Two-neutron removal reaction from ^{22}C†

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We report the first measurement of the two-neutron removal reaction from a ^{22}C secondary beam at around 240 MeV/nucleon. The experiment was performed at the RI beam factory in 2009, as detailed in Ref.[1)]. The extracted quantities are the inclusive cross section of ^{22}C and the momentum distribution for the charged residues of ^{20}C. ^{22}C is known to be the most neutron-rich bound nucleus among C isotopes, whereas ^{21}C is particle unbound. Hence, ^{22}C is pictured as a three-body (^{20}C + n + n) Borromean system, which may be useful in deriving the two-neutron halo formation in ^{22}C.

There is little knowledge about ^{22}C. Until Gaudefroy *et al.* performed the mass measurement of ^{22}C (i.e., $S_{2n}(^{22}\mathrm{C}) = -0.14(46)$ MeV),[2)] its experimental mass was never known. Hence, we followed the 2003 mass evaluation,[3)] in which the two-neutron separation energy was 0.42(94) MeV. The ground state of ^{21}C was assumed to be produced at a continuum energy of ε^* = 0.30 MeV after neutron removal with a ground-state separation energy $S_{1n}(^{22}\mathrm{C})$ of 0.70 MeV.

Based on the shell model with the WBP effective interaction[4)] in a *psd*-model space truncated to allow $0\hbar\omega$ and $1\hbar\omega$ excitations, three final states of ^{21}C are predicted below the ^{20}C first neutron threshold of 2.90 MeV. These states are a $1/2^+_1$ ground state with $C^2S = 1.4$, a $5/2^+_1$ state at $E_x = 1.11$ MeV with $C^2S = 4.2$, and a $3/2^+_1$ state at $E_x = 2.19$ MeV with $C^2S = 0.34$. Using these C^2Ss and an eikonal reaction model,[5,6)] the theoretical inclusive cross section is calculated to be 283 mb, which is in agreement with the experimental cross section of 266(19) mb.

The measured and theoretical inclusive ^{20}C parallel momentum distributions (convoluted with the experimental resolution of 27 MeV/c) are compared in Fig. 1. The theoretical distribution (solid curve) corresponds to the inclusive (unbound) ^{21}C momentum distribution, which is calculated as the weighted sum of the momentum distributions to the individual final states. Prior to this sum being calculated, the neutron emission recoil broadening for the ^{20}C residue is included for each final state according to its ε^* value, i.e., $\varepsilon^* = E_\mathrm{x} + 0.30$ MeV. The dashed (dot-dashed) curve shows the contribution of knockout via the $1/2^+_1$ ($5/2^+_1$) state of ^{21}C. Each of two states contributes almost half of the inclusive one-neutron removal cross section. The theoretical calculation is in good agreement with the experimental distribution, providing strong support for the weakly bound $\nu 2s_{1/2}$ character for the ^{22}C ground state. This result is consistent with the result of the recent interaction-cross-section measurement and associated analysis presented in Ref.[7)], which is suggestive of an extended ^{22}C matter density.

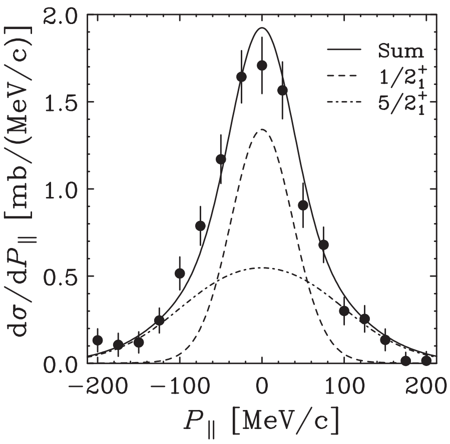

Fig. 1. Comparison of measured and theoretical inclusive parallel momentum distributions of ^{20}C, following two-neutron removal from ^{22}C on a carbon target at 240 MeV/nucleon. See the text for a description of the curves.

References
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