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Probing Near-Threshold Narrow Resonances in ^{11}B Using the HELIOS Spectrometer

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The unusually large branching ratio observed in the β-delayed proton emission of ^{11}Be has been attributed to the existence of a narrow, near-threshold proton-emitting resonance in ^{11}B. However, direct measurements of this process have generated significant debate concerning the properties of this resonance and the unexpectedly high β-decay feeding. Multiple subsequent experiments have reported evidence for this elusive state, and while both theoretical and experimental studies broadly agree on its existence, its underlying nature remains unclear. A key difficulty arises from the complex structure of ^{11}B and its coupling to the continuum, involving four particle-emission thresholds within approximately 2 MeV of excitation energy. The characteristics of states near these thresholds—critical for understanding the nuclear structure of ^{11}B—are either poorly known or insufficiently constrained. To address these challenges, we performed an experiment to investigate the high-lying structure of ^{11}B via the ^{10}B(d,p) reaction in inverse kinematics using the HELIOS spectrometer. Detection of protons in coincidence with heavy recoils enabled precise determination of low-probability branching ratios and state widths near the particle-emission thresholds. The high-quality recoil identification achieved in this measurement allowed us to observe the long-debated near-proton-threshold resonance at 11.4 MeV, providing new insight into its structure and decay properties. This research was supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357. It utilized resources from the Argonne National Laboratory ATLAS facility and the Facility for Rare Isotope Beams (FRIB), both DOE Office of Science User Facilities. Additional support was provided by the Xunta de Galicia (CIGUS Network of Research Centers) and the Spanish Ministerio de Economía y Competitividad through the "Ramón y Cajal"program.

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