Single-neutron knockout from ^{20}C and the structure of ^{19}C[†]

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The unbound states of ^{19}C have been investigated using the one-neutron knockout reaction. ^{19}C has a well established $1n$ halo structure with a weakly bound s-wave neutron. The almost degenerate $0d_{5/2}$ and $1s_{1/2}$ orbitals are expected to govern the low-lying level structure of ^{19}C, comprising $1/2^+$, $3/2^+$, and $5/2^+$ states.[1)] Theoretically, while most shell models suggest that these states are closely located below 1 MeV, their ordering has remained uncertain. Experimentally, a few studies have reported the low-lying states including $3/2^+_1$ and $5/2^+_1$. There is an argument of the bound nature of $5/2^+_1$ provided by recent measurements.[2)]

The ^{20}C beam of 280 MeV/nucleon at mid-target was produced from BigRIPS with using a 345 MeV/nucleon ^{48}Ca primary beam ($\sim$100 pnA). The secondary beam impinged on a secondary carbon target (1.8 g/cm^2) in front of the SAMURAI spectrometer to produce ^{19}C.[3)] The decay products, including ^{18}C and a neutron, were detected using SAMURAI and NEBULA neutron array. Note that the measurement was a part of the first experimental campaign using SAMURAI to study the light neutron-rich nuclei.[4)]

Figures 1 show the relative energy ($E_{\rm rel}$) spectrum for the ^{18}C + n system containing a narrow threshold resonance and two peaks at higher energies. The positions were determined to be at 0.036(1), 0.84(4), and 2.31(3) MeV by fitting analysis with R-matrix lineshapes convoluted with the experimental resolution. The longitudinal momentum distributions for each resonance show clear ℓ characters compared with Glauber model calculation.[5)] Such results allow the spin-parity assignment of $5/2^+_1$ and $1/2^-_1$ for the levels at E_x =0.62(9) and 2.89(10) MeV with S_n = 0.58(9) MeV. Spectroscopic factors were also found to agree with the shell-model calculations. The valence neutron configuration of the ^{20}C$_{\rm g.s.}$ is thus expected to have a significant $0d^2_{5/2}$ contribution together with the known $1s^2_{1/2}$ component. The level scheme of ^{19}C is well described by the shell model with YSOX interaction based on the monopole-based universal interaction.[6)]

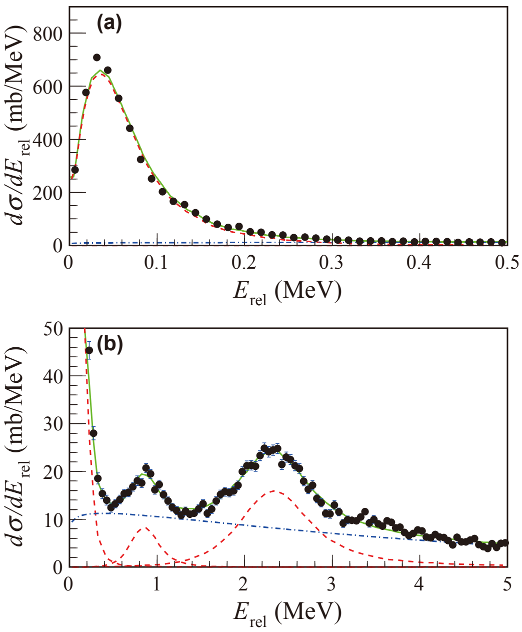

Fig. 1. Relative energy spectrum for the ^{18}C + n system up to (a) 0.5 MeV and (b) 5 MeV. The solid (green), dashed (red), and dot-dashed (blue) curves represent the lineshapes of the results of the fit, individual resonances, and background, respectively.

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† Condensed from the article in Phys. Lett. B **769**, 503-508 (2017)

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