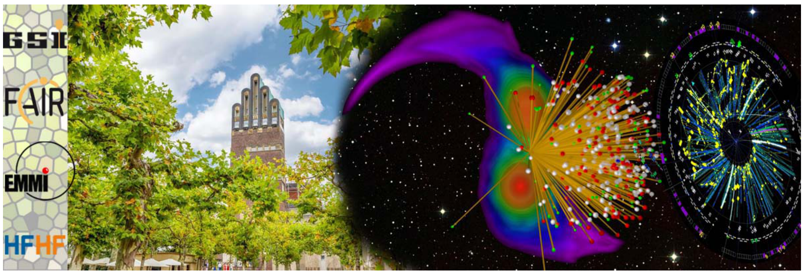

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Nuclear pastas in neutron stars: role of the symmetry energy

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The deepest region of the neutron star (NS) crust may consist of a layer 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.

Here we study the pasta phases by employing the fourth-order extended Thomas-Fermi method (ETF) with Strutinsky integral (SI) and pairing corrections consistently added on top. We consider the series of Brussels-Montreal functionals accurately fitted to nuclear masses but imposing various symmetry-energy coefficients J or constraining to reproduce a different neutron-matter equation of state. These functionals predict different behaviors for the symmetry energy at subsaturation densities corresponding to the pasta phases.

In our calculations at the pure ETF level, we observe a larger fraction of pasta phases for functionals with higher values of the symmetry energy at the relevant densities (generally corresponding to lower values for J and slope L). This is due to the threshold density $\bar{n}_{\rm sp}$ for the onset of pasta phases being decreased while the crust-core transition density $\bar{n}_{\rm cc}$ is raised. However, the inclusion of microscopic (SI plus pairing) corrections reduces substantially the abundance of pastas for all functionals by shifting $\bar{n}_{\rm sp}$ and blurring its correlation with symmetry energy. As a result, the influence of symmetry energy on the pasta phases presence weakens.

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