THE PROBLEM OF SOLIDIFICATION IN NEUTRON STARS

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The possibility existing crystal lattice in the interior of neutron stars is an interesting topic, Vela pulsar's glitches phenomenon is explained by means of this structure. There have been many articles in this respect in recent more than ten years. We are doing some work on the same topic.

The pure neutron matter in density region of about 0.4 - 3.6 fm^{-3} at zero temperature is examined. We assume that it is possible to exist diamond lattice with " parallel-spin " configuration in neutron stars.

The neutron-neutron (N-N) interaction is chosen to be the central part of the Reid soft-core potential, the interaction of all singlet states are taken to be $V(^1D_2)$, all triplet states are taken to be $V_c(^3P_2 - ^3F_2)$. In addition, HJ and BKR potentials are examined.

Let the single-particle wave functions are Gaussians centered round any lattice site. The uncorrelated two-particle wave function is an antisymmetric wave function constructed from two single-particle wave functions. The N-N interaction exerts an influence on two-particle wave function. The influence is expressed by two-body correlation function.

The enrgies of the solid enutron matter are obtained by using Pandharipande's lowest-order constrained variation method. There isn't any indication of solidification in neutron stars for this three potentials.

We calculate the loss of energy because of $V(^1D_2)$ instead of $V(^1S_0)$ at $\rho = 1.6\ fm^{-3}$ and correct the energy at this density. The resulting energy is more unfavorable to appearing solidification. This shows that the choice of the interaction has a substantial effect on the appearing of solidification in neutron stars.

Finally, we discuss the effect of crystal lattice on solidification in neutron stars. We compare our results obtained from the Reid potential with the energy of b.c.c. and f.c.c. lattices obtained by Mittet (1983) using the same method and potential. In order to illustrate the problem further, we compare with their packing fractions either. We find that the crystal lattice is marginally favorable to solidification when the packing fraction is large.

Reference

Mittet,R., et al.:1983, Nucl.Phys., A411,417

D. J. Helfand and J.-H. Huang (eds.), The Origin and Evolution of Neutron Stars, 448.