Measurement of unbound states in ^{17}C at SAMURAI

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To study unbound states in ^{17}C above the neutron separation energy of 0.735(18) MeV[1)], an experiment was performed at RIBF during the first physics run of the SAMURAI spectrometer[2)]. The unbound states of ^{17}C were produced using the one-neutron knockout reaction of ^{18}C. The ^{18}C beam was provided by BigRIPS. The beam intensity was typically 2300 pps with the energy of 250 MeV/nucleon under the momentum acceptance of ±3%. Particle identification of the beam was carried out by employing the $B\rho$-TOF-ΔE method with a mass resolution of $A/\Delta A$ = 770 at 1 sigma. The unbound states of ^{17}C populated by one-neutron knockout of ^{18}C on a carbon reaction target with a thickness of 1.8 g/cm^2 immediately decays into a ^{16}C fragment and a neutron. The particle identification of this fragment was also carried out using the $B\rho$-TOF-ΔE method with a mass resolution of $A/\Delta A$ = 250 at 1 sigma. The identification of the states of the ^{16}C fragment subsequent to the decay was carried out on the basis of γ-n coincidence. The de-excitation γ-rays in ^{16}C were detected by a γ-ray detector array DALI2[3)], while neutrons were detected by the neutorn detector array NEBULA consisting of neutron detectors (NEUT) and charged-particle veto detectors (VETO). For NEUT, the timing resolution was 270 ps in a flight length of approximately 11 m.

The relative energy ($E_{\rm rel}$) of ^{17}C was reconstructed using the momentum vectors of the ^{16}C fragment and the neutron. To determine the positions of the resonances, responses were generated using a Monte Carlo simulation that considers the beam characteristics, reaction mechanism, and detector resolutions. From the simulation, the $E_{\rm rel}$ resolution was evaluated as $\Delta E_{\rm rel} = 0.4\sqrt{E_{\rm rel}}$ MeV in FWHM.

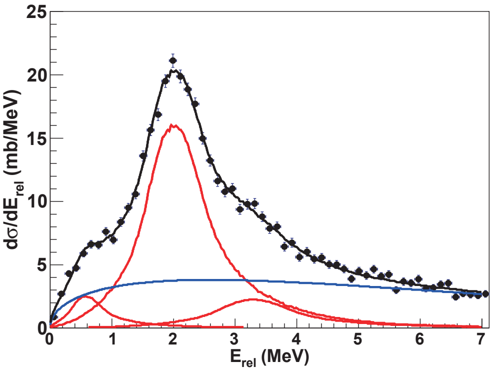

Fig. 1. Preliminary spectrum of the relative energy of ^{17}C. The black solid line represents the result of the overall fit by three responses (red solid lines) and a Maxwellian background (a blue solid line).

A preliminary result of the fitting to the experimental spectrum with three responses and a Maxwellian background is shown in Fig. 1 where resonances at $E_{\rm rel}$ = 0.58(3), 2.01(2), and 3.30(6) MeV are observed. In this measurement, the resonance at $E_{\rm rel}$ = 0.58(3) exhibited a correlation with a gamma line at 1.72(12) MeV, which corresponds to the 2^+ state of ^{16}C[4)]. Consequently, the three resonances correspond to excited states at 3.04(12), 2.75(3), and 4.04(6) MeV. The excited states at 2.75(3) and 4.04(6) MeV are likely to correspond to the states at 2.71(2) and 3.93(2) MeV, respectively, which have been observed in the β-delayed neutron measurement[5)]. Further analysis involving a comparison with Glauber model calculations is in progress to investigate the orbital angular momentum and spin-parity of the observed resonances.

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