ID de Contribution: **168** Type: **Talk**

Nuclear pastas in neutron stars: uncertainties of ETFSI approach

mercredi 22 mars 2023 16:00 (30 minutes)

The region between the crust and the core of a neutron star (NS) may consist of a mantle of so-called nuclear pastas. If they exist, these exotic nuclear structures could significantly affect the transport and mechanical properties of dense matter, leaving their imprints on such NS observables as continuous gravitational-wave emission, NS oscillations and their damping, the spin period of x-ray pulsars, and NS cooling.

Such an extremely dense, neutron-rich and inhomogeneous environment represents unique conditions inaccessible to laboratory experiments and challenging for a fully microscopic treatment. Although nuclear pastas have been extensively studied within (semi-) classical methods, limited self-consistent mean-field calculations have been carried out so far due to high computational cost. For this reason, we follow an alternative approach adding proton shell corrections perturbatively via the Strutinsky integral theorem on top of the energy calculated within the 4th-order Extended Thomas-Fermi method [1]. We evaluate the uncertainties of this ETFSI approach using the generalized Skyrme effective interaction BSk24 [2].

First, we show within the ETF approach that the range of densities for which pasta phases are present and the types of pastas can depend on the parameterization of the nucleon profiles employed to speed up the calculations. To improve them, we introduce two new parametrizations for which we have found lower ETF energy solutions, therefore, more accurate nucleon profiles than previously obtained. In the second stage, when adding the SI corrections, we find that the differences in energies corresponding to the adopted parametrizations are (partially) compensated, such that the ETFSI results for the two new profiles are in good agreement. In contrast to the purely ETF calculations, the spaghetti phase is now replaced by spherical clusters, which can also intersperse the lasagna phase and thus shrink the NS mantle. However, results at high densities become sensitive to the imposed boundary conditions to calculate the SI correction. In summary, quantum effects are shown to play an important role for pasta phases, however, fully self-consistent mean-field calculations are still required to identify the configurations that are present near the crust-core boundary.

[1] J. M. Pearson and N. Chamel, Phys. Rev. C 105, 015803 (2022)
[2] S. Goriely, N. Chamel, and J. M. Pearson, Phys. Rev. C 88, 024308 (2013)

Auteurs principaux: SHCHECHILIN, Nikolai (Universite Libre de Bruxelles); Dr CHAMEL, Nicolas (Universite Libre de Bruxelles); Dr PEARSON, John Michael (Universite de Montreal); Dr GUSAKOV, Mikhail (Ioffe Institute); Dr CHUGUNOV, Andrei (Ioffe Institute)

Orateur: SHCHECHILIN, Nikolai (Universite Libre de Bruxelles)

Classification de Session: Wednesday 16:00-18:00

Classification de thématique: Nuclear Astrophysics