Structure of ^{19}C studied by one-neutron knockout at SAMURAI

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The structure of light nuclei near the neutron drip line has been studied extensively over the past decades. With development in experimental technology, heavier nuclei have emerged as a major focus, and a large number of relevant experiments for neutron-rich carbon or more massive nuclei have been conducted. The present work aims to expore neutron-unbound states of ^{19}C by one-neutron knockout. A study exploiting in-beam γ-ray spectroscopy for ^{19}C concluded that $3/2^+_1$ and $5/2^+_1$ states are bound.[1)] A recent report on the inclusive measurement of one-neutron knockout cross section, however, argued that the experimental knockout cross section from ^{20}C to ^{19}C did not support the existence of the $5/2^+_1$ state below the threshold.[2)] In this reserach, the invariant mass measurement in inverse kinematics was carried out, which allows us to elucidate the issue of boundedness of the $5/2^+_1$ state.

The experiment was performed at RIBF. BigRIPS produced a ^{20}C secondary beam with an energy of 280 MeV/nucleon. The beam intensity was 170 cps at the target position with a momentum acceptance of $\Delta P/P = \pm 3\%$. The beam impinged on a carbon target with a thickness of 1.8 g/cm^2, which produced ^{19}C via the one-neutron knockout. The trajectory of the beam was determined with two drift chambers (BDCs). Charged fragments from the reaction were separated using SAMURAI[3)], and their energy loss and time of flight were measured using a hodoscope, which is an array of plastic scintillators. Their momenta were reconstructed from their trajectories with two drift chambers (FDCs) placed before and after the magnet. Momenta of decay neutrons were measured with NEBULA using the TOF method.[4)] The experimental scheme is identical to that of Ref.[5)].

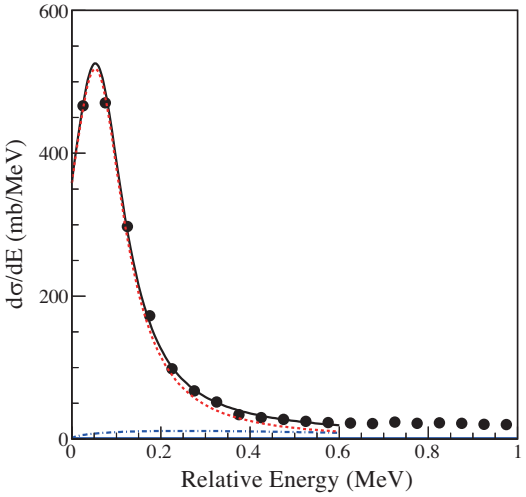

Fig. 1. Relative energy spectrum for the $^{18}\mathrm{C}+n$ unbound system (filled circles). The black solid line is the result of the fit; the blue dash-dot line is the assumed background; the red dashed line is the extracted resonance.

A preliminary spectrum for the relative energy of the C(^{20}C,^{18}C$+n$) reaction is shown in Fig. 1. Geometrical acceptance was estimated with a Monte-Carlo simulation. The observed resonance close to the threshold is consistent with the result of Thoennessen et al.[6)] A preliminary value for the cross section populating this state was derived, which seems to corroborate the argument that the $5/2^+_1$ state is unbound. A quantitative analysis will be carried out to obtain (1) the position of the resonance and (2) the angular momentum of the knocked-out neutron by examining the parallel momentum distribution of the knockout residue.

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References

1) Z. Elekes et al.: Phys. Lett. B **614**, 174 (2005).
2) N. Kobayashi et al.: Phys. Rev. C **86**, 054604 (2012).
3) T. Kobayashi et al.: Nucl. Instr. Meth. B **317**, 294 (2013).
4) Y. Kondo et al.: RIKEN Accel. Prog. Rep. **45**, 131 (2012).
5) Y. Kondo et al.: RIKEN Accel. Prog. Rep. **46**, 6 (2013).
6) M. Thoennessen et al.: Nucl. Phys. A **912**, 1 (2013).