Interaction cross section study of the two-neutron halo nucleus $^{22}C^{\dagger}$

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To obtain high precision root-mean-squared matter radius $\tilde{r}_m$ of ^{22}C, the interaction cross section σ_I has been measured with a carbon target at 235 MeV/nucleon.

Recently the most neutron-rich carbon isotope ^{22}C has attracted much attention owing to a possibly greatly extended two-neutron halo structure, as suggested by a reaction cross section (σ_R) study on a proton target at 40 MeV/nucleon.[1)] $\tilde{r}_m$ of 5.4 ± 0.9 fm was deduced from the measured $\sigma_R = 1.338 \pm 0.274$ b. These large uncertainties in σ_R and the deduced $\tilde{r}_m$ do not significantly constrain the theoretical models. A mean-field model using an adjusted Skyrme interaction yielded an $\tilde{r}_m$ of 3.89 fm.[2)] Three-body models yielded $\tilde{r}_m$ in the range of $3.5 \sim 3.7$ fm.[3,4)] Given the large uncertainty in the experimental values of Ref. 1) and that the theoretical values are within $\sim 2\sigma$ of the experimental value, more definitive conclusions require data with higher precision.

A cocktail beam of $^{19,20,22}C$ was produced via the projectile fragmentation of a 345 MeV/nucleon ^{48}Ca beam. The $^{19,20,22}C$ beams were separated and transported to SAMURAI by BigRIPS. The cocktail beam impinged on a carbon target with a thickness of 1.789 g/cm^2. The incident particles were identified event-by-event by measuring the time of flight, magnetic rigidity, and energy loss with detectors located at the upstream of the carbon target. The incident angle and position on the carbon target were measured using two multi-wire drift chambers placed just upstream of the carbon target. The reaction products from the $^{19,20,22}C + C$ reactions were identified using detectors located at the entrance and exit of the SAMURAI magnet. The detailed experimental setup can be found in Ref. 5).

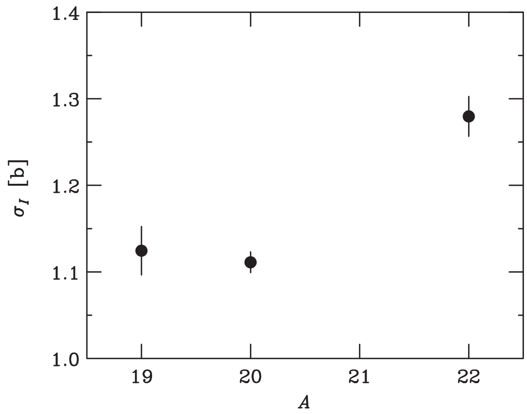

Fig. 1. Mass number dependence of the interaction cross section obtained in the present study.

The interaction cross sections σ_I obtained in the present study are shown in Fig. 1. The enhancement of σ_I for ^{22}C relative to those of $^{19,20}C$ is consistent with a two-neutron halo nature of ^{22}C.

The present σ_I of ^{22}C is analyzed using a four-body (three-body projectile plus target) Glauber reaction model.[4)] In the following discussion σ_I and σ_R are compared directly by assuming the inelastic scattering cross section is negligible. From the comparison with the model calculations and the present σ_I value, $\tilde{r}_m$ is deduced to be 3.44 ± 0.08 fm. This deduced $\tilde{r}_m$ is consistent with the theoretical predictions based on ^{22}C three-body model wave functions,[3,6)] while it is about 2σ smaller than the previously reported experimental value (5.4 ± 0.9 fm). More measurements, such as Coulomb dissociation, will allow for a more detailed study of the ^{22}C structure.

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