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(I) Fusion in massive stars: Pushing the 12C+12C cross-section to the limits with the STELLA experiment at IPN Orsay

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The 12C+12C fusion reaction is one of the key reactions governing the evolution of massive stars as well as being critical to the physics underpinning various explosive astrophysical scenarios. Our understanding of the 12C+12C reaction rate in the Gamow window –the energy range relevant to the different astrophysical scenarios –is presently confused. This is due to the large number of resonances around the Coulomb barrier and persisting down to the lowest energies measured. In usual circumstances, where the fusion cross-section is smooth it can be readily extrapolated from the energy range measured in the laboratory down to the Gamow window but this is not possible for 12C+12C. Moreover, the existing data on this reaction obtained either through detection of evaporated charged particles or detection of gamma rays do not agree. In addition, there is considerable disagreement in the theoretical extrapolation of the data down to the Gamow window. Classically, the origin of the resonances has been attributed to molecular states based on a 12C+12C configuration, while others have attributed it to low level density in the compound system.

The STELLA experiment has been commissioned at IPN Orsay. A intense 12C beam from the Andromede accelerator is incident on thin self-supporting 12C foils. A target rotation system can allow for cooling supporting beam currents in excess of 1 eμA. Evaporated charged particles are detected with a dedicated silicon array while gamma rays are detected in coincidence with an array of 30 LaBr3 detectors. Results from initial studies with STELLA will be presented which appear to support sub-barrier fusion in this system underlying the fusion resonances.

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