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The $^{19}\mathrm{F}(\alpha, p)^{22}\mathrm{Ne}$ and $^{23}\mathrm{Na}(p, \alpha)^{20}\mathrm{Ne}$ reactions at energies of astrophysical interest via the Trojan Horse Method

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$^{19}\mathrm{F}$ has been clearly observed in AGB stars, and its abundance is strongly related to the physical conditions of stars. This element in fact can be destroyed via $^{19}\mathrm{F}(n, \gamma)^{20}\mathrm{F}$, $^{19}\mathrm{F}(p, \alpha)^{16}\mathrm{O}$, and $^{19}\mathrm{F}(\alpha, p)^{22}\mathrm{Ne}$, with α capture that is expected to dominate in the He-intershell region. Direct measurements for this reaction are nonetheless scarce and affected by large uncertainties at He-burning temperatures ($0.2 \leq \mathrm{T}_9 \leq 0.8$): the Gamow peak, in fact, lies between 0.2 and 1.2 MeV, while there are no direct measurements below 0.7 MeV. The Coulomb barrier effects strongly suppress such low energies reactions, and indirect methods such as the Trojan Horse Method (THM) can be a powerful tool to overcome the difficulties related to the presence of the Coulomb barrier itself.

As regard the $^{23}\mathrm{Na}(\mathrm{p}, \alpha)^{20}\mathrm{Ne}$, this reaction is considered to have great importance in intermediate-mass AGB stars ($\mathrm{M} = 4 \div 8\ \mathrm{M}_\odot$), and could be strongly related to the wide known Na/O anticorrelation in globular clusters. This reaction also represents the turning point between the NeNa and MgAl cycles. $^{23}\mathrm{Na}(\mathrm{p}, \alpha)^{20}\mathrm{Ne}$ has not been studied at astrophysical energies with direct methods in the energy range of astrophysical interest. Here the Gamow window lies between 50 keV and 200 keV, while the Coulomb barrier is at 2.57 MeV. Nonetheless, several states of $^{24}\mathrm{Mg}$ were studied, via transfer reaction, and two resonant states at 37 keV and 138 keV were found: the former had a too low cross section to be studied (but uncertainties were reduced by a factor of 515), and the latter is still the bigger source of uncertainties (approximately a factor of 12) in the temperature region near $\mathrm{T} \sim 70 \cdot 10^6$ K.

For the reasons above, in the recent years it has been decided to study such reactions using the Trojan Horse Method: the $^{19}\mathrm{F}(^6\mathrm{Li}, p^{22}\mathrm{Ne})d$ and $d(^{23}\mathrm{Na}, \alpha^{20}\mathrm{Ne})n$ have been used to explore the resonant cross section of the $^{19}\mathrm{F}(\alpha, p)^{22}\mathrm{Ne}$ and $^{23}\mathrm{Na}(p, \alpha)^{20}\mathrm{Ne}$ respectively in the Gamow region ov interest.

In this talk the cross section and reaction rate for the $^{19}\mathrm{F}(\alpha, p)^{22}\mathrm{Ne}$ reaction will be discussed, along with their impact on stellar nucleosinthesys. Also some preliminary results regarding the $^{23}\mathrm{Na}(p, \alpha)^{20}\mathrm{Ne}$ one will be presented.

Session

Experimental Nuclear Astrophysics

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