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 due to their smaller neutron separation energy and excess neutrons. One of the exotic giant resonances in neutron-rich nuclei is a dipole resonance found at excitation energies lower than 10 MeV[1)]. The nature of these resonances is of great interest. One of the method to understand the nature of these resonances is to investigate if they are iso-vector or iso-scalar resonances. In order to study the relationship between iso-vector and iso-scalar dipole resonances in neutron-rich oxygen isotopes, we performed an experiment at RIBF and measure the dipole resonances of the neutron-rich nuclei ^{20}O, ^{22}O, and ^{24}O. These beams were produced via projectile fragmentation of a 345MeV/nucleon ^{48}Ca beam on ^{9}Be targets with mass thicknesses of 2.8 g/cm^2, 2.8 g/cm^2, and 2.2 g/cm^2. 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 Au for coulomb excitation and 300 mg/cm^3 liquid helium for inelastic α particle scattering, were used to obtain the iso-vector and iso-scaler dipole strengths respectively.

A preliminary particle identification (PID) plot of Z versus A/Z for the ^{24}O beam is shown in Fig. 1. PID was performed by the Bρ-ΔE-TOF technique using the BigRIPS. The $B\rho$ information was reconstructed from the time difference between the left- and right-hand sides of the plastic scintillator installed at the dispersive focal plane. The achieved purity of ^{20}O, ^{22}O, and ^{24}O was 73%, 66%, and 51%, respectively. PID of the outgoing beams was performed by the same Bρ-ΔE-TOF technique using the ZD spectrometer. Low-pressure multi-wire drift chambers[4)] were used to measure Bρ of the outgoing beams. Figure 2 shows a preliminary PID plot of Z versus A/Z for the outgoing beam where an ^{24}O beam is on a Au target. The reaction products are clearly observed. The analysis of γ rays is in progress.

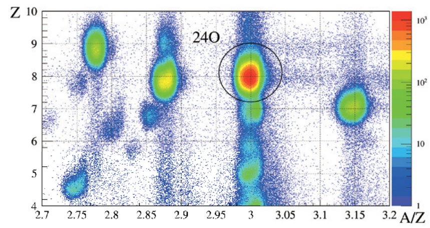

Fig. 1. PID plot of the ^{24}O beam setting

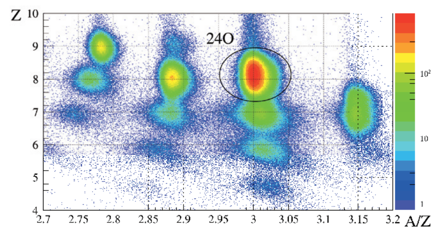

Fig. 2. PID plot of the ^{24}O beam and the Au target setting on ZD spectrometer

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References

1) V. Derya et al. J. Phys. Conf. Ser. 366, 012012 (2012)
2) A. Giaz et al. Nucl. Instrum. Methods Phys. Res., Sec. A **729**, 910 (2013)
3) S. Takeuchi et al. Nucl. Instrum. Methods Phys. Res., Sec. A **763**, 596 (2014)
4) H. Miya et al. Nucl. Instrum. Methods Phys. Res., Sec. B **317**, 701 (2013)