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New Results on the Direct Measurement of Carbon Burning at Astrophysical Energies

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Fusion reactions play an essential role in the energy production, the nucleosynthesis of chemical elements and the evolution of massive stars. Among these reactions, carbon burning is a crucial ingredient to understand the late stages of massive stars essentially driven by the 12C+12C reaction [1]. It presents prominent resonances at energies ranging from a few MeV/nucleon down to sub-Coulomb barrier energies, possibly due to molecular 12C-12C configurations of 24Mg and persisting down to the Gamow window [2]. The direct measurement of key fusion reactions at stellar energies offers an unbiased and evident experimental access to this region where cross sections are of the sub-nano barn range, but calls for innovative measures for efficient background reduction [3,4].
This contribution will discuss recent results from our last experimental campaigns obtained in the 12C+12C system at deep sub-barrier energies using the STELLA setup combined with the UK-FATIMA detectors, installed at the ANDROMEDE 4 MV facility of the University Paris-Saclay and IJC Lab (France).
Novel background reduction techniques will be presented which have allowed to extract new astrophysical 12C+12C S-factors at the highest precision reached so far. These will be discussed in terms of sub-barrier hindrance effects as well as resonant features in the 24Mg compound system.
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[2] D. Jenkins and S. Courtin J. Phys. G: Nucl. Part. Phys. 42, 034010 (2015).
[3] M. Heine, S. Courtin et al., Nucl. Inst. Methods A, 903 1 (2018), and references therein.
[4] G. Fruet, S. Courtin et al., Phys. Rev. Lett. 124, 192701 (2020).

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