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Study of ^{10}He using the SAMURAI spectrometer at RIKEN

Content

The study of neutron-rich helium isotopes provides a valuable probe of the behaviors and mechanisms of neutron interactions as these nuclei can be considered as a ^{4}He core surrounded by n neutrons. In particular, the interest in ^{10}He nucleus is high because it has the highest N/Z ratio of all nuclei beyond the extremely neutron rich Hydrogen isotopes. Although it is doubly closed-shell, its magic characteristics are predicted to vanish when approaching the neutron drip line [1]. Because ^{10}He is unbound and typically forms broad resonances, determining their resonance energy (E_r) and width (Γ) is especially challenging and has been a subject of ongoing debate.

Accordingly, the SAMURAI spectrometer[2] at the RIBF facility at RIKEN Nishina Center was utilized for the SAMURAI12 experiment. An ^{18}O primary beam of 230 A.MeV was used to produce a secondary beam of ^{14}Be at 150 A.MeV to perform the (p,pα) reaction with a 2 mm solid Hydrogen target [3] in inverse kinematics producing ^{10}He. Scintillation detectors, drift chambers, and silicon detectors were utilized to detect the different nuclei involved in the quasi-free scattering reaction[4]. The recoil protons were detected by ESPRI[4] covering angles from $50° - 70°$ while the alphas were detected by Si-CsI Telescopes covering $4° - 14°$. Finally, the different decay products of ^{10}He were detected at the exit of the SAMURAI magnet by its standard detectors.

The missing-mass method was used to determine the ^{10}He excitation energy spectrum and a Voigt fit was applied to extract the position and width of the ground-state and excited-state resonances with respect to the ^{8}He+n+n threshold. The results will be compared to previous experiments[4][5]. Additionally, the branching ratios of the populated resonances in ^{10}He to ^{8}He and ^{4}He channels will be compared to theoretical calculations. These quantities provide insight into the structure of these resonances. In the near future, the precise determination of the alpha produced in the ^{10}He decay will, for the first time, enable the extraction of the energy spectrum of 6-neutron system via missing mass method.

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