Enhanced or not enhanced – That is the question
Low energy fusion studies for stellar carbon burning

During the last few thousands of years in the life of a massive star, before it explodes a supernova, the star has consumed all of its light burning fuel hydrogen and helium. The internal pressure against gravitational collapse is only balanced by nuclear fusion reactions between carbon and oxygen isotopes. This balance is not well known since the rates by which those nuclei undergo fusion in the stellar core are only based on uncertain theoretical extrapolations of experimental data taken at energies that are substantial higher than the ones in stellar interiors.

The extrapolations are based on theoretical assumptions such as the incompressibility of nuclei reducing the probability of fusion [1] and the possible impact of molecular cluster formation during the fusion process that increases the fusion probability [2]. This uncertainty range may have severe consequences for our understanding of stellar heavy ion burning associated with late stellar evolution and stellar explosions [3].

New measurements of the $^{12}C+^{16}O$ fusion reaction were performed at the 5U accelerator at the University of Notre Dame over a wide energy range. The fusion cross section was measured towards the very low energies. The results indicate a decrease in the so-called S-factor, which corresponds to the reaction probability, towards lower energy as shown in figure 1. These findings seem to support the claims for the existence of a pronounced hindrance. Yet there is also indication of a resonance structure at 4MeV center of mass energy. Further experiments in the lower energy range will be necessary to generate stronger experimental evidence for this observation.

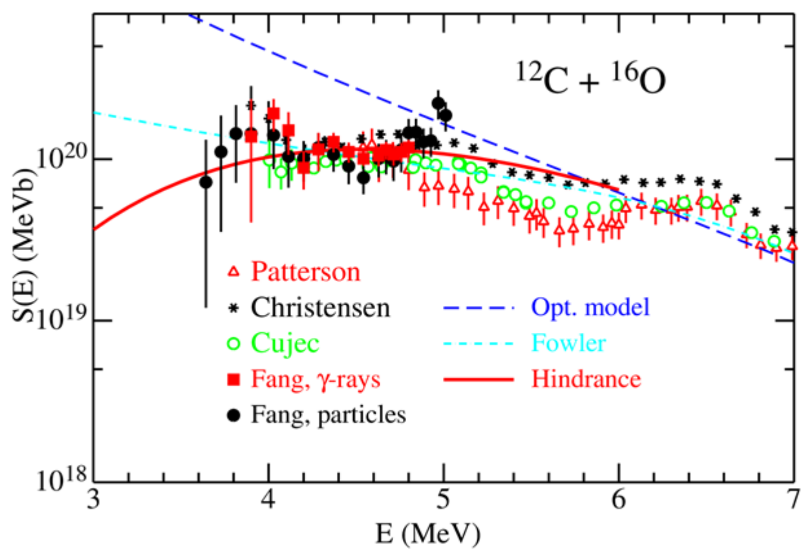

Fig. 1: Present S-factor values (Fang) in comparison with previous results and theoretical predictions based on different extrapolation models.

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