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

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^{19}F is one of the few naturally occurring isotopes whose nucleosynthesis is still uncertain. SNe, AGB and WR stars are its most likely sources. In particular fluorine abundances observed in giants can constrain AGB star models since they are sensitive to the environmental conditions in the intershell region and to the dynamics of the mixing phenomena taking place in such stars. The $^{18}O(p,\alpha)^{15}N$ reaction can affect fluorine yield from AGB stars since it produces ^{15}N nuclei which are later burnt to ^{19}F through the $^{15}N(\alpha,\gamma)^{19}F$ capture reaction during a thermal pulse. Large uncertainties characterize ^{19}F nucleosynthesis since experimental ^{19}F abundances are not reproduced by current AGB models.

A possible solution of these experimental problems can come from nuclear physics studies. Indeed the measurement of nuclear cross sections at ultra-low energies is a very difficult task because of the presence of the Coulomb barrier exponentially suppressing the cross section. Therefore extrapolation is necessary when data at astrophysical energies are unavailable. Even when measurements are available inside the Gamow window, electron screening makes the bare-nucleus cross section inaccessible. Thus indirect techniques such as the Trojan Horse Method (THM) have been developed to extract low-energy cross sections with no need of extrapolation.

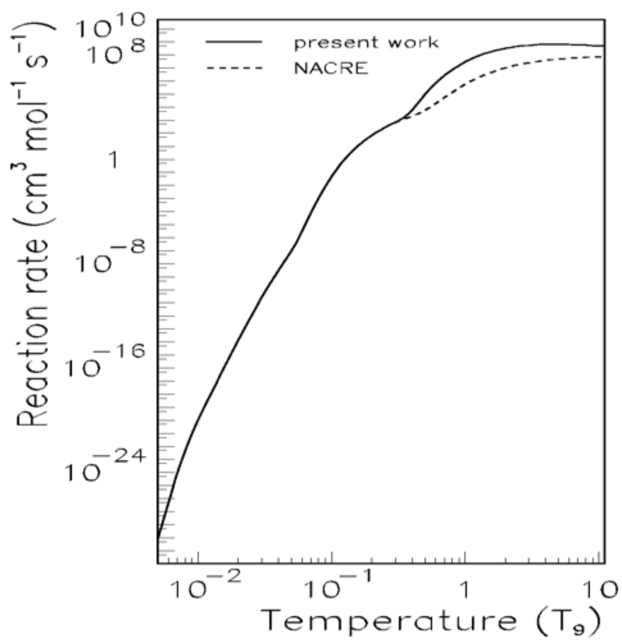

Figure 1. Reaction rate for $^{18}O(p,\alpha)^{15}N$ as function of temperature.

In the present work the THM is applied to the $^{2}H(^{18}O,^{15}N\,\alpha)n$ ($2\rightarrow3$ particles process) to deduce the sub-Coulomb astrophysical S(E)-factor for the $^{18}O(p,\alpha)^{15}N$ reaction.

The experiment was performed at the Texas A&M University Cyclotron Institute, with a 54 MeV, 5~enA ^{18}O beam impinging onto a 100 $\mu g / cm^2$ thick CD_2 target.

The second stage of the experiment with better resolution has been performed at Catania National Laboratory,. The results of the experiments are being analyzed and new theoretical approach developed at Texas A&M University is applied to determine the astrophysical factor for the $^{18}O(p,\alpha)^{15}N$ reaction from the THM data. New reactions rates calculated using the data obtained from these measurements are shown in Fig. 1. The paper has been submitted to Phys. Rev. Lett.