**Nuclear symmetry energy and single-nucleon potential in asymmetric nuclear matter**

C. Xu,[1] B.A. Li,[2] L.W. Chen,[3] and C.M. Ko

[1]*Department of Physics, Nanjing University, Nanjing 210008, China*

[2]*Department of Physics and Astronomy, Texas A&M University-Commerce, Commerce, TX 75429-3011,*

[3]*Department of Physics, Shanghai Jiao Tong University, Shanghai 200240, China*

Using the Hugenholtz–Van Hove theorem [1], we have derived general expressions for the quadratic and quartic symmetry energies in terms of the isoscalar and isovector parts of the single-particle potentials in isospin asymmetric nuclear matter [2]. These expressions allow us to connect directly the symmetry energies with the underlying isospin dependence of strong interactions. Since the single-particle potentials are direct inputs in both shell and transport models, the derived expressions facilitate the extraction of symmetry energies from experimental data. They thus help constrain the corresponding energy density functionals. As two examples, the BGBD [3] and the MDI [4] potentials are used in deriving the corresponding symmetry energies. For both interactions, the isovector potential is responsible for the uncertain high density behavior of the quadratic symmetry energy. The analytical formulas for the nuclear symmetry energies in terms of the isoscalar and isovector potentials are expected to be useful for extracting reliable information about the EOS of neutron-rich nuclear matter from experimental data. Also, the magnitude of the quartic symmetry energy is found to be generally small compared to the quadratic term. However, it could be important for determining the compositions and the core-crust transition densities of neutron stars.

[1] N.M. Hugenholtz and L. Van Hove, Physica **24**, 363 (1958).

[2] C. Xu, B.A. Li, L.W. Chen, and C.M. Ko, Nucl. Phys. **A865**, 1 (2011).

[3] I. Bombaci, Chapter 2 in “Isospin Physics in Heavy-Ion Collisions at Intermediate Energies”, edited by Bao-An Li and W. Udo Schröer, (Nova Science Publishers, Inc., New York, 2001).

[4] C.B. Das, S. Das Gupta, C. Gale, and B.A. Li, Phys. Rev. C **67**, 034611 (2003).