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## Population and decay of states of $^{12}\text{C}$

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Population and decay of states of  $^{12}\text{C}$

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By using the CHIMERA detector, we have measured the alpha and gamma decay width of excited states of  $^{12}\text{C}$  important for the carbon production in astrophysical environments. Gamma rays were detected in CsI stages of the CHIMERA (Si-CsI) telescopes. Inelastically scattered beam particles, carbon recoils and alpha-particles from the decay of excited states were detected and identified with DE\_E and Time of flight methods. In the same experiment, we directly compared all decay modes of the excited levels, so decreasing systematic errors. We have checked the efficiency for gamma-ray decay measurement by well-known levels, such as the 15.1 and 12.7 MeV obtaining a good agreement between observations and expectations. With the simultaneous measurement of scattered beam, recoiling carbon and decay gamma-rays we reduced considerably the background of the measurement. We observed for the first time in a direct way the gamma-ray decay of the 9.64 MeV level, with a signal to noise ratio around 2 with a decay probability of only  $5.5 \times 10^{-5}$  [1]; the most recent indirect observation of this decay mode [2] obtained a similar result but with a much worse signal to noise ratio. The observed decay width is more than one order of magnitude larger than the expected upper limits reported in literature from previous measurements [3] with a very large background. Evidently, our result has a significant consequence on the carbon production rate, for instance in supernova explosions. A gamma-ray decay width larger than previous observations was measured also for the Hoyle state. In addition, we investigated on the recently proposed population of an Efimov state at 7.458 MeV [4], as a possible alternative explanation for the observed large decay width. The investigation was done by an accurate analysis of the alpha decay width of the region near the Hoyle state. Preliminary results will be shown.

References

[1] G.Cardella et al submitted to Phys.Rev.C

[2] M.Tsumura et al Phys.Lett. B817(2021)136283.

[3] D. Chamberlin et al Phys. Rev. C 10 (1974) 909–911.

[4] H. Zheng et al Phys. Lett. B 779, 460 (2018).

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