Updated THM astrophysical factor of the $^{19}F(p, \alpha)^{16}O$ reaction and influence of new direct data at astrophysical energies

M. La Cognata, S. Palmerini, C. Spitaleri, I. Indelicato, A.M. Mukhamedzhanov, I. Lombardo, and O. Trippella

Fluorine nucleosynthesis represents one of the most intriguing open questions in nuclear astrophysics. It has triggered new measurements which may modify the presently accepted paradigm of fluorine production and establish fluorine as an accurate probe of the inner layers of asymptotic giant branch (AGB) stars. Both direct and indirect measurements have attempted to improve the recommended extrapolation to astrophysical energies, showing no resonances. In this work, we will demonstrate that the interplay between direct and indirect techniques represents the most suitable approach to attain the required accuracy for the astrophysical factor at low energies, Ec.m. $\lesssim$ 300 keV, which is of interest for fluorine nucleosynthesis in AGB stars. We use the recently measured direct $^{19}F(p, \alpha)^{16}O$ astrophysical factor in the 600 keV $\lesssim E_{c.m.} \lesssim$ 800 keV. Energy interval to renormalize the existing Trojan Horse Method (THM) data spanning the astrophysical energies, accounting for all identified sources of uncertainty. This has a twofold impact on nuclear astrophysics. It shows the robustness of the THM approach even in the case of direct data of questionable quality, as normalization is extended over a broad range, minimizing systematic effects. Moreover, it allows us to obtain more accurate resonance data at astrophysical energies, thanks to the improved $^{19}F(p, \alpha)^{16}O$ direct data. Finally, the present work strongly calls for more accurate direct data at low energies, so that we can obtain a better fitting of the direct reaction mechanism contributing to the $^{19}F(p, \alpha)^{16}O$ astrophysical factor. Indeed, this work points out that the major source of uncertainty affecting the low-energy S(E) factor is the estimate of the non-resonant contribution, as the dominant role of the 113 keV resonance is now well established.

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