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Understanding the origin of "nova" grains and the ^{13}N(α,p)^{16}O reaction

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Primitive meteorites hold several types of dust grains that condensed in stellar winds or ejecta of stellar explosions. These grains carry isotopic anomalies which are used as a signature of the stellar environment in which they formed. As such, extreme excesses of ^{13}C and ^{15}N in rare presolar SiC grains have been considered as a diagnostic of an origin in classical novae, however an origin in core collapse supernovae (ccSNe) has also been recently proposed~[1].

In the context of ccSNe, explosive He shell burning can reproduce the high ^{13}C and ^{15}N abundances if H was ingested into the He shell and not fully destroyed before the explosion~[2]. The supernova shock will then produce an isotopic pattern similar to the hot-CNO cycle signature obtained in classical novae. Indeed in absence of H ingestion there is no production of ^{13}N in the helium region. It has been shown that a variation of a factor of five for the ^{13}N(α,p)^{16}O reaction rate induces several orders of magnitude in the production of ^{13}N which β^+-decays to ^{13}C.

So far the ^{13}N(α,p)^{16}O reaction rate is calculated using a statistical model or the time reverse reaction and these determinations have large uncertainties. We have determined an experimental based reaction rate using the spectroscopic information of the ^{17}F compound nucleus. Alpha spectroscopic factors of the states of interest ($E_x = 6.5 - 7.2$~MeV) in ^{17}F were deduced from those of the ^{17}O mirror nucleus which were determined using the ^{13}C(^{7}Li,t)^{17}O alpha-transfer reaction.

After a brief presentation of the astrophysical context of ^{13}C and ^{15}N nucleosynthesis, the current situation of the ^{13}N(α,p)^{16}O reaction rate will be discussed. The determination of spectroscopic information from the ^{13}C(^{7}Li,t)^{17}O reaction will be presented together with an R-matrix calculation of the ^{13}N(α,p)^{16}O astrophysical S-factor. The impact of the new reaction rate wil be discussed.

\bigskip
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\noindent [1] N.~Liu et al. The Astrophysical Journal, 820:140 (2016).

\noindent [2] M.~Pignatari et al. The Astrophysical Journal Letters, 808:L43 (2015).

\noindent [3] A.~M.~Laird and M.~Pignatari, private communication.}
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