Measurement of the ^{26g}Al(d,p)^{27}Al Reaction to Constrain the ^{26g}Al(p,γ)^{27}Si Reaction Rate

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The long-lived radioactive nuclide ^{26}Al was the first radioisotope detected in the interstellar medium, by observation of the 1809-keV γ ray associated with the beta decay of its ground state (^{26g}Al). The nuclide has been the subject of several subsequent astronomical studies, resulting in a detailed directional map of its galactic distribution. Due to its half life of $\sim 7.2\times10^5$ years, which is short on stellar timescales, its abundance is indicative of ongoing nucleosynthesis within our galaxy.

Wolf-Rayet stars and asymptotic giant branch (AGB) stars have been suggested as possible locations contributing to ^{26}Al production. At T $\geq$ 0.03 GK, where ground and metastable states of ^{26}Al are decoupled, the ^{26g}Al(p,γ)^{27}Si reaction is expected to be the main destruction mechanism for ^{26}Al, thus impacting the net ^{26}Al synthesis rate. At these stellar temperatures, the dominant contribution to the ^{26g}Al(p,γ) reaction rate is capture through low lying resonances in ^{27}Si, the strengths of which have not been measured.

It is vital to constrain the destruction of ^{26}Al in order to determine the contribution of giant stars to the overall galactic abundance of ^{26}Al. However, due to small cross sections, it is impractical to measure the strengths of the lowest energy (dominant) resonances directly, and proton transfer reactions (which yield spectroscopic information on the states of interest) are experimentally problematic. An alternative indirect approach has been conducted by measuring mirror states in the ^{27}Al nucleus, using ^{26g}Al(d,p)^{27}Al reaction to determine neutron spectroscopic factors and hence obtain information about the ^{27}Si structure from mirror symmetry. The measurement was conducted at the Holifield Radioactive Ion Beam Facility at Oak Ridge National Laboratory, using a beam of $\sim$5 million ^{26g}Al per second and a $\sim$150 μg/cm^2 CD_2 target. Proton ejectiles were detected in the SIDAR and ORRUBA silicon detector arrays. Details of the motivation, experiment, data and astrophysical implications will be discussed. * *This work was supported in part by the US Department of Energy Office of Nuclear Physics and the National Science Foundation.*