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

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The ^{25}Al(p,γ)^{26}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}Al(p,γ)^{26}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 theses states [1], but the properties of the key resonances in ^{26}Si remain unsettled.
The combination of GRETINA [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 GRETINA 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}Al(p,γ) reaction over most of the novae peak temperature range, while the introduction of the new 1- state increases the reaction rate by ~25% at the highest novae temperatures.
In this talk, new results on ^{26}Si from the GRETINA+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}Al(p,γ)^{26}Si reaction will be discussed.

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[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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