Static and Dynamic Properties of Weakly-bound Nuclei

Shin WATANABE
Lecturer, Dr. Sci.
Email : s-watanabe@gifu-nct.ac.jp

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Research Outline

Static Properties: Ground-state Properties of Neutron-rich Mg isotopes

Thanks to the recent development of experimental techniques, many kinds of nuclear properties have been found and established. Now, we entered a new era on unstable nuclei, which are the source of new exotic properties. Neutron-rich Mg isotopes are the good example. Figure 1 shows the total reaction cross sections (σ_R) as a function of the neutron number (N). The σ_R correspond to the nuclear size. The blue triangles show the calculation without deformation and do not follow the experimental data. If the deformation effect is taken into account, the red circles are obtained. The calculated σ_R are enhanced by the deformation effects and reproduce the experimental data well. From this analysis, we found that the large deformation appears at N=19 and lasts until N=28. The numbers N=20 and 28 are the so-called magic numbers where the spherical shape was believed. Our result indicates that these magicities may disappear in this region.

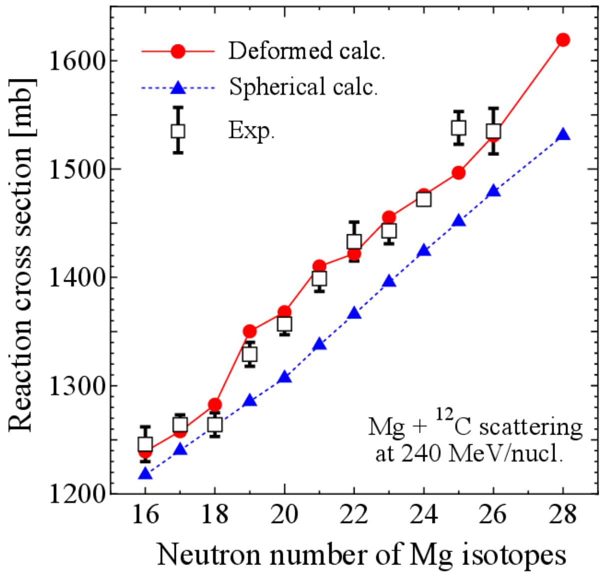

Fig. 1 Reaction cross section and deformation

Dynamic Properties: Breakup effects on ^{6}Li Elastic Scattering

In the first subject, we have investigated the *static* properties of nuclei as an isolated system. On the other hand, we should also investigate reaction dynamics in scattering systems of projectile and target nuclei. This is nothing but elucidation of *dynamic* properties. For example, ^{6}Li is a weakly-bound nuclei composed of neutron (n), proton (p), and an alpha particle (α). Therefore, it is expected that ^{6}Li is easily broken up into these constituents by a target nucleus (T) during the scattering. From the theoretical points of view, it is necessary to treat these breakup channel explicitly. The continuum-discretized coupled-channel method (CDCC) is a powerful tool for treating this kind of breakup reactions. We then apply CDCC for the scattering of ^{6}Li + ^{209}Bi at around the Coulomb barrier energy. As a result, we found that ^{6}Li is not mainly broken up into n, p, and α, but into deuteron (d) and α. We call this property "$d\alpha$-dominance" and found that the $d\alpha$-dominance is realized in a wide incident energy range. The schematic picture of this mechanism is shown in Figure 2.

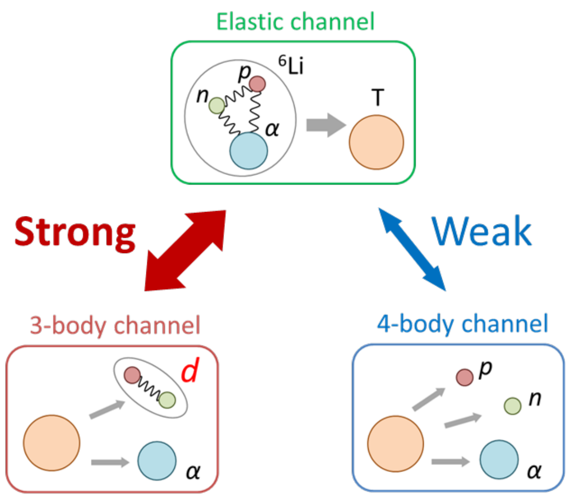

Fig. 2 Schematic picture of ^{6}Li-scattering mechanism