High accuracy $^{18}O(p,\alpha)^{15}N$ reaction rate at AGB nucleosynthesis relevant temperatures

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The $^{18}O(p,\alpha)^{15}N$ reaction is of great importance in several astrophysical scenarios, as it influences the production of key isotopes such as ^{19}F, ^{18}O and ^{15}N. Fluorine is synthesized in the intershell region of asymptotic giant branch stars, together with s-elements, by α radiative capture on ^{15}N, which in turn is produced in the ^{18}O proton-induced destruction. Peculiar ^{18}O abundances are observed in R-Coronae Borealis stars, having $^{16}O/^{18}O \leq 1$, hundreds of times smaller than the galactic value. In the framework of the double degenerate scenario, a quantitative account of such abundances can be provided if H-rich material is ingested and the $^{18}O(p,\alpha)^{15}N$, $^{18}O(p,\alpha)^{15}N(p,\alpha)^{12}C$ chain is activated, thus reducing ^{18}O overproduction. Finally, there is no definite explanation of the $^{14}N/^{15}N$ ratio in presolar grains formed in the outer layers of asymptotic giant branch stars. Again, such an isotopic ratio is influenced by the $^{18}O(p,\alpha)^{15}N$ reaction that might increase the ^{15}N yield during non-convective mixing episodes. In this work, a high accuracy $^{18}O(p,\alpha)^{15}N$ reaction rate is proposed, based on the simultaneous fit of direct measurements and the results of a new Trojan Horse experiment. Indeed, current determinations are uncertain because of the poor knowledge of the resonance parameters of key levels of ^{19}F. In particular, we have focused on the study of the broad 660 keV $½^+$ resonance corresponding to the 8.65 MeV level of ^{19}F. Since $\Gamma \sim$ 100-300 keV, it determines the low-energy tail of the resonant contribution to the cross section and dominates the cross section at higher energies. We get a factor of 2 larger reaction rate above $T \sim 0.5 x 10^9$ based on our new improved determination of its resonance parameters compared to previous estimations, which could strongly influence present-day astrophysical model predictions. This work has been published in Astrophysical Journal.