Hyperon ordering in neutron star matter

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We explore the possible formation of an ordered phase in neutron star matter, related to the localization of hyperons at high densities. In a simplified quantum hadrodynamics model where neutrons, protons and Λ hyperons interact via the exchange of sigma and omega mesons, we compare the energy of the usually assumed uniform, liquid phase, to a configuration in which di-lambda pairs immersed in an uniform nucleon fluid are localized on the nodes of a regular lattice. We adopted a simple approximation analog to the Sommerfeld's free electron approximation for a Coulomb lattice.
The confining potential is calculated self consistently as resulting from the combined action of the nucleon fluid and the others hyperons, under the condition of beta equilibrium. We were able to obtain stable ordered phases for some reasonable sets of values of the model parameters. Typical results [1] yield a lattice size $a \sim 2$ fm, a confining potential with a depth $U_0 \sim 50 - 60$ MeV, and an energy difference between the solid and liquid phase of the order of ~ 5 MeV.
It is found that the equation of state could be considerably softened if such an ordering transition takes place. This could in turn have important consequences on the structure and cooling of neutron stars.

References

[1] M.A. Pérez Garcia, N. Corte Rodriguez, L. Mornas, J.P. Suárez, J. Diaz-Alonso, Nucl. Phys. **A699** (2002) 939-962