Parity-transfer reaction for study of spin-dipole 0^- mode

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The spin-dipole (SD) 0^- excitation has recently attracted theoretical attention owing to its strong relevance in the tensor correlations in nuclei. For example, self-consistent HF+RPA calculations in Ref.[1] predict that the tensor correlations produce a strong hardening (shifting toward higher excitation energy) effect on the 0^- resonance. It is also predicted that the effect is sensitive to the magnitude of the tensor strength. Thus experimental data of the SD 0^- distribution enable us to examine the tensor correlation effects quantitatively. Despite this importance, experimental information on 0^- states is limited because of the lack of the experimental tools suitable for 0^- studies.

We propose a new probe, the parity-transfer $(^{16}\mathrm{O}, ^{16}\mathrm{F}(0^-, \mathrm{g.s.}))$ reaction, for 0^- studies[2]. The parity-transfer reaction selectively excites unnatural-parity states for a 0^+ target nucleus, which is an advantage over the other reactions used thus far. In order to establish the parity-transfer reaction as a new tool for 0^- studies, we measured the $^{12}\mathrm{C}(^{16}\mathrm{O}, ^{16}\mathrm{F}(0^-, \mathrm{g.s.}))^{12}\mathrm{B}$ reaction. We demonstrate the effectiveness of this reaction by identifying the known 0^- state at $E_x = 9.3$ MeV in ^{12}B.

The experiment was performed at the RIKEN RI Beam Factory (RIBF) by using the SHARAQ spectrometer and the high-resolution beam line. Figure 1 shows a schematic layout of the experimental setup. A primary ^{16}O beam at 250 MeV/nucleon and 10^7 pps from the superconducting RING cyclotron (SRC) was transported to the S0 target position. The beam line to the spectrometer was set up for dispersion-matched transport. We used a segmented plastic scintillation detector as an active ^{12}C target. This detector consisted of 16 plastic scintillators with a size of 30 mm × 5 mm × 1 mm, and it was used to determine the x-position of the beam on the target. The outgoing $^{15}\mathrm{O} + p$ particles produced by the decay of ^{16}F were measured in coincidence. The particles were momentum analyzed by using the SHARAQ spectrometer. The ^{15}O particles were detected with two low-pressure multi-wire drift chambers (LP-MWDCs) at the S2 focal plane, while the protons were detected with two MWDCs at the S1 focal plane.

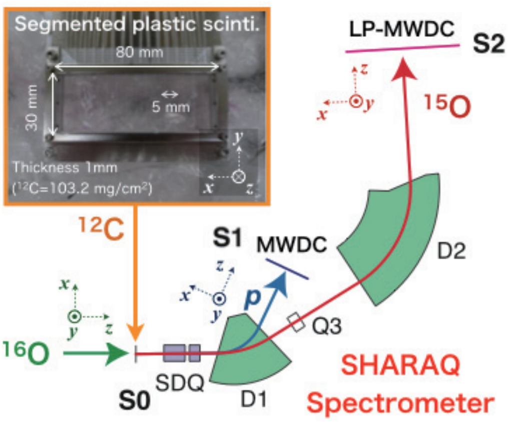

Fig. 1. Schematic layout of the experimental setup.

We reconstructed the relative energy E_{rel} between the ^{15}O and the proton. A preliminary result is shown in Fig. 2. The obtained E_{rel} resolution was 150 keV in FWHM at $E_{\mathrm{rel}} = 535$ keV, and the 0^- ground state of ^{16}F was clearly separated from other excited states. In order to identify the $^{12}\mathrm{B}(0^-, 9.3\ \mathrm{MeV})$ state, data analysis for obtaining the $^{12}\mathrm{C}(^{16}\mathrm{O}, ^{16}\mathrm{F}(0^-, \mathrm{g.s.}))$ spectrum and its angular distributions is in progress.

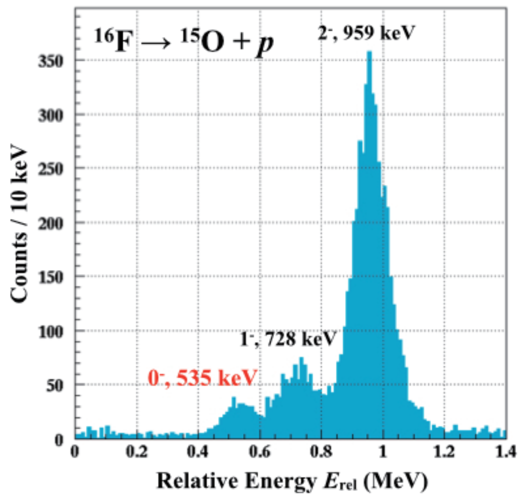

Fig. 2. Preliminary result of the relative energy between the ^{15}O nucleus and the proton from the decay of ^{16}F.

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References

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