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The search for double Gamow–Teller giant resonance with the (^{12}C,^{12}Be(0^+_2)) reaction

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The double Gamow–Teller (DGT) transition is a nuclear process such that the spin and isospin are changed twice by a $(\sigma\tau)^2$ operator. Existence of giant resonance in DGT (DGT giant resonance, DGTGR) was first proposed in 1989 [1], but it remains undiscovered experimentally. We are aiming at the observation of the DGTGR. The experimental observation of DGTGR will provide information about two-phonon excitations with the nuclear spin-dependent correlations. In addition, it is also important in neutrino physics since the observables such as the transition strength and centroid energy of the DGTGR are suggested to be strongly correlated with the nuclear matrix element for a neutrinoless double β decay [2].
We utilize the double-charge exchange reaction (^{12}C, ^{12}Be(0^+_2)) for the observation of the DGTGR. This reaction has mainly two advantages to observe the DGTGR. First, the transition from ^{12}C($0^+_{\rm g.s.}$) to ^{12}Be(0^+_2) through the intermediate state of ^{12}B(1^+) is expected to be strong since these states are all dominated by $0\hbar\omega$ configurations. Second, Be(0^+_2) decays into the ground state by emitting an electron-positron pair. Detecting the delayed-γ ray from the ^{12}Be(0^+_2) serves to tag the events of the double spin-flip mode.
We performed the first measurement of the (^{12}C, ^{12}Be(0^+_2)) at RIBF in May 2021. In this experiment, we used a part of BigRIPS separator, F0–F5, as a spectrometer [3]. The ^{12}C primary beam of 250 MeV/u and ^{48}Ca and ^{116}Cd target were used for the reaction. The momentum spread of the primary beam was suppressed by applying the dispersion-matching optics and we achieved the energy resolution of 1.6 MeV. The delayed-γ ray was detected by DALI2. The observed timing spectrum of the photon is consistent with the known lifetime of ^{12}Be(0^+_2). This suggests that ^{12}Be(0^+_2) is successfully detected.
In the preliminary spectrum of the excitation energy of ^{48}Ti, there seems to be an enhancement in the energy region where the DGTGR is expected to be observed, especially in the forward angle.
In this contribution, the outline of the experiment and the preliminary result will be reported.

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Experimental study on nuclear physics

Primary author: SAKAUE, Akane

Co-author: SAKAUE, Akane (CNS)

Presenter: SAKAUE, Akane (CNS)

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