# Fusion Reactions and Molecular Resonances in the Light $^{12}C+^{12}C$ and $^{12}C+^{16}O$ systems

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Fusion is the dominant mechanism in the collisions between light and medium mass heavy ions. For the fusion of light systems like $^{12}C+^{12}C$ and $^{12}C+^{16}O$, strikingly narrow resonances have been observed in the fusion cross sections at the Coulomb barrier (CB) and below. These have often been discussed in terms of possible molecular configurations of the compound nucleus [1]. Recent measurement on such resonances will be presented.

Fusion reactions in light systems also play a major role in the sysnthesis of chemical elements in massive stars. In a proton-rich stellar environment, the stable $^{13}C$ and $^{12}C$ are the first nuclei with sufficiently negative (p,α) Q values preventing their disappearance at low temperatures. The knoweledge of the $^{12}C+^{12}C$ fusion reaction is of the highest importance for nuclear astrophysics ; it may indeed occur in several stellar environments : in the centre of massive stars during the C burning phase, in stellar explosions like type Ia supernovae and in the superbursts of neutron stars [2]. Stellar temperatures imply that Gamow energies for light heavy-ion fusion reactions are far below their CB. Fusion cross-sections of astrophysical interest are therefore as small as the sub-nanobarn, and their experimental study is very challenging. The survival of resonances at the lowest energies is a debated question. Interestingly enough, the process may also be affected by the fusion hindrance phenomenon which has been evidenced recently for medium mass systems.

The present contribution will present the STELLA project which will make use of high intensity stable beams (I > 10 μA), and a detection system based on charged particle detectors coupled with an array of $LaBr_3$ scintillators. The STELLA target system developed to sustain high beam currents will be presented. The project will allow direct measurements of deep sub-barrier fusion cross-sections and the investigation of cluster resonances for $^{12}C+^{12}C$, $^{12}C+^{16}O$ and $^{16}O+^{16}O$, towards the Gamow region.

[1] D. Jenkins and S. Courtin, Journal of physics G-Nuclear and Particle Physics, Vol. 42, 034010 (2015).
[2] C. E. Rolfs, and W. S. Rodney, *Cauldrons in the Cosmos*, The Univ. of Chicago Press, 1988.