Recent results of decay spectroscopy at RIBF

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The nucleus is an isolated quantum system which consists of a finite number of fermions. A nucleus has a defined surface due to its finite volume, giving rise to a variety of nuclear shapes and dynamics depending on the interactions between the constituent protons and neutrons. Such shape-transitional behavior of atomic nuclei has been one of the major subjects explored in both experimental and theoretical nuclear physics. Meanwhile, the stability of nuclear shape is potentially influenced by the presence of the magic numbers (shell closures). For the last few decades, the study of exotic (unstable) nuclei using radioactive isotope (RI) beams revealed that the magic numbers that have been observed for the nuclei near the line of β-stability are not necessarily universal and are subjected to a change in certain regions with highly unbalanced ratios of protons and neutrons. The research on such a paradigm shift is the frontier of nuclear structure science.

γ-ray spectroscopy following the β decay is an effective tool for exploring low-lying yrast and non-yrast states, which provide key structure information such as the shape transitions/coexistence and the single-particle levels. For the study of rare isotopes, especially when the nucleus of interest lies at the boundaries of availability for spectroscopic studies, isomeric decays are likely to be a more useful means than decays to populate lower-lying levels. The identification of such characteristic isomers will pin down currently controversial subjects including the evolution of shell structures. The combined β- and isomeric-decay measurements at the RI Beam Factory (RIBF) [1], which has the capability of providing the world's strongest RI beams, are at the forefront of exploration of exotic nuclei far from the stability line.

This presentation focuses on the achievements obtained in the first decay spectroscopy at RIBF in 2009. A major aim of this work was the study of neutron-rich nuclei around Z = 40 and A = 110, where the shape transitions from prolate, via gamma-soft, to oblate deformations are predicted to occur with increasing the number of neutrons. New results include the observation of shape evolution in ^{106,108}Zr [2], a possible oblate-shape isomer in ^{109}Nb [3], and a large-amplitude -soft dynamics in ^{110}Mo [4]. These findings revealed the shape-transitional phenomena in this neutron-rich region for the first time.

Research opportunities for decay spectroscopy at RIBF will be expanded with the high-efficient gamma-ray spectrometer EURICA (EUROBALL-RIKEN Cluster Array) [5]. The first long-term EURICA experimental campaign has been carried out in November and December in 2012. Very neutron-rich nuclei in the vicinity of the doubly-magic nuclei ^{78}Ni and ^{132}Sn were produced from ^{238}U beams with an intensity of 7-12 pnA. The highlights of this experimental campaign will be also introduced.

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[1] Y. Yano, Nucl. Inst. Meth. **B** 261, 1009 (2007).

[2] T. Sumikama *et al.*, Phys. Rev. Lett. 106, 202501 (2011).
[3] H. Watanabe *et al.*, Phys. Lett. **B** 696, 186 (2011).
[4] H. Watanabe *et al.*, Phys. Lett. **B** 704, 270 (2011).
[5] http://www.riken.jp/engn/r-world/info/release/press/2012/120326_4/index.html