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Beta Decay of the Halo Nucleus, ^{31}Ne

Historically, the N=20 region of the nuclear chart has played a significant role in our understanding of nuclear structure. In this mass region, deformed excited states from neutron occupations in the νf_{7/2} orbital are observed to compete with normal configurations in the sd-shell leading to so-called intruder-states. Interestingly, this large evolution of shell structure is not a general feature for all nuclei in the sd-shell but rather focused around a nexus of nuclei colloquially referred to as the island of inversion (IoI). On the extreme neutron side of the IoI, lies ³¹Na where, to date, no negative-parity excited states have been observed above the positive-parity ground state which would help confirm the placement of the νf_{7/2} orbital. Thus, studying the β-delayed γ-ray spectroscopy of ³¹Ne, which has a negative-parity ground-state, will directly populate these critical states and bring new information to the table which has so far not been available.

Here, we will present the experiment to study the β-decay of ³¹Ne. This work was carried out at the NSCL. A ³¹Ne beam was selected by the A1900 separator following the fragmentation of a 140-MeV/nucleon ⁴⁸Ca beam impinged on a ~700-mg/cm² ⁹Be target. To maximize transmission of the exotic fragments to the Beta-Counting Station (BCS), the fully 5% transmission capability of the A1900 was used. Various Si detectors and timing information in the BCS allowed for event-by-event identification of individual fragments entering the system. At the center of the BCS, fragments were implanted into a thick DSSD where these identified implant events were time-correlated to individual decay-events. The BCS was placed at the center of an array of sixteen Clover-style HPGe, and fifteen LaBr₃ detectors for subsequent γ-ray detection released during the decay process.

Due to the high momentum acceptance, complete separation of ³¹Ne from its neighboring nucleus ³⁰Ne is complicated, however separation has been achieved and verified through half-analysis. ³¹Ne has been proposed to have a significant p-wave neutron-halo component in its ground state configuration and present results indicate an extremely high β-delayed neutron branch for the decay of ³¹Ne with a few possible γ-ray transitions in ³¹Na present. The results will be presented from isotope identification and separation verification to observed γ-ray spectra and level schemes compared to shell-model calculations.

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