SEARCH FOR DOUBLE GAMOW-TELLER RESONANCE
VIA HEAVY-ION DOUBLE CHARGE EXCHANGE REACTION

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Among all two-phonon excitation modes, a Double Gamow-Teller Resonance (DGTR) is a missing piece for better understanding of two-phonon states in terms of the nuclear spin-dependent correlations. Possible existence of the DGTR was first proposed by Auerbach, Zamick, and Zheng in 1989 [1]. A basic question concerning the DGTR is that if the DGTR is a simple superposition of GTRs. According to conclusive results of pion double charge exchange reaction studies, double isobaric analogue resonances and double giant dipole resonances are the simple superposition [2]. However, the nuclear response can be anharmonic and we can expect occurrence of anharmonicity, especially when the spin-degrees of freedom play a role. Therefore, the experimental observation of the DGTR provides us with a unique opportunity to investigate the effect.

Heavy-ion double-charge exchange (HIDCX) reactions are the most promising spectroscopic tools for DGTRs. It can induce two-phonon excitations with spin and isospin transfer by two units [3]. In spite of the potential of HIDCX reactions as probes to DGTRs, there have not been many experiments with the reactions. The reason is that it is difficult to find a reaction with significant DGT strengths and a clear event identification capability. We have succeeded in inventing a new experimental method based on the ($^{12}$C,$^{12}$Be(0$^+$)) reaction in the first experiments in difficulties. The idea has been conceived through our previous double charge exchange studies with the $^{12}$C($^{18}$O,$^{18}$Ne)$^{12}$Be reaction. In the experiment, we found that this reaction has relatively large cross section for the second 0$^+$ state of $^{12}$Be at 0 degree. This is because $^{12}$Be(0$^+$) state in the final state is dominated by 0$\hbar\omega$ configuration as well as the initial $^{12}$C(0$^+_{g.s.}$) and intermediate $^{4}$Be(1$^+_{g.s.}$) states. Furthermore, this reaction bears an additional strong point: identification of the final state in the ejectile ($^{12}$Be) is possible by detecting the delayed $\gamma$-ray emitted from the $^{12}$Be(0$^+$) state. The $^{12}$Be(0$^+$) state is a long-life isomer state and has a lifetime of 331 ns [4].

To investigate the DGTR in $^{48}$Ti, we performed the $^{48}$Ca($^{12}$C,$^{12}$Be(0$^+$)) reaction experiment at Research Center for Nuclear Study (RCNP), Osaka University. The 100A MeV $^{12}$C beam bombarded a $^{48}$Ca-enriched target with the areal density of 10 mg/cm$^2$. The outgoing particles were momentum-analyzed with the high-resolution magnetic spectrometer Grand Raiden. Excitation energies of the residual nuclei were measured with a missing mass method. The momentum-analyzed $^{12}$Be was stopped in one plastic scintillator at a focal plane and detected $\gamma$-rays from $^{12}$Be(0$^+$) state with NaI scintillators.

At present, we succeed in identifications of the outgoing $^{12}$Be particles and its characteristic $\gamma$-rays. Excitation energy spectra of $^{48}$Ti is going to be obtained. In the conference, the results of the $^{12}$C($^{18}$O,$^{18}$Ne)$^{12}$Be reaction and the DGTR search experiments will be reported.

REFERENCES