Contribution ID: **39** Type: **Presentation**

Ground-state properties of neutron-rich Mg isotopes through reaction cross sections

Wednesday, 2 July 2014 11:50 (25 minutes)

The elucidation of the so-called "island of inversion" (Z ~ 10-12, N ~ 20-22) is one of the most important subjects in current nuclear physics. Since nuclei in the region have exotic properties that never appear in stable nuclei, it is important to understand them properly through the microscopic framework with no free parameter. In the previous works [1, 2], interaction cross sections σI measured for 28-32Ne [3] were analyzed by the double folding model with the densities calculated by antisymmetrized molecular dynamics (AMD). This fully microscopic framework, which never assumes structure of the nuclei, reproduces the measured σI with no adjustable parameter, and concludes that 28-32Ne have large deformation and in particular 31Ne is a deformed halo nucleus.

In this study, we apply the microscopic framework to 24-40Mg (N = 12-28) and determine the ground-state properties (spin-parity, total binding energy, deformation and radius) from reaction cross sections measured very lately at the Radioactive Ion Beam Factory (RIBF) [4]. The AMD calculations, which predict large deformation for all the Mg isotopes, succeed in reproducing the measured reaction cross sections overall. For 37Mg as a new candidate of deformed halo nucleus, however, the AMD calculation considerably underestimates the data, even though the predicted deformation is fairly large. This result suggests that 37Mg is a deformed halo nucleus and hence the tail correction should be made for the AMD density with the resonating group method. We will discuss the point in the presentation.

Furthermore, the AMD calculations predict large deformation for 24-40Mg (N = 12-28). This prediction is supported by the fact that the E(4+)/E(2+) ratios for 34,36,38Mg deduced by in-beam γ-ray spectroscopy are about 3.1 independently of N [5]. These results suggest that not only the N = 20 magicity but also the N = 28 magicity disappears in the region.

[1] K. Minomo et al., Phys. Rev. Lett. 108, 052503 (2012).
[2] T. Sumi et al., Phys. Rev. C 85, 064613 (2012).
[3] M. Takechi et al., Phys. Lett. B 707, 357 (2012).
[4] M. Takechi et al., submitted to Phys. Rev. Lett., to be published in EPJ Web of Conferences.
[5] P. Doornenbal et al., Phys. Rev. Lett. 111, 212502 (2013).

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Session Classification: Session 6

Track Classification: Prefer Presentation