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The ^{13}C$(\alpha, n)^{16}$O reaction rate

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Neutron production for the slow neutron capture process (s-process) is dominated by (α, n) reactions on light nuclei during stellar helium burning. The two most prominent are ^{13}C$(\alpha, n)^{16}$O and ^{22}Ne$(\alpha, n)^{25}$Mg. New measurements of the angle integrated cross section have recently been reported by both the LUNA and JUNA underground facilities, reaching to unprecedentedly low energies and giving further constraints on the low-energy energy-dependence. However, even though these measurements have begun to reach down into the Gamow window, the cross section must still be extrapolated to lower energies to cover the full range of interest. Since these extrapolations are made using phenomenological R-matrix and the cross section is the result of broad underlying resonances, differential cross section measurements, even made at higher energies can likewise provide constraint on the extrapolated S-factor. Therefore, using the novel technique of deuterated liquid scintillators and spectrum unfolding, we have utilized the well-characterized ODeSA array to make differential cross section measurements that extend from laboratory α-particle energies of 0.8 to 6.5~MeV in approximately 10~keV energy steps at 18 angles between 0 and 160°, resulting in over 700 distinct angular distributions. These measurements extend both to lower energies and have significantly greater energy coverage than any previous measurements. We have used these differential data to augment the previous state-of-the-art R-matrix fit of the low energy ^{13}C$(\alpha, n)^{16}$O reaction developed for the ENDF/B evaluations and have used Bayesian uncertainty estimation to demonstrate that this differential data can decreases the uncertainty by up to a factor of two, from ≈10\% to ≈5\%, over the energy region of astrophysical interest. Further plans for a new cross section evaluation will also be discussed.

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