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New Determination of the $^{13}C(\alpha, n)^{16}O$ reaction rate and its influence on the s-process nucleosynthesis in AGB stars

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The $^{13}C(\alpha, n)^{16}O$ reaction is believed to be the main neutron source for the s-process in AGB stars. The direct measurements have been performed at energies down to 270 keV [1 and references therein], whereas the Gamow window is at 190 ± 40 keV (T=100MK). At present the experimental cross sections have to be extrapolated below 270 keV. This extrapolation is critically affected by the $1/2^+$ subthreshold resonance (E_x = 6.356 MeV) in ^{17}O. Its contribution depends strongly on the α-width of the $1/2^+$ state in ^{17}O, which can be derived from the spectroscopic factor (S_α) or the ANC of the α-cluster in this state. Although three indirect measurements via the (^{6}Li, d) or the (^{7}Li, t) system have been performed to study the S_α or the ANC of the $1/2^+$ state [2-4], a significant discrepancy of up to a factor of ~30 still exists in the derived S_α and ANC. Therefore, it is interesting to perform a new measurement of the S_α and the ANC via an independent transfer reaction. In addition, it is necessary to understand the impact of the different resulting $^{13}C(\alpha, n)^{16}O$ rates on the *s*-process nucleosynthesis in AGB stars.

We present a new measurement of the S_α and the asymptotic normalization coefficient for the $1/2^+$ subthreshold state of ^{17}O through the $^{13}C(^{11}B, ^7Li)^{17}O$ transfer reaction and we determine the α-width of this state [5]. This provided an independent examination to shed some light on the existing discrepancies in the S_α and ANC values derived from different authors. The most recent measurement via Trojan horse method [6] confirmed our new result. Based on the new width we derive the astrophysical *S*-factor and the stellar rate of the $^{13}C(\alpha, n)^{16}O$ reaction. At a temperature of 100 MK, our rate is roughly two times larger than that by Caughlan & Fowler and two times smaller than that recommended by the NACRE compilation (see Figure 1). We use the new rate and different rates available in the literature as input in simulations of AGB stars to study their influence on the abundances of selected *s*-process elements and isotopic ratios. When the ^{13}C burns completely in radiative conditions, there are no changes in the final results using the different rates. When the ^{13}C burns in convective conditions, as in stars of initial mass lower than ~2M_{sun} and in post-AGB stars, some changes are to be expected, e.g., of up to 25% for Pb in our models.

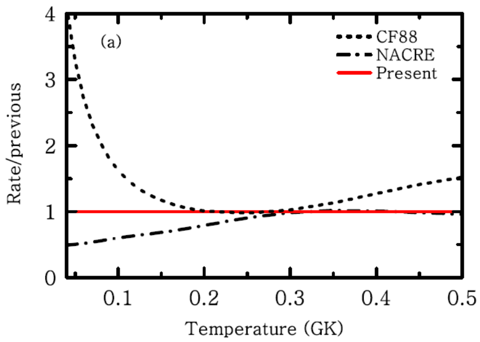

Figure 1: *Comparison of the present rate with the previous compilations*

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