THE FLUORINE DESTRUCTION IN STARS: FIRST EXPERIMENTAL STUDY OF THE $^{19}F(p,\alpha_0)^{16}O$ REACTION AT ASTROPHYSICAL ENERGIES

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ABSTRACT

The $^{19}F(p,\alpha)^{16}O$ reaction is an important fluorine destruction channel in the proton-rich outer layers of asymptotic giant branch (AGB) stars and it might also play a role in hydrogen-deficient post-AGB star nucleosynthesis. So far, available direct measurements do not reach the energy region of astrophysical interest (E_{cm} < 300 keV), because of the hindrance effect of the Coulomb barrier. Therefore, below E_{cm} = 460 keV, where data do not exist, a non-resonant contribution is calculated for s-capture and the cross section has been extrapolated assuming this contribution as the dominant one. The Trojan Horse (TH) method was thus used to access this energy region, by extracting the quasi-free contribution to the $^{2}H(^{19}F,\alpha^{16}O)n$ and the $^{19}F(^{3}He,\alpha^{16}O)d$ reactions. A novel approach, the so-called Modified R-matrix, has been developed to analyze the data, aiming to account for the half-off-energy-shell nature of the TH cross section and for the experimental energy resolution. The TH measurement of the α_0 channel, which provides the largest contribution below about 1 MeV, shows the presence of resonant structures not observed before, showing up right at astrophysical energies, which cause an increase of the reaction rate at astrophysical temperatures (about 10^8 K) up to a factor of 1.7, with potential important consequences for stellar nucleosynthesis.

Reference

M. La Cognata, et al., The Astrophysical Journal Letters, 739, L54 (2011)