KMI Colloquium

Exploring the most neutron-rich nuclei and beyond

Takashi Nakamura
(Tokyo Institute of Technology)

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Abstract:

How many neutrons can be added to a given atomic nucleus? It sounds like a simple question, but this is still an unresolved, fundamental question in nuclear physics. Indeed, the neutron-rich bound limit, called neutron-drip line in the nuclear chart, has been established only up to oxygen isotopes (Z=8). We also ask ourselves how atomic nuclei behave near and beyond the neutron drip line. We know that a cluster of the order of 10^{57} neutrons can form a neutron star, much beyond the neutron drip line. As such, neutron-rich nuclei can be a femto-scale laboratory for neutron stars, realized on Earth. We also note that extremely neutron-rich nuclei may be produced, for a very short period, in explosive environments in the universe, such as Type-II supernova or neutron-star mergers. How such extremely neutron-rich nuclei play a role in the nucleosynthesis is also one of the key questions in current nuclear and astrophysics.

In this seminar, after some introduction, I present how extremely neutron-rich nuclei are produced and studied in the laboratory. By showing some recent experimental results on extremely neutron-rich nuclei from helium to oxygen isotopes, I'll illustrate characteristic features of such nuclei and physics behind [1,2]. I will focus, for instance, the recently observed very weakly "unbound" two neutron state in ^{26}O [2]. These experiments have been performed using intermediate-energy (c.a. 200MeV/nucleon) rare-isotope beams at RIBF (RI-Beam factory) at RIKEN [3,4], which is now the world center for rare isotope physics. I also mention the implication of these recent experimental results in terms of neutron-star physics. Finally, I will provide perspectives on the near future exploration of exotic nuclei towards/beyond the neutron-rich limit [3,4].

[1] Y. Togano, T. Nakamura et al., Phys. Lett. B **761**, 412 (2016).
[2] Y. Kondo, T. Nakamura et al., Phys. Rev. Lett. **116**, 102503 (2016).
[3] T. Nakamura, H. Sakurai, H. Watanabe, Prog. Part. Nucl. Phys. **97**, 53 (2017).
[4] 中村隆司著「不安定核の物理」基本法則から読み解く物理学最前線８、共立出版