独立行政法人理化学研究所　仁科加速器研究センター
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The 86th RIBF Nuclear Physics Seminar

Formation of nuclear "pasta" in supernovae

Dr. Gentaro Watanabe （Theoretical Nuclear Physics Laboratory, RIKEN）

Ordered structures in mesoscopic scale due to the competition between attractive and repulsive forces are ubiquitous in nature. In collapsing supernova cores, nuclear “pasta” phases such as triangular lattice of rod-like (i.e., spaghetti-like) nuclei and layered structure of slab-like (i.e., lasagna-like) nuclei are considered to exist due to the competition between the surface tension of nuclei resulting from the medium-range attractive nuclear force and the repulsive Coulomb force. Although 25 years have passed since the first prediction of the pasta phases [1, 2], it has been unclear whether or not they are actually formed in supernova cores. Using ab-initio numerical simulations called the Quantum Molecular Dynamics (QMD), we have solved this problem by demonstrating that a lattice of rod-like nuclei is formed from a bcc lattice by compression [3]. We have also discovered that, in the transition process, the system undergoes zigzag configuration of elongated nuclei, which are formed by a fusion of two original spherical nuclei.
In my talk, I will present our recent work [3] followed by an explanation about the astrophysical background of the supernova explosion and the pasta phases.

References
[1] D. G. Ravenhall, C. J. Pethick, and J. R. Wilson, Phys. Rev. Lett. 50, 2066 (1983).
[2] M. Hashimoto, H. Seki, and M. Yamada,Prog. Theor. Phys. 71, 320 (1984).
[3] GW, H. Sonoda, T. Maruyama, K. Sato, K. Yasuoka, and T. Ebisuzaki, arXiv:0904.0512, to appear in Phys. Rev. Lett.

* This is the part of the consecutive seminars organized by CNS and RIBF.

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The seminar will be given in English.

Contact: RIBF Nuclear Physics Seminar Organizer
seminar@ribf.riken.jp
http://ribf. riken.jp/~seminar