Storage-ring mass spectrometry in Japan

T. Yamaguchi, F. Suzaki, the Rare-RI Ring collaboration

Department of Physics, Saitama University, Saitama 338-8570, Japan
yamaguti@ribf.riken.jp

Thanks to the advent of radioactive nuclear beam techniques, exotic structures of nuclei such as halo and skin have appeared near and at the drip lines on the chart of nuclides. Systematic studies on such exotic nuclei will eventually define the nuclear matter equation of state (EOS), which might be an important application in the understanding of the structure of neutron stars.

Among nuclear properties, atomic mass is of fundamental importance reflecting a variety of structures and interactions formed by constituent nucleons embedded in the nucleus. In particular, precision masses of extremely neutron-rich nuclei are most essential to determine the pathway of the r-process nucleosynthesis, one of the unanswered questions of physics in this century.

As a next generation nuclear physics tool, high-energy heavy-ion storage rings will provide us with a unique opportunity to give access to precision masses of exotic short-lived nuclei, where the highest-precision ion-trap experiments are difficult to apply. A challenge is now devoted to overcome the difficulty in measuring masses of such short-lived rare isotopes with extremely low production rates. Combined with high-energy and high-intensity exotic RI beams available at the RIKEN RI Beam Factory (RIBF), a new type of storage-ring mass spectrometry will be conducted near future [1]. The new storage ring called “Rare-RI Ring” is currently under construction at the RIBF.

A novel idea of cyclotron-like storage ring coupled with the individual injection scheme is introduced in the isochronous mass spectrometry [2]. In the mass spectrometry, the mass of an exotic nucleus stored in the storage ring is determined from the revolution time. Thanks to the excellent performance of the BigRIPS fragment separator [3], high-precision revolution time measurements combined with the event-by-event correction technique will enable us to determine the masses of short-lived nuclei with the precision of an order of $\delta m/m \approx 10^{-6}$. The principle can be applied even for only one particle produced in an experiment.

The present project will shed light on the understanding of the r-process nucleosynthesis as well as further accelerate RI beam science far from the stability. The contribution will present the status of the Rare-RI Ring project with physics cases and compare with currently operating storage rings in the world, ESR at GSI, Darmstadt [2] and CSRe at IMP, Lanzhou [4].

References