Contribution ID: **32** Type: **Contributed Oral/Poster**

Deformation and halo structure through reaction cross sections

Monday, 11 July 2016 13:55 (15 minutes)

We deduce the ground-state properties of neutron-rich Mg isotopes through analyses of recently-measured reaction cross sections ($\sigma_{\rm R}$) [1], and then reanalyze the so-called "island of inversion (IoI)". The IoI is the region of Ne, Na, and Mg isotopes around the neutron number $N = 20$-22. The nuclei in the IoI have exotic properties induced by the rapid shell evolution, and the elucidation is still an important subject. Our analyses are based on optical potentials constructed by the double folding model and densities calculated by antisymmetrized molecular dynamics (AMD). This framework, which does not assume nuclear structures such as deformation, enables us to calculate various observables microscopically. Our framework reproduces the measured $\sigma_{\rm R}$ well, and we can then deduce the ground-state properties (spin parity, total binding energy, and deformation) of Mg isotopes properly. By combing the present study on Mg isotopes[2] with the previous study on Ne isotopes[3], we find that there exists large deformation beyond the IoI from $N = 19$ (^{31}Mg and ^{29}Ne) to $N = 28$ (^{40}Mg). This is consistent with the fact that the $E(4+)/E(2+)$ ratios for ^{34,36,38}Mg deduced from in-beam γ-ray spectroscopy are about 3.1 independently of N [4]. The result indicates that the so-called island of inversion may be enlarged by melting of both the $N = 20$ and 28 magicities.

Furthermore, we investigate ^{37}Mg as a halo nucleus with a deformed ^{36}Mg core, i.e. deformed halo nucleus. In fact, the measured $\sigma_{\rm R}$ on ^{37}Mg is fairly large compared with our calculation, which already includes deformation effects. In this talk, we would also like to discuss weak-binding effects and general properties of one-neutron halo nuclei from the view point of $\sigma_{\rm R}$.

[1] M. Takechi et al., Phys. Rev. C 90, 061305(R) (2014).

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[3] T. Sumi et al., Phys. Rev. C 85, 064613 (2012).

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Track Classification: Exotic structures through direct reactions