High accuracy $^{18}O(p,a)^{15}N$ reaction rate in the 8 10^6 – 5 10^9 K temperature range

M. La Cognata[1,2], C. Spitaleri[1,2], A. Mukhamedzhanov[3], A. Banu[3], S. Cherubini[1,2], A. Coc[4], V. Crucillà[1,2], V. Goldberg[3], M. Gulino[1], B. Irgaziev[5], G. G. Kiss[1,2], L. Lamia[1,2], J. Mrazek[6], R. G. Pizzone[1,2], S. M. R. Puglia[1,2], G. G. Rapisarda[1,2], S. Romano[1,2], M. L. Sergi[1,2], G. Tabacaru[3], L. Trache[3], R. E. Tribble[3], W. Trzaska[7], A. Tumino[1,8]

[1]INFN – Laboratori Nazionali del Sud
[2]DMFCI – Università di Catania, Catania, Italy
[3]Cyclotron Institute – Texas A&M University, College Station, TX, USA
[4]CSNSM CNRS/IN2P3, Université Paris Sud, Orsay, France
[5]GIK – Institute of Engineering Sciences and Technology, Topi District, Pakistan
[6]Nuclear Physics Institute of ASCR, Rez near Prague, Czech Republic
[7]Physics Department, University of Jyvaskyla, Finland
[8]Università degli studi di Enna “Kore,” Enna, Italy

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 radiative capture on ^{15}N, which in turn is produced in the ^{18}O proton-induced destruction [1]. Peculiar ^{18}O abundances are observed in R-Coronae Borealis stars, having $^{16}O/^{18}O <1$, 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 $^{18}O(p,\alpha)^{15}N(p,\alpha)^{12}C$ chain is activated, thus reducing ^{18}O overproduction [2]. Finally, there is no 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 [3].

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 (see [4] for a description of the method). Indeed, current determinations are uncertain because of the poor knowledge of the resonance parameters of key levels of ^{19}F. A key role is played by the 20 keV resonance in the $^{18}O(p,\alpha)^{15}N$ cross section, whose strength has been recently determined in a novel THM approach [5]. Moreover, we focus on the study of the broad 660 keV 1/2+ resonance corresponding to the 8.65 MeV level of ^{19}F. Since Γ=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. Here we provide a factor 2 larger reaction rate above T=0.5 10^9 K based over our new improved determination of its resonance parameters, which could strongly influence present-day astrophysical model predictions [6].

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