Candidate for the double Gamow-Teller giant resonance studied by ^{48}Ca(^{12}C, ^{12}Be(0_2^+)) reaction at RIBF[†]

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Giant resonance in double Gamow-Teller (DGT) transition, known as the double Gamow-Teller giant resonance (DGTGR), is predicted to exist,[1)] but it has not yet been established experimentally. The experimental information of the DGTGR will open new opportunities to study anharmonicity in two-phonon excitation with spin-isospin flips. It will also provide information on the nuclear matrix element of neutrino-less double β decay.[2)]

We have applied a new method using the double charge exchange (^{12}C, ^{12}Be(0_2^+)) reaction to the experiment at RIBF. The first experiment was performed in 2021 with a ^{48}Ca target. The introduction of the dispersion-matching technique into BigRIPS system[3)] enabled us to achieve the energy resolution of ΔE = 1.5 MeV, which is enough to investigate DGTGR. A ^{9}Be stopper and DALI2[5)] were used to identify the final state of the reaction by detecting the delayed γ-rays from ^{12}Be(0_2^+). This resulted in a signal-to-noise ratio of 9 : 1, which has been greatly improved from the pilot experiment at RCNP, 1 : 1.[4)]

The top panel of Fig. 1 shows the measured differential cross sections as a function of the excitation energy in ^{48}Ti for the ^{48}Ca(^{12}C, ^{12}Be(0_2^+)) reaction at 0–0.3°. The integrated cross section over 0–34 MeV is 1.33 ± 0.12 μb/sr. At around 20 MeV, there is an enhancement in the forward angle. The forward-peaking distribution suggests the existence of the $\Delta L = 0$ component which is characteristic of DGT transition.

The DGT components are extracted from the observed structure by comparing the experimental angular distribution with the two-step distorted-wave calculations carried out using ECIS97.[6)] The extracted DGT transition strengths B(DGT) are shown in the bottom panel of Fig. 1. The structure below 34 MeV is considered to be attributed to the DGT transition. We evaluated the centroid energy as 23 ± 3 MeV, the width as 6 ± 1 MeV, and the integrated strength as 22^{+17}_{-6}% of the sum rule value. This is the first quantitative evaluation of the DGT strengths at high excitation energy, though the limited statistics do not allow us to discuss the anharmonicity in the present result. Future studies with the present method will provide clearer insights into the DGT strengths.

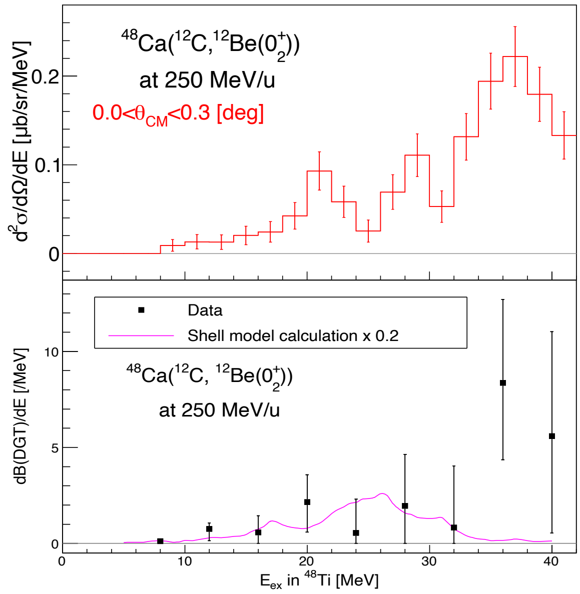

Fig. 1. (Top) Excitation energy spectra for ^{48}Ca(^{12}C, ^{12}Be (0_2^+))^{48}Ti reaction at the most forward angle. (Bottom) Double Gamow-Teller transition strength B(DGT).

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