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Revealing the nature of near-threshold narrow resonances in 11B with the HELIOS spectrometer

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The large branching ratio observed in the β-delayed proton emission of 11Be was explained by the existence of a narrow, near-threshold proton-emitting resonance in 11B. The direct measurement of this process sparked a heated debate surrounding the properties of this resonance and the unusually large β-decay branching ratio that populates it. Since then, several experiments have reported the observation of such an elusive resonance. While there is widespread agreement on the existence of this resonance from both theoretical and experimental standpoints, many open questions remain regarding its nature. One of the main challenges lies in describing the complex structure of 11B and the role of continuum coupling with four different particle emission thresholds in approximately 2 MeV of excitation energy. Moreover, the properties of the states in the vicinity of these thresholds, critical for understanding the structure of 11B, are either unknown or poorly constrained. With the intention of clarifying such an entangled situation, we conducted an experiment to investigate the 11B structure at high excitation energy through the 10B(d,p) reaction in inverse kinematics using the HELIOS spectrometer. The detection of protons in coincidence with heavy recoils in inverse kinematics enabled the determination of low-probability branching ratios of several states around particle emission thresholds and their widths. The much-debated near-proton-threshold resonance at 11.4 MeV was observed thanks to the high-quality recoil identification provided by the experiment. This material is based upon work supported by the U.S. Department of Energy, Office of Science, Office of Nuclear Physics, under Contract No. DE-AC02-06CH11357. This research used resources of ANL's ATLAS facility, which is a DOE Office of Science User Facility and used resources of the Facility for Rare Isotope Beams (FRIB) Operations, which is a DOE Office of Science User Facility under Award Number DE-SC0023633. This work has received financial support from Xunta de Galicia (CIGUS Network of Research Centers) and from the Spanish Ministerio de Economia y Competitividad through the Programmes "Ramon y Cajal"with the Grant No. RYC2019-028438-I

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