



Nuclear Theory

Proton fraction in the inner neutron-star crust

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Monte Carlo simulations of neutron-rich matter of relevance to the inner neutron-star crust are performed for a system of $A=5,000$ nucleons. To determine the proton fraction in the inner crust, numerical simulations are carried out for a variety of densities and proton fractions. We conclude---as others have before us using different techniques---that the proton fraction in the inner stellar crust is very small. Given that the purported "nuclear pasta" phase in stellar crusts develops as a consequence of the long-range Coulomb interaction among protons, we question whether pasta formation is possible in such proton-poor environments. To answer this question, we search for physical observables sensitive to the transition between spherical nuclei and exotic pasta structures. Of particular relevance is the static structure factor $S(k)$ ---an observable sensitive to density fluctuations. However, no dramatic behavior was observed in $S(k)$. We regard the identification of physical observables sensitive to the existence---or lack-thereof---of a pasta phase in proton-poor environments as an open problem of critical importance.

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