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Transfer Reactions with 16C as a Probe of Neutron-Rich Carbon Structure

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Carbon isotopes provide a rich testing ground for the evolution of shell structure and halo phenomena in light neutron-rich nuclei. In particular, 15C is a well-known one-neutron halo candidate, with the valence neutron weakly bound ($S_n \approx 1.2$ MeV) in a 2s1/2 orbital. Its first excited state at 0.74 MeV has a dominant single-particle configuration with a neutron in the 1d5/2 orbital and a half-life of 2.61 ns. The transition between these states is expected to involve weak core polarization due to the inert 14C core, which may be further reduced by the spatial decoupling of the halo neutron. Understanding how the halo in 15C impacts core polarization is directly relevant for constraining the quadrupole moments of 16C. To address these questions, we studied the one-neutron transfer 16C(p, d)15C and the two-neutron transfer 16C(p, t)14C. These complementary reactions provide sensitivity to single-particle and pairing correlations in neutron-rich carbon isotopes and serve as benchmarks for theoretical models of transfer reactions with exotic beams. The experiment was performed in 2023 at the Argonne Tandem Linac Accelerator System (ATLAS) using the Active Target Time Projection Chamber (AT-TPC) and HELIOS solenoidal spectrometer. A primary 18O beam with an energy of 222.72±0.43 MeV was degraded to produce a 16C secondary beam, which was subsequently used to study these transfer channels. This work has received financial support from the Xunta de Galicia (CIGUS Network of Research Centres) and the European Union.

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