Notre Dame Science
Department of Physics

A NEW SPECTROSCOPIC TOOL BY THE RADIOACTIVE-ISOTOPE-BEAM INDUCED EXOTHERMIC CHARGE-EXCHANGE REACTION

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Charge-exchange reactions induced by radioactive heavy-ions have potentiality for studies of a variety of spin-isospin responses due to their unique reaction kinematics and selectivities.

Among them the (^{12}N,^{12}C) reaction has peculiar features:
This reaction can be exothermic (Q>0) owing to the large mass difference of about 17MeV between the ^{12}N projectile and the ^{12}C ejectile, and accordingly it can realize small momentum transfer even for highly-excited states. Moreover, since the final state in the ^{12}C ejective can be identified by detecting the de-excitation gamma rays, the excitation modes with the transferred quantum numbers (S=1, T=1) and (S=0, T=1) can be selected. These features make this reaction suitable for the study of yet-to-be-discovered states such as the isovector spin-isospin monopole resonance (IVSMR).

We performed for the first time an experiment of this exothermic charge-exchange (^{12}N,^{12}C) reaction on a ^{90}Zr target at an incident energy of 175MeV/u. The experiment was carried out at the RI Beam Factory (RIBF) at RIKEN using the magnetic spectrometer SHARAQ and the gamma-ray detector array DALI2. The double differential cross sections were measured at the excitation energy of 0--70MeV and at the scattering angles of 0—3 degrees for both of the (S=1, T=1) and (S=0, T=1) modes. In the former mode, peaks for the Gamow-Teller giant resonance (GTGR) and the isovector spin monopole resonance (IVSMR) were clearly observed at ~10 MeV and ~30 MeV, respectively. In the latter mode, a peak for the isobaric analog state was also clearly observed at ~5 MeV. Furthermore, we obtained the cross section of the GTGR per Gamow-Teller transition strengths of the target-residual and projectile-ejectile systems and that of the IAS per Fermi transition strengths, and found that their ratio was enhanced compared with the (p,n) reaction.

In this talk, I will present the details of the experiment and discuss the results.

Nuclear Seminar

All interested persons are cordially invited to attend.