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Surface energy of the nuclear matter at all possible conditions of two-phase boundary coexistence

We calculate the surface energy, the surface tension and the neutron skin thickness of the nuclear matter at all possible conditions of two-phase boundary coexistence [nuclear matter-vacuum, nuclear matter-neutron matter (after neutron drip), and nuclear matter-nuclear matter (after proton drip)]. Following [1,2], calculations are based on extended Tomas-Fermi approach. We apply a set of Skyrme-type forces [3], which agrees with nuclear physical and astrophysical constraints. The results for surface energy, surface tension and neutron skin thickness are approximated by simply analytical expression, which explicitly agree with thermodynamic consistency conditions [4]. This approximations are especially useful for modeling the inner crust of neutron stars, where atomic nuclei (nuclear clusters) are immersed into background of unbound neutrons. In particular, they can be applied to model nonspecial nuclear shapes, which can exist at the deepest regions of the inner crust (so-called pasta phases, because cluster shape can be of spaghetti or lasagna type).

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