New Resonances in $^{24}Mg(\alpha,\gamma)^{28}Si$ and stellar Carbon burning

^{20}Ne and ^{24}Mg are important products of nucleosynthesis in stellar carbon burning. The $^{24}Mg(\alpha,\gamma)^{28}Si$ reaction is of significant importance for the possible subsequent depletion of ^{24}Mg. The cross section in the stellar Gamow window for carbon burning between 1.0 MeV and 1.6 MeV is characterized by a number of resonances which are not well known. Only estimates or upper limits have been tabulated for the strengths of the resonances below 1.4 MeV.

We have measured the resonance contributions over the entire Gamow window range of the reaction at carbun burning temperatures at the Notre Dame KN VdG accelerator. The γ background was reduced by Q-value gating of the resonance gamma spectra from the Ge-clover detector with the summing signal in a NaI detector array The yield curve shows several pronounced resonance states and the resonance strength was directly determined from the corresponding thick target yield. The experimental uncertainty of the resulting reaction rate is much reduced compared to previous estimated. The rate slightly larger than these estimates but shows good agreement with statistical Hauser Feshbach calculations [1].

Detailed reaction network calculations were performed to simulate the nucleosynthesis in stellar carbon burning subsequent to the release of fresh alpha and proton fuel through the $^{12}C+^{12}C$ fusion process. The main goal was to study the impact of the $^{24}Mg(\alpha,\gamma)^{28}Si$ reaction on the depletion of ^{24}Mg and the production of ^{28}Si. While the ^{28}Si production is correlated with the abundance change of ^{24}Mg, detailed flux analysis shows that the $^{24}Mg(\alpha,\gamma)^{28}Si$ only plays a secondary role, both in depletion of ^{24}Mg as well as in production of ^{28}Si. The reaction rate is too small and most of the nucleosynthesis towards ^{28}Si is driven by neutron and proton capture processes at the characteristic carbon burning temperatures [2].

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[1] T. Rauscher, F.-K. Thielemann, J. Görres, M. Wiescher , Nucl. Phys A675, 695 (2000)
[2] E. Strandberg, M. Wiescher, J. Görres, K. Scheller, M. Pignatari, Phys. Rev. C (2008) submitted

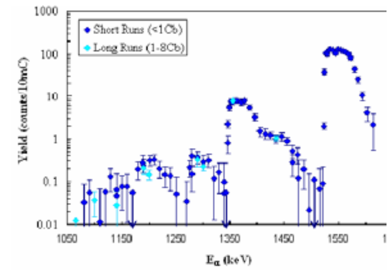

Figure 1: The reaction yield curve for $^{24}Mg(\alpha,\gamma)^{28}Si$ in the energy range of its Gamow window in stellar carbon burning.

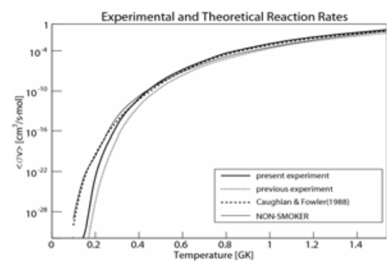

Figure 2: Experimental and theoretical predictions for the reaction rate of $^{24}Mg(\alpha,\gamma)^{28}Si$.

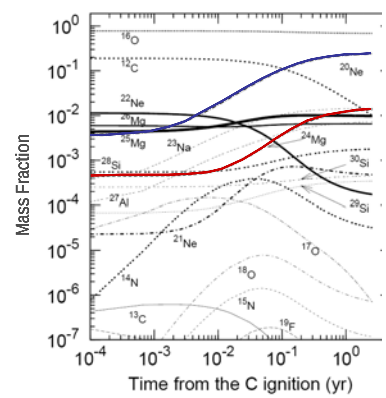

Figure 3: Nucleosynthesis of isotopes in the carbon to silicon range in stellar carbon burning. Highlighted is the evolution of the abundances of ^{20}Ne and ^{24}Mg with time.

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