1 - 10 Density-dependent Symmetry Energy at Subsaturation Densities

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The symmetry energy which characterizes the isospin dependence of the equation of state of asymmetric nuclear matter, plays a crucial role in understanding a variety of issues in nuclear physics and astrophysics, such as heavy ion collisions, exotic nuclei, stability of superheavy nuclei, fusion cross sections, the structures, composition and cooling of neutron stars[1−5]. Much theoretical and experimental effort has been made to constrain the density dependence of symmetry energy. Up to now, we have got some basic knowledge about the symmetry energy at low densities, while at high densities we even do not know its variation tendency as a function of density. The problem remains unsolved due to the difficulty of nucleon-nucleon interactions and many-body problems.

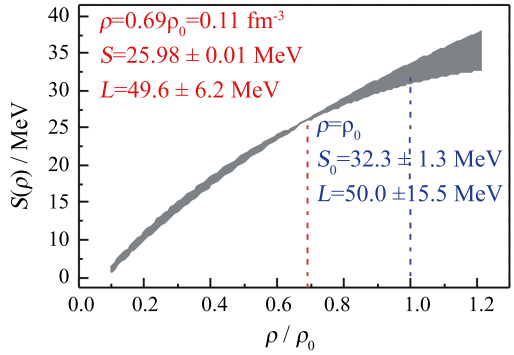

Fig. 1 (color online) Symmetry energy as a function of density.

In the present work, the symmetry energy coefficients of heavy nuclei are determined by using the available experimental nuclear masses of heavy nuclei[6]. This approach prevents interference from other energy terms very effectively, which is better than that using the β^--decay energies of odd-A heavy nuclei since the nuclear odevity changes in β decay. The result is applied to analyze the density dependence of symmetry energy of nuclear matter at subsaturation densities. The slope parameter at the saturation density is determined to be L= (50.5 ± 15.5) MeV in the present work. Fig. 1 shows the calculated symmetry energy as a function of density. According to some existing investigations, the neutron skin thickness of heavy nuclei is expected to be uniquely fixed by the slope parameter $L(\rho)$ of symmetry energy at a subsaturation density of $\rho\approx0.11$ fm^{-3} rather than that at the saturation density[7]. At this subsaturation density, the symmetry energy and its slope parameter obtained here are (25.98 ±0.01) MeV and L= (49.6 ± 6.2) MeV, respectively, in agreement with the results given by other independent analyses. The present results are expected to be useful to further determine the neutron skin thickness.

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