Experimental study of isoscalar and isovector dipole resonances in neutron-rich oxygen isotopes

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Giant resonance is one of the most important phenomena for understanding quantum many-body systems. Neutron-rich nuclei are predicted to have exotic giant resonances owing to their smaller neutron separation energy and excess neutrons. One of the exotic giant resonances in neutron-rich nuclei is a electric dipole resonance found at excitation energies lower than 10 MeV[1]. The identification of the isovector or isoscalar resonances is of great interest to understand the nature of these resonances. In order to study the relationship between the isovector and isoscalar dipole resonances in neutron-rich oxygen isotopes, we performed an experiment at RIBF and measured the dipole resonances of the neutron-rich nuclei ^{20}O, ^{22}O, and ^{24}O. These beams were produced via projectile fragmentation of a 345 MeV/nucleon ^{48}Ca beam on ^{9}Be targets with thicknesses of 2.8 g/cm^2, 2.8 g/cm^2, and 2.2 g/cm^2. The γ rays from the excited beam particles were detected with large volume $LaBr_3$ crystals from INFN Milano[2] in combination with DALI2[3]. Two different targets, 5 g/cm^2 natural gold target for coulomb excitation and 300 mg/cm^2 liquid helium target for inelastic α particle scattering, were used to obtain the isovector and isoscaler dipole strengths, respectively.

A preliminary doppler-corrected γ-ray spectrum of $\alpha(^{20}\mathrm{O},^{20}\mathrm{O}\gamma)\alpha$ reaction is shown in Fig. 1, and the spectrum of $^{\mathrm{nat}}\mathrm{Au}(^{20}\mathrm{O},^{20}\mathrm{O}\gamma)^{\mathrm{nat}}\mathrm{Au}$ reaction is shown in Fig. 2. A clear difference is observed between the spectrum of the different target. This suggests that the comparison of the coulomb excitation and the inelastic α particle scattering is actually effective to distinguish the isovector and isoscaler resonances. Further analysis is in progress to search for the isovector and isoscalar nature of the excited states.

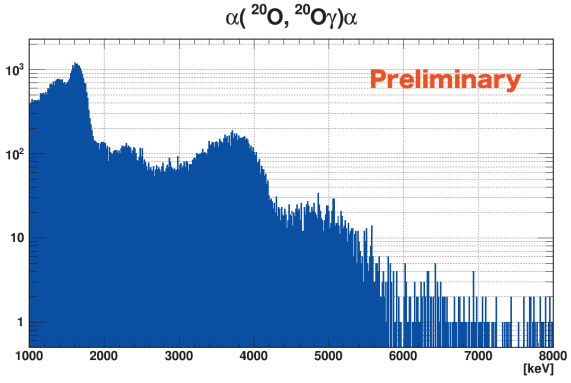

Fig. 1. Preliminary doppler-corrected γ-ray spectrum of $\alpha(^{20}\mathrm{O},^{20}\mathrm{O}\gamma)\alpha$ reaction

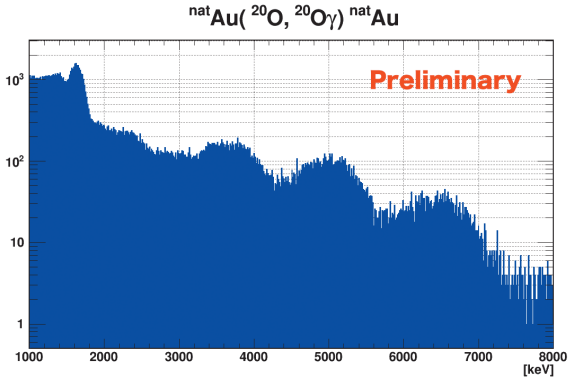

Fig. 2. Preliminary doppler-corrected γ-ray spectrum of $^{\mathrm{nat}}\mathrm{Au}(^{20}\mathrm{O},^{20}\mathrm{O}\gamma)^{\mathrm{nat}}\mathrm{Au}$ reaction

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