

New determination of the ${}^2\text{H}(d,p){}^3\text{H}$ and ${}^2\text{H}(d,n){}^3\text{He}$ reaction rates at astrophysical energies

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The cross-sections of the ${}^2\text{H}(d,p){}^3\text{H}$ and ${}^2\text{H}(d,n){}^3\text{He}$ reactions have been measured via the Trojan Horse method applied to the quasi free ${}^2\text{H}({}^3\text{He},p){}^3\text{H}$ and ${}^2\text{H}({}^3\text{He},n){}^3\text{He}$ processes at 18 MeV off the proton in ${}^3\text{He}$. For the first time, the bare nucleus $S(E)$ factors have been determined from 1.5 MeV, across the relevant region for standard Big Bang nucleosynthesis, down to the thermal energies of deuterium burning in the pre main sequence (PMS) phase of stellar evolution, as well as of future fusion reactors. Both the energy dependence and the absolute value of the $S(E)$ factors deviate by more than 15% from the available direct data and existing fitting curves, with substantial variations in the electron screening by more than 50%. As a consequence, the reaction rates for astrophysics experience relevant changes, with a maximum increase of up to 20% at the temperatures of the PMS phase. From a recent primordial abundance sensitivity study, it turns out that the ${}^2\text{H}(d,n){}^3\text{He}$ reaction is quite influential on ${}^7\text{Li}$, and the present change in the reaction rate leads to a decrease in its abundance by up to 10%. The present reaction rates have also been included in an updated version of the FRANEC evolutionary code to analyze their influence on the central deuterium abundance in PMS stars with different masses. The largest variation of about 10%–15% pertains to young stars (≤ 1 Myr) with masses $\geq 1M_{\odot}$.

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