Nuclear Theory

The cluster structure of the inner crust of neutron stars in the Hartree-Fock-Bogoliubov approach

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We analyse how the structure of the inner curst is influenced by the pairing correlations. The inner-crust matter, formed by nuclear clusters immersed in a superfluid neutron gas and ultra-relativistic electrons, is treated in the Wigner-Seitz approximation. The properties of the Wigner-Seitz cells, i.e., their neutron to proton ratio and their radius at a given baryonic density, are obtained from the energy minimization at beta equilibrium. To obtain the binding energy of baryonic matter we perform Skyrme-HFB calculations with zero-range density-dependent pairing forces of various intensities. We find that the Wigner-Seitz cells have much smaller numbers of protons compared to previous calculations. For the dense cells the binding energy of the configurations with small proton numbers do not converge to a well-defined minimum value which precludes the determination of their structure. We show that for these cells there is a significant underestimation of the binding energy due to the boundary conditions at the border of the cells imposed through the Wigner-Seitz approximation.

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