Constraining Stellar Matter to Earthly Experiments

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A search towards understanding the evolution of the universe, the birth, evolution and fate of the stars and their chemical composition has lead scientists to investigations in different frontiers of knowledge. In this talk a relativistic model able to describe nuclear and stellar matter for applications ranging from nuclear structure to nuclear astrophysics is searched. Experimental results obtained from electron scattering, heavy-ion collisions and astronomical observations are used as constraints towards this search. Some of the equations of state can then be ruled out. To investigate the evolution of proto-neutron stars, the renmants of supernova explosions, an adequate equation of state has to be chosen.

At very low densities and not high temperatures a phase normally called pasta phase is expected to emerge in the crust of these stars. The pasta phase is the result of a frustrated system. Frustration is a phenomenon characterised by the existence of more than one low-energy configuration. At low densities, both in neutral nuclear matter or in β- equilibrium stellar matter, a competition between the strong and the electromagnetic interactions takes place leading to a frustrated system. Normally the short and large distance scales related to the nuclear and Coulomb interactions are well separated so that nucleons bind into nuclei but at densities of the order of $10^{13} - 10^{14}$ g/cm^3 these length scales are comparable . A variety of complex structures exist and they are commonly named droplet (bubble), rod (tube) and slab for three, two and one dimensions respectively. A droplet (bubble) and a rod (tube) have densities larger (smaller) than their surroundings, and are normally defined within a Wigner-Seitz cell. The pasta phase is the ground state configuration if its binding energy is lower than the corresponding homogeneous phase. We incorporate the pasta phase in the choice for an appropriate equation of state aiming the description of proton-neutron stars.