# The $^{12}$C($\alpha, \gamma$) Reaction: Most Important, Least Known: Current Status and Prospects for Future Progress

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Over the last four decades conflicting data plagued our attempts to deduce the cross section of the $^{12}$C($\alpha, \gamma$) reaction at low energies and did not allow an accurate extrapolation of the astrophysical s-factor to stellar energies. In particular conflicting data did not allow us to chose between the high value ($\sim$80 keVb) and the low value ($\sim$10 keVb) solutions of the E1 s-factor at stellar energies. The so called "cascade" s-factors were deduced with large uncertainty, as large as a factor of 25. Recent modern measurement of $S_{E1}$ and $S_{E2}$ at Stuttgart, were demonstrated [1] to have error bars which are considerably larger than quoted by the authors [2, 3, 4]. In spite of the little progress in measurements of the cross section of the $^{12}$C($\alpha, \gamma$) reaction, several recent R-Matrix global analyses claim to achieve accuracies of the total s-factor (E1 + E2 + cascade) between 4.5% and 12%.

We apply the strict criteria established in the two Seattle workshops [5, 6] to examine current conflicting measurements of the $^{12}$C($\alpha, \gamma$) reaction. The Seattle workshops addressed similar confusion in measurements of the $^{7}$Be(p,$\gamma$) reaction and the criteria that were established at the Seattle workshops to judge conflicting data can be used as a model for progress in the field. Applying the Seattle workshops criteria we conclude yet a new ambiguity previously not noticed in the value of $S_{E2}$(300); namely either $\sim$60 keVb or $\sim$155 keVb values are consistent with current data [1].

We establish strict requirements on future measurements to allow progress in the field and we point out that such data are within reach using gamma-ray beams of the HI$\gamma$S facility in the USA or ELI-NP facility in the European Union.

## References

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