Temperature Dependence of the Symmetry Energy and Neutron Skins in Ni, Sn, and Pb Isotopic Chains

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The symmetry energy and its temperature dependence in the cases of the isotopic chains of even-even Ni, Sn, and Pb nuclei is investigated [1] in the framework of the local density approximation (LDA). The Skyrme energy density functional with two Skyrme-type effective interactions, SkM* and SLy4, is used in the calculations. The temperature-dependent proton and neutron densities are calculated through the HFBTHO code [2] that solves the nuclear Skyrme-Hartree-Fock-Bogoliubov problem by using the cylindrical transformed deformed harmonic-oscillator basis. In addition, two other density distributions of ^{208}Pb [3], namely the Fermi-type density determined within the extended Thomas-Fermi (TF) method [4] and symmetrized-Fermi local density obtained within the rigorous density functional approach [5], are used. The kinetic energy densities are calculated either by the HFBTHO code or, for a comparison, within the extended TF method up to the second order in temperature (with T^2 term) [6]. Alternative ways to calculate the symmetry energy coefficient within the LDA are proposed. The results for the thermal evolution of the symmetry energy coefficient in the interval $T = 0 - 4$ MeV show that its values decrease with temperature. The temperature dependence of the neutron and proton root-mean-square radii and corresponding neutron skin thickness is also investigated. It is shown that the effect of temperature leads mainly to a substantial increase of the neutron radii and skins, especially in the heavier neutron-rich nuclei. This feature may have consequences on astrophysical processes and neutron stars.

References

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