Indirect measurement of the $^{18}O(p,\alpha)^{15}N$ reaction rates through the Trojan horse method

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In this paper we have evaluated the impact of the new improved measurement of the 20 keV resonance on the reaction rate of the $^{18}O(p,a)^{15}N$ reaction. For the first time, the strength of the low-lying 8.014 MeV resonance in ^{19}F has been experimentally determined via the indirect THM, while the same measurements have proved elusive or highly uncertain for any direct and indirect approach. The present result turns out to be about 35% larger than the NACRE rate [1] in the region where the effect of the presence of the 20 keV resonance is more intense. On the other hand the accuracy of the data has been improved by a factor ≈ 8.5. These changes reflects on the reaction rate, while no significant change is produced by the THM measurement of the strength of the 8.084 MeV state in ^{19}F. The correct reproduction of the strength of the 90 keV resonance, which has been more accurately determined than the 20 keV one by previous experiments, represents a benchmark of the present approach, making us confident of its validity. The main advantage of the THM approach is the possibility to provide not only a more precise determination of the relevant resonance strength but, more importantly, a much more accurate one. In details, this newly developed approach is based on experimental data in contrast to the previous works, which mainly rely on various kinds of estimates. Moreover, the THM leads to the determination of the strength of the unknown resonance avoiding information about the spectroscopic factors, which are a primary source of systematic errors. Finally, our results are not affected by the electron screening, which can enhance the cross section by a factor larger than about 2.4 at 20 keV, thus spoiling any direct measurement of this resonance. As a next step, the astrophysical consequences of the present work are to be evaluated. These results have to be linked with the recent developments in astrophysical models to provide an up-to-date and consistent picture of AGB star nucleosynthesis. In addition, at higher temperatures, higher energy resonances in the $^{18}O(p,\alpha)^{15}N$ reaction can play a role. These studies will be the subject of forthcoming works. The paper will be submitted to Phys. Rev. C.

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