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Indirect measurement of the 19F(p,αγ)16O and 19F(p,γ)20Ne reactions and direct observation of the 11 keV resonance

The amount of fluorine in stars is a crucial indicator of the internal physical conditions and of the processes taking place within them, such as extra mixing in asymptotic giant branch stars. Also, it is a branching point in proton induced nucleosynthesis, since its proton radiative capture may lead to the synthesis of heavier nuclei (such as Ca in early stars). Recent extrapolated findings on the 19F(p,αγ)16O and 19F(p,γ)20Ne fluorine-destruction channels by the JUNA collaboration indicated a rise in the astrophysical factor by several orders of magnitude below about 100 keV, significantly affecting our comprehension of stellar evolution and nucleosynthesis. Utilizing the Trojan Horse Method (THM), we have indirectly measured the 19F(p,αγ)16O cross section, fully covering astrophysical energies without requiring extrapolations (and with no electron screening enhancement). The strength of the 11-keV resonance was determined, revealing a considerable decrease in the reaction rate compared to earlier studies. The THM results on the αγ channel were also used to rescale the 19F(p,γ)20Ne astrophysical factor, with similar conclusions. Our analysis of its astrophysical significance suggests that this measurement challenges existing models of fluorine and heavier element abundances, reopening unresolved questions in the field, in particular in the case of early stars.

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