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Direct Measurements of (α,n) Reactions Using the DEMAND Array with DRAGON

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Almost half of the elements heavier than iron are produced through the r-process. While it is now recognized that the r-process occurs in neutron star mergers, evidence suggests additional sites must also contribute. One such possibility is core-collapse supernovae, which are predicted to be driven by the weak r-process, where heavy elements are synthesized via a series of (α,n) reactions. A sensitivity study by Bliss et al. identified 45 (α,n) reactions that significantly influence the abundances of elements produced in core-collapse supernovae [1]. Furthermore, (α,n) reactions play a critical role in neutron production for the s-process in AGB and massive stars. Accurately measuring (α,n) reaction rates is, therefore, key to understanding the origins of elements in the Universe.

To address this, the DEMAND array has been developed to study (α,n) reactions directly in inverse kinematics with the DRAGON recoil separator at TRIUMF. The array consists of eight organic glass scintillator detectors used to detect the neutrons produced in these reactions. A proof-of-principle experiment was conducted to measure the 1434-keV resonance in the ^{22}Ne$(\alpha,n)^{25}$Ne reaction. This resonance was chosen as it has previously been measured in normal kinematics and is known to have a very strong resonance strength (1.067 eV) [2], making this an ideal test case. Preliminary results from this experiment demonstrate the detector's excellent pulse shape discrimination capabilities and confirm the feasibility of this novel approach.

[1] J. Bliss et al., Phys. Rev. C 101, 055807 (2020)
[2] M. Jaeger et al., Phys. Rev. Lett. 87, 20 (2001)

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