Institute of SCIENCE TOKYO

Advanced Research Center for ***Quantum Physics and Nanoscience***

量子物理学・ナノサイエンス第 422 回セミナー

Nuclear pasta in neutron stars

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日程　：　9 月 26 日（金）16:00–

場所　：　Zoom*

概　要

Immense pressure locks dense nuclear matter in the crust of a neutron star in a tightly packed periodic lattice. In its deepest region, exotic nuclear "pasta" configurations are expected to emerge. Due to the peculiarities of their structure, pasta phases affect the crustal elastic and transport properties. As a result, pasta shapes can leave their imprints on the entire spectrum of multi-messenger neutron star phenomena, from their magnetic, thermal and rotational evolution to their oscillations and emission of gravitational waves. Liquid-drop models and semi-classical (extended) Thomas-Fermi methods predict that half of the crust mass consists of pasta. Within these simplified frameworks, pasta phases appear whenever the volume fraction of nuclear clusters reaches around 14%. The density ranges of "traditional" pasta sequence (spaghetti, lasagna, bucatini and Swiss cheese) depend on the values of nuclear symmetry energy. However, accounting for quantum shell and pairing effects perturbatively within the Strutinsky integral method alters the pasta sequence (even interspersing it with spheres) and leads to a substantial shrinking of the pasta layer, questioning its very existence. To better assess the presence of nuclear pasta in neutron stars, we follow a fully three-dimensional quantum treatment based on the self-consistent nuclear energy-density functional approach. We employ a finely calibrated Brussel parametrization of the generalized Skyrme effective force, which is particularly well suited for the description of extremely deformed nuclear clusters in a superfluid medium, since it precisely reproduces (i) experimental data on nuclear fission and (ii) microscopic calculations of pairing gaps at arbitrary isospin asymmetries. In the talk, I will show that the accurate determination of exotic nuclear configurations requires large computational domains (encompassing several pasta replicas) and accounting for various nuclear shapes and crystal structures. The stability of pasta phases will be discussed through full 3D Hartree-Fock plus BCS pairing numerical calculations.

* 本 ZOOM セミナーに参加されます場合には、事前に下記より登録を済ませてください。

https://zoom.us/meeting/register/5kT3nmhnQoChpBTahh8_uA

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