The (^{16}O, ^{16}F(0^-)) reaction to study spin-dipole 0^- states

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We proposed the parity-transfer (^{16}O, ^{16}F(0^-)) reaction as a powerful tool to study spin-dipole (SD) 0^- states in nuclei[1]. The parity-transfer reaction has a unique selectivity to unnatural-parity states, which is an advantage over the other reactions used thus far. As the first (^{16}O, ^{16}F(0^-)) measurement, the experiment for a ^{12}C target was performed with the SHARAQ spectrometer. The known 0^- state at $E_x = 9.3$ MeV in ^{12}B[2] serves as a benchmark to verify the effectiveness of this reaction. The experimental setup and method can be found in Ref.[3].

The preliminary result of the excitation-energy spectrum for the ^{12}C(^{16}O, ^{16}F(0^-))^{12}B reaction at $\theta_{\rm lab} = 0° - 0.25°$ is shown in Fig. 1. The energy resolution is 2.6 MeV in FWHM. We note that the events at $E_x \sim -10$ MeV are due to the (^{16}O, ^{16}F(0^-)) reaction on hydrogens in the plastic scintillator used as a reaction target. The obtained distribution is largely different from those previously obtained by other reaction probes such as (n, p) and $(d, {}^2\mathrm{He})$ (e.g., see Fig. 1 in Ref.[4]). A distinct difference is that the 1^+ ground-state Gamow-Teller (GT) transition is strongly hindered. Furthermore, an enhancement at $E_x \sim 9$ MeV can be seen, which is due to the 0^- state at $E_x = 9.3$ MeV. Therefore, the obtained distribution shows high selectivity of the present reaction to 0^- states.

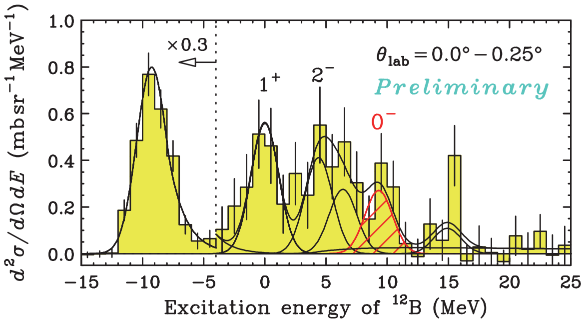

Fig. 1. Preliminary result of the excitation-energy spectrum for the ^{12}C(^{16}O, ^{16}F(0^-))^{12}B reaction at $\theta_{\rm lab} = 0° - 0.25°$.

In order to extract the yield of the 0^- state, we performed peak fitting, and the results are shown as the solid lines in Fig. 1. Figure 2 shows the angular distribution for the 0^- state at $E_x = 9.3$ MeV together with the results for the 1^+ g.s. and the 2^- state at $E_x = 4.4$ MeV. The solid curves denote the results calculated by the distorted-wave Born approximation (DWBA). The DWBA calculations predict the oscillatory patterns of the cross sections that are different depending on the spin-parity. The 0^- has the strong forward peaking, while the other states, 1^+ and 2^-, have the first maximum at finite angles. These patterns reproduce the experimental data very well. Thus, the oscillatory pattern of the angular distribution allows a clear spin-parity determination for the unnatural-parity state. Further analysis is underway to finalize experimental results.

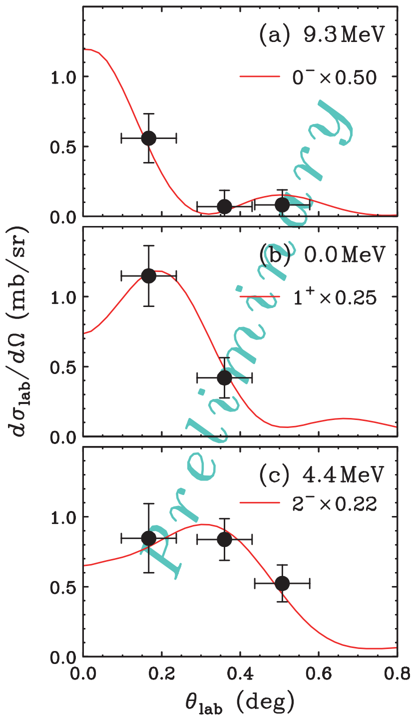

Fig. 2. Measured and calculated differential cross sections for $E_x = 9.3$ MeV, 0.0 MeV, and 4.4 MeV states.

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