Spin-dipole response of ^{4}He by using (^{8}He, ^{8}Li(1$^+$))

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The spin dipole (SD) (Δ S = Δ L =1) of spin-isospin responses is connected with the tensor correlation in nuclei. Especially, on a double-closed nucleus, the SD excitation contribution is large because of the nucleon configuration. The SD excitation function was measured on ^{4}He which is the lightest double-closed nucleus. This is important for the study of supernova nucleosynthesis with the neutrino-nucleus reaction[1)].

We coducted the exothermic charge-exchange (CE) reaction of ^{4}He(^{8}He, ^{8}Li(1$^+$))^{4}H. CE reactions are powerful tools to study the spin-isospin responses. The spin-flip transition of ^{8}He(0$^+$) $\rightarrow$ ^{8}Li(1$^+$) can be identified by measuring the de-excited γ-rays (E_γ=0.98 MeV) from the first 1$^+$ state of ^{8}Li. The beam energy region of 100–300 MeV/nucleon is suitable for the study of the spin-isospin responses[2)].

The experiment was performed at the RIKEN RIBF facility by using BigRIPS[3)], the high-Resolution beamline[4)], and the SHARAQ spectrometer[5)]. The ^{8}He beam, which was produced via a projectile-fragmentation reaction with an ^{18}O beam and ^{9}Be target, was transported to the secondary target position at an intensity of 2 MHz. We used the liquid-^{4}He target[6)] with a thickness of 120 mg/cm^2. In order to determine the excitation energy using missing mass method, the momenta of ^{8}He and ^{8}Li at an energy of 190 MeV/nucleon were measured at the beamline and SHARAQ within the low-pressure multi-wire drift chamber (LP-MWDC) [7)] and cathode readout drift chamber[8)]. The γ-ray detector array DALI2[9)] was placed around the target position to measure the 0.98 MeV γ-ray.

Figure 1 shows the missing mass spectrum of the (^{8}He,^{8}Li) reaction (black line). The contribution of both the ^{4}He target and hydrogen is included in this spectrum. The region around 10 MeV and −17 MeV shows the ^{4}He $\rightarrow$^{4} H and ^{1}H $\rightarrow$ n reactions, respectively. The ^{1}H $\rightarrow$ n reaction originates at the plastic scintilator installed at the upstream of the target. The amount of contamination (red line) was estimated by using the energy loss of the LP-MWDC placed between the scintilator and the target. Thus, the ^{4}He(^{8}He, ^{8}Li)^{4}H reaction was obtained.

Further analysis to obtain the angular distribution and double differential cross-sections is now in progress to obtain the isovector SD strength of ^{4}He.

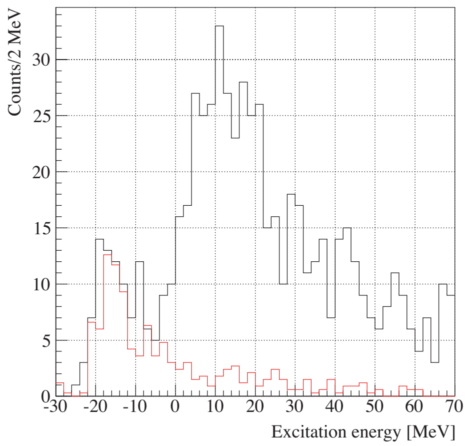

Fig. 1. Excitation energy distribution of ^{4}H obtained using missing mass method. The red line shows the background estimated from the contamination of the excitation energy distribution.

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