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Evolution of Proto Neutron Stars and Nuclear Pasta

A protoneutron star is believed to be born from the collapse of a very massive star and a supernova explosion. During the first few seconds of the star evolution, almost all the binding energy is taken away by the neutrinos. The neutrino luminosity is controlled mainly by the total protoneutron star mass and the neutrino opacity. In this work we show that an important difference in the evolution of a protoneutron star is seen if a pasta phase is present in its inner crust. The deleptonization and cooling processes take longer than if the crust would be made of homogeneous matter only. This statement results from the smaller diffusion coefficients obtained with the inclusion of the pasta phase. The diffusion coefficients present in the transport equations determine the temporal behavior associated with the deleptonization and cooling processes. The nuclear pasta was calculated by the coexistence phases method. We have assumed total charge neutrality, β-equilibrium and neutrino trapping in the equation of state. The surface energy coefficient was obtained with three different parameterizations and one of them practically reproduces results obtained with the more sophisticated Thomas-Fermi method, yielding credibility to our method.

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