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Determining the $^{13}\mathrm{C}(\alpha,n)^{16}\mathrm{O}$ absolute cross section trough the concurrent application of ANC and THM and astrophysical consequences for the s-process in AGB-LMSs.

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The s-process is responsible for the production of neutron-rich nuclei between Sr and Bi during the asymptotic giant branch (AGB) phase of low-mass stars ($< 3-4$ $\mathrm{M}_\odot$ or LMSs) [1]. In this astrophysical site, the $^{13}\mathrm{C}(\alpha,n)^{16}\mathrm{O}$ reaction is considered to be the main neutron source providing n-densities of the order of $10^6 - 10^8$ cm^{-3} at low temperatures [2]. Several direct and indirect measurements were recently performed to determine the cross section at the energies of astrophysical interest ($140-230$ keV), but the contribution from a broad resonance, corresponding to the $1/2^+$ excited state of $^{17}\mathrm{O}$, close to the reaction threshold still remains a debated problem. For long time, this state was recognized as a sub-threshold resonance, but it is recently considered to be centred at positive energies [3]; so, we had to calculate the asymptotic normalization coefficient (or ANC) of the same resonance in the case of unbound states [4]. Moreover, direct measurements are affected by large systematic errors due to the spread in absolute normalization even at high energies [5]. In this context, we have reversed the usual normalization procedure combining two indirect approaches, ANC and the Trojan Horse Method (THM) [6], to unambiguously determine the absolute value of the $^{13}\mathrm{C}(\alpha,n)^{16}\mathrm{O}$ astrophysical factor. Implementing the recent and precise ANC calculation [7] and the full width for the threshold resonance from literature [3] into a modified R-matrix fit of THM experiment [8], it was possible to define an absolute and unique normalization for $^{13}\mathrm{C}(\alpha,n)^{16}\mathrm{O}$ data. Therefore, we calculated a very accurate reaction rate to be introduced into astrophysical models of s-process nucleosynthesis in LMSs [9] during their AGB phase. We do not expect significant variations for those nuclei which are produced exclusively by slow neutron captures. Verification of the new results is highly desirable using independent nucleosynthesis codes and the THM rate could also produce higher changes in other astrophysical sites.
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