Contribution ID: **58** Type: **Oral**

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

Tuesday, 14 May 2019 11:40 (20 minutes)

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 [1]. 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.

Jiang et al. have developed a new experimental approach to study of the 12C+12C reaction which can circumvent issues related to target contamination [2]. They used the Gammasphere array to detect fusion gamma rays in coincidence with detection of evaporated charged particles using annular silicon strip detectors [2]. This technique has shown considerable promise in essentially removing experimental background from the measurement [2].

The STELLA experiment has been established 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 μA beam currents. Evaporated charged particles are detected with a dedicated silicon array while gamma rays are detected in coincidence with an array of 30 LaBr3 detectors [3]. The design and status of STELLA will be presented along with results on the cross-sections and astrophysical S-factors obtained down into the Gamow window for massive stars.

REFERENCES

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Session Classification: Session VI