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New results on the level structure of ^{26}Si and consequences for the $^{25}\text{Al}(p,\gamma)^{26}\text{Si}$ reaction in Classical Novae environments

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The $^{25}\text{Al}(p,\gamma)^{26}\text{Si}$ reaction is of tremendous interest in nuclear astrophysics. The production of the γ -ray emitter ^{26}Al ground state can be bypassed in classical novae via the production of ^{26}Si which decays to an isomeric state of ^{26}Al . In order to more precisely estimate the amount of ^{26}Al that is of classical novae origin, it's crucial to determine the rate of the $^{25}\text{Al}(p,\gamma)^{26}\text{Si}$ reaction at nova-burning temperatures. The production of ^{26}Si is dominated by resonant captures to several excited states above the proton threshold in ^{26}Si . There has been considerable experimental effort in recent years to observe and identify these states [1], but the properties of the key resonances in ^{26}Si remain unsettled.

The combination of GRETTINA [2] coupled with the Fragment Mass Analyzer (FMA) [3] at Argonne National Laboratory (ANL), provided a powerful opportunity to identify transitions in ^{26}Si , owing to the large acceptance of the separator and the Doppler-reconstruction capabilities and high-energy efficiency of the GRETTINA array. The experiment, presented here, follows an earlier γ -ray spectroscopy study of the ^{26}Si mirror nucleus, ^{26}Mg , performed with Gammasphere at ANL where a $l=1$ resonance was identified for the first time (fig.1) [4]. In the same study, the lifetime of the $3+$, 6125-keV state in ^{26}Mg was measured via the Doppler shift attenuation method. The $3+$, 414-keV resonance in ^{26}Si dominates the $^{25}\text{Al}(p,\gamma)$ reaction over most of the novae peak temperature range, while the introduction of the new $1-$ state increases the reaction rate by $\sim 25\%$ at the highest novae temperatures.

In this talk, new results on ^{26}Si from the GRETTINA+FMA study will be presented along with further information gained on the $A=26$ system. Information on both the level structure of ^{26}Si and the impact on the astrophysical $^{25}\text{Al}(p,\gamma)^{26}\text{Si}$ reaction will be discussed.

[1] K. Chipps, Phys. Rev. C 93, 035801 (2016).

[2] D. Weisshaar et al, Nucl. Instrum. Methods Phys. Res. A 847, 187 (2017).

[3] C.N. Davis et al., Nucl. Instrum. Methods Phys. Res. B 70, 358 (1992).

[4] L. Canete et al, Phys. Rev. C 104, L022802 (2021).

Field of work

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