Excitations of the giant dipole resonance in ^{4}He via a (p,p') reaction

T. Yamagata,[1] M. Kinoshita,[1] N. Warashina,[1] H. Akimune,[1] S. Asaji,[2] M. Fujiwara,[3,4] M.B. Greenfield,[5] H. Hashimoto,[3] R. Hayami,[6] K. Ishida,[2] K. Kawase,[3] T. Kudoh,[2] K. Nakanishi,[3] S. Nakayama,[6] S. Okumura,[3] K. Sagara,[2] M. Tanaka,[7] H. Utsunomiya,[1] and M. Yosoi[8]

[1]*Department of Physics, Konan University, Kobe 658-8501, Japan*

[2]*Department of Physics, Kyushu University, Fukuoka 812-8581, Japan*

[3]*Research Center for Nuclear Physics (RCNP), Osaka University, Osaka 567-0047, Japan*

[4]*Advance Photon Research Center, JAERI, Kizu 619-0215, Japan*

[5]*Department of Physics, International Christian University, Tokyo 113-0033, Japan*

[6]*Department of Physics, University of Tokushima, Tokushima 770-8502, Japan*

[7]*Kobe Tokiwa College, Kobe 654-0830, Japan*

[8]*Department of Physics, Kyoto University, Kyoto 606-8502, Japan*

Recently we observed dipole resonances in ^{6}Li and ^{7}Li at $E_x$$\sim$27 and 29 MeV, respectively via the (p,p') reaction at 300 MeV [1]. We also observed their analogs in ^{6,7}Be and ^{6,7}He via the (^{3}He,t) and (^{7}Li,^{7}Be) reactions, respectively [2]. Based on the comparison of the observed resonance shapes with resonance shape reported in the ^{4}He(γ,n) reaction [3] we concluded that the dipole resonances are the giant dipole resonance (GDR) in the α cluster of ^{6,7}Li and their analogs [1]. It is very interesting to compare the resonances with the intrinsic GDR in ^{4}He excited via the same (p,p') reaction in order to understand the medium effect on the α cluster in nuclei.

The 300-MeV proton beams from the ring cyclotron at the Research Center for Nuclear Physics (RCNP), Osaka University bombarded a ^{4}He gas target. To increase the target thickness a cryogenic refrigerator cooled down the ^{4}He gas to 11.17$\pm$0.01 K [4]. The gas shell has windows of Aramide foils with a thickness of 12 μm. The thickness of the target was 3.9 mg/cm^2 with a pressure of 1.474$\pm$0.002 atm. We analyzed scattered protons using the magnetic spectrograph "Grand Raiden" and detected with the focal plane detector system. We measured the spectra of the ^{4}He(p,p') reaction in an angular range from θ_L= 2.7° to 30° and the excitation-energy region of E_x=0 $\sim$60 MeV. We monitored the beam intensity and the target thickness during the measurement by observing proton yields for the elastic scattering off ^{4}He with the Large Acceptance Spectrograph at the angle of θ_L=-59.0°.

We observed the GDR as a broad peaks at $E_x$$\sim$25 MeV in ^{4}He. At the lower excitation side of the GDR the excitation of the spin dipole, 2^- (T=1) state at $E_x$$\sim$23 MeV was seen. The excitation of the 0^+ (T=0) state at E_x=20.21 MeV is not apparent. Detailed analysis is in progress.

This experiment was performed at the Research Center for Nuclear Physics, Osaka University under the Program No. E234.

References

[1] T. Yamagata *et al.*, Phys. Rev. **C 69**, 044313 (2004).

[2] S. Nakayama *et al.*, Phys. Rev. Lett. **87**, 122502 (2001).

[3] B. L. Berman and S. C. Fultz, Rev. Mod. Phys. **47**, 713 (1975).

[4] K. Sagara *et al.*, RCNP Annual Report 1995, p. 158, unpublished.