Transition density and pressure in hot neutron stars

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Using the momentum-dependent MDI interaction we have studied the transition density and pressure at the boundary that separates the liquid core from the inner crust of neutron stars. Both the neutrino-trapped matter and the neutrino-free matter at finite temperatures [1], which are expected to exist during the early evolution of neutron stars, have been considered. In particular, we have investigated the effect of nuclear symmetry energy by varying the parameter *x* in the MDI interaction from 1 to -1, corresponding to the values $15<L<106$ MeV for the slope of the nuclear symmetry energy at normal density that have been constrained by both the isospin diffusion data [2-4] and other experimental observables [5]. We have found that both the transition density and pressure are larger in the neutrino-trapped matter than in the neutrino-free matter. Furthermore, both are found to roughly decrease with increasing temperature and *L* for both the neutrino-trapped and the neutrino-free matter as shown in the left window of Fig.1, except that the transition pressure shows a complicated relation to the temperature for the neutrino-trapped matter as shown in the right window of Fig. 1. Also, negative values of the pressure at the transition density have been obtained, which can be used to rule out a very stiff symmetry

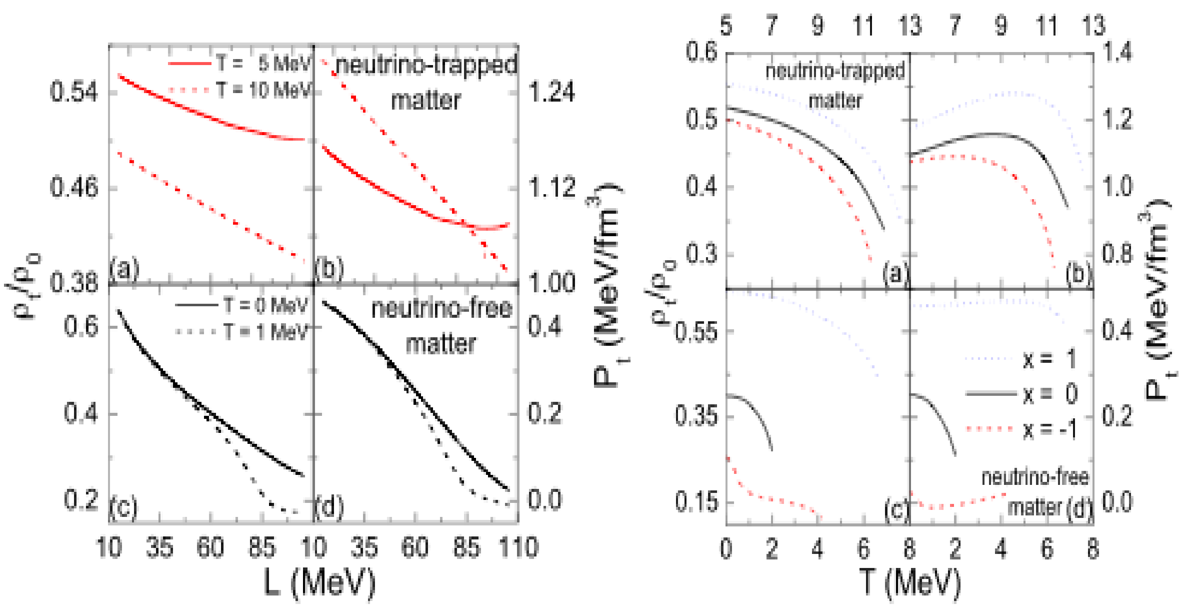

FIG. 1. Transition densities ρ_t ((a) and (c)) and pressure P_t ((b) and (d)) as functions of the slope parameter *L* of the nuclear symmetry energy at different temperatures (left window) and as functions of temperature for different nuclear symmetry energy parameter *x* (right window) in both the neutrino-trapped matter ((a) and (b)) and the neutrino-free matter ((c) and (d)).

energy at subsaturation densities. We have also studied the critical temperature above which the inner crust described by the so-called nuclear pasta phase cannot be formed in newly born neutron stars and found that it depends sensitively on the density dependence of the nuclear symmetry energy at subsaturation densities.

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