Triton contamination in the ^{10}C secondary beam produced by RIPS

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We have performed missing mass spectroscopy on ^{8}C to measure its excited states populated by the two-neutron transfer reaction from ^{10}C, ^{10}C$(p,t)^{8}$C, in an inverse kinematics.[1,2] In this experiment, an unexpected triton contamination was found to occur in a proton-rich ^{10}C secondary beam produced and separated by the RIKEN Projectile-fragment Separator (RIPS).[3]

The ^{10}C secondary beam was produced by the projectile-fragmentation of a ^{12}C beam with an energy of 70 MeV/nucleon impinging on a 94.2-mg/cm^2-thick ^{9}Be production target. The secondary beam was first separated by its magnetic rigidity ($B\rho$) using the first dipole magnet (D1) and a slit at the dispersive focal plane (F1) of the RIPS. A wedge-shaped aluminum degrader of 321-mg/cm^2 thickness was placed at F1 for further selection of the beam through analysis of its $B\rho$ using the second dipole magnet (D2) and a slit at the achromatic focus (F2). The widths of the F1 and F2 slits were adjusted to $\pm$24 mm and $\pm$5 mm, and magnetic rigidities of D1 and D2 were set to 1.9858 Tm and 1.8262 Tm, respectively. We expected to obtain nearly pure ^{10}C beam using this RIPS setting.

The secondary ^{10}C beam was injected into a cryogenic H_2 gas target (CRYPTA)[4] to induce the (p,t) reaction. The recoil tritons were detected with a Dubna telescope consisting of an annular double-sided strip silicon detector followed by cesium iodide scintillators. The telescope was installed downstream of the CRYPTA target. The excitation energy of the proton-unbound ^{8}C nucleus of was reconstructed by measuring the scattering angle and the total kinetic energy (TKE) of the recoil tritons.

Figure 1 shows the TKE spectra of tritons detected with the Dubna telescope. The solid line represents the TKE spectrum measured with the H_2 gas target (target run) and the shaded histogram represents that without the target (empty run) normalized by the beam intensity. The peak at 55 MeV ($G_{\mathrm{g.s.}}$), which is found only in the target run, corresponds to the ground state of ^{8}C produced by the two-neutron transfer reaction. The mass excess of the ground state of ^{8}C deduced from this peak is consistent with previous studies.[5–8] Hence, the peak at 48 MeV (G_0) should not originate from the (p,t) reaction.

To identify the origin of the G_0 peak, the position of the detected triton on the Dubna telescope is plotted by gating on G_0 and $G_{\mathrm{g.s.}}$ as shown in Fig. 2 (a) and (b), respectively. While tritons produced by the transfer reaction were found to distribute through the entire region of the Dubna telescope, tritons in G_0 were detected only at the inner rings of the telescope. In addition, the TKE of tritons having $B\rho$ of D2 is 52 MeV, which is close to the measured TKE of G_0. Therefore, we concluded that a triton contaminant was present in the proton-rich ^{10}C secondary beam.

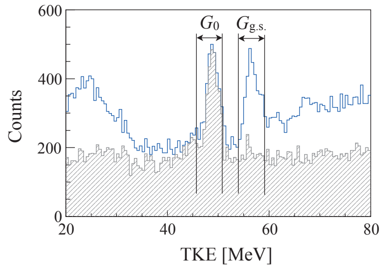

Fig. 1. Total kinetic energy of tritons measured with the Dubna telescope in the target run (solid line) and empty run (shaded)

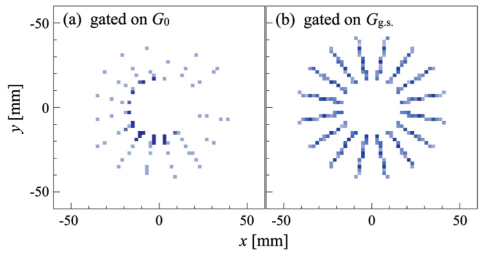

Fig. 2. Hit position of tritons on the Dubna telescope gated on the TKE spectra of G_0 (a) and $G_{\mathrm{g.s.}}$ (b).

In the present experiment, data acquisition was triggered by timing signals of the plastic scintillator placed upstream of the target ($\mathrm{Pl_{F3}}$) coincident with the Dubna telescope. Since the threshold of $\mathrm{Pl_{F3}}$ was set to be much higher than the energy loss for the tritons, the triton contaminants on the Dubna telescope were obtained as an accidental-coincidence events and the count rate of the tritons could not be estimated. The contaminants were removed by gating on the prompt timing of the Dubna telescope for further analysis.

In conclusion, we observed the unexpected triton contaminant in the proton-rich ^{10}C secondary beam, even though a large A/Q difference exists between ^{10}C and triton.

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References

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