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\(^-\) is sensitive to the magnitude of the tensor strength. Experimental data of the SD 0\(^-\) is sensitive to the magnitude of the tensor strength. 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 (16O, 16F(0\(^-\), 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 12C(16O, 16F(0\(^-\), g.s.))12B reaction. We demonstrate the effectiveness of this reaction by identifying the known 0\(^-\) state at \(E_s = 9.3\) MeV in 12B.

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 16O 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 scintillator as an active 12C target. The detector consisted of 16 plastic scintillators with a size of 30 mm \(\times\) 5 mm \(\times\) 1 mm, and it was used to determine the x-position of the beam on the target. The outgoing 16O + p particles produced by the decay of 16F were measured in coincidence. The particles were momentum analyzed by using the SHARAQ spectrometer. The 15O 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.

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

Fig. 1. Schematic layout of the experimental setup.

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

References