce, Commerce, Texas*

Expressing explicitly the Skyrme interaction parameters in terms of the macroscopic properties of asymmetric nuclear matter, we have found in the Skyrme-Hartree-Fock approach that unambiguous correlations exist between observables of finite nuclei such as the neutron skin thickness Δr_{np} and nuclear matter properties such as the nuclear symmetry energy $E_{sym}(\rho_0)$ and its slope L at saturation density [1]. Combining constraints on $E_{sym}(\rho_0)$ and L from the application of this novel correlation analysis to existing data on the neutron skin thickness of Sn isotopes [2,3] with those from recent analyses of isospin diffusion and double neutron/proton ratio [4] in heavy ion collisions at intermediate energies leads to a value of L=58±18 MeV, approximately independent of $E_{sym}(\rho_0)$, as shown by the shaded region in the $E_{sym}(\rho_0)$-L plane shown in Fig. 1. Using this constrained value of L, we have evaluated the transition density ρ_t and pressure P_t at the boundary of the liquid core and inner crust in a neutron star following the dynamic method of Ref.[5]. The resulting values of ρ_t=0.069±0.017 fm^{-3}, shown in the left panel of Fig.1, and P_t=0.322±0.2.2 MeV/fm^3 agree with the empirical ones [6], This value of L has also allowed us to

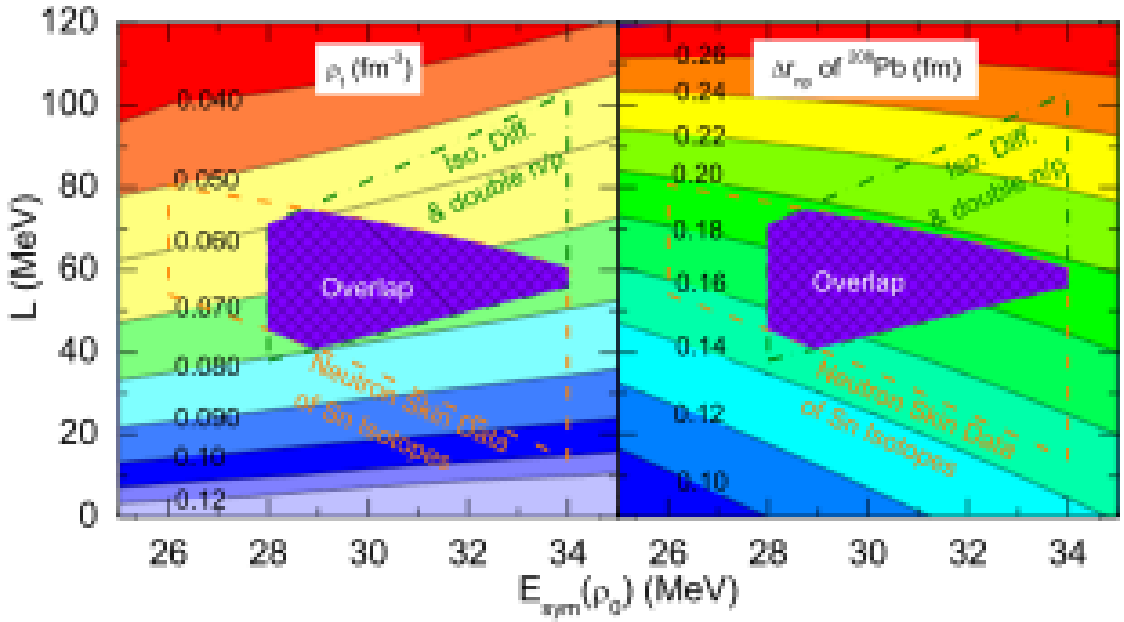

FIG. 1. Contour curves in the $E_{sym}(\rho_0)$-L plane for the core-crust transition density ρ_t (left panel) and the neuteron skin thickness Δr_{np} of ^{208}Pb (right panel) from Skyrme-Hartree-Fock calculation with MSL0. The shaded region represents the overlap of constraints obtained in the present work (dashed lines) and that from Ref.[4] (dash-dotted lines).

constrain the neutron skin thickness of ^{208}Pb to a narrow region of 0.175±0.02 fm as shown in the right panel of Fig. 1. and this is consistent with other constraints from various experiments [7] but with a much smaller uncertainty.

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