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Investigation of the nuclear structure of ^{33}Al through β-decay of ^{33}Mg to probe the island of inversion (G)

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Some nuclei far from the valley of stability have been found to have ground state properties that are different than those naively expected from the nuclear shell model. The term 'island of inversion' is used to refer to regions of the nuclear landscape in which deformed intruder configurations dominate nuclear ground states over the normal spherical shell model ones. The nuclear structure of transitional nuclei, in which the normal and intruder configurations compete, can be used to test theoretical models used to explain the inversion mechanism. One such transition occurs along the N = 20 isotones, where neutron-rich ^{32}Mg is known to have a deformed ground-state configuration in the $f_{7/2}$ shell, while ^{34}Si displays a normal one. Previous studies [1, 2] of the intermediate N = 20 isotone ^{33}Al have yielded conflicting results regarding its structure. In the present work, ^{33}Al was studied through the β-decay of ^{33}Mg to clarify these discrepancies.

A low-energy radioactive beam of ^{33}Mg was delivered at a rate of 10^4 ions/s by the Isotope Separator and Accelerator (ISAC-I) facility at TRIUMF. Data were collected with the GRIFFIN [3] high-purity germanium γ-ray spectrometer coupled with the SCEPTAR plastic scintillator β particle detector. The majority of the data were collected in a cycled mode (with a period of ∼10 s beam on, 1.5 s beam off) to provide sensitivity to all of the ^{33}Mg, ^{33}Al, ^{32}Al (β-n daughter) and ^{33}Si half-lives. The high efficiency of the GRIFFIN detector provided new γ-γ coincidences to elucidate the excited state structure of ^{33}Al, and the capability of GRIFFIN to detect weak transitions has provided more complete β-decay branching ratios for the ^{33}Mg→ ^{33}Al→ ^{33}Si decay chain. Results from this analysis will be presented and their significance discussed.

[1] V. Tripathi, et al., Phys. Rev. Lett. 101, 142504 (2008)
[2] J. C. Angélique, et al., AIP Conf. Proc. 831, 134 (2006)
[3] C. E. Svensson and A. B. Garnsworthy, Hyperfine Int. 225, 127 (2014)

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