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Fusion of $^{12}\text{C} + ^{28}\text{Si}$ at deep sub-barrier energies

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Heavy-ion fusion reactions are essential to investigate the fundamental problem of quantum tunnelling of many-body systems in the presence of intrinsic degrees of freedom.

The fusion of light nuclei is a base for the understanding of the astrophysics reaction networks responsible for energy production and elemental synthesis in stellar environments [1]. Fusion enhancements are found near the Coulomb barrier, however, the hindrance phenomenon shows up [2] at lower energies. Fusion of light systems has $Q > 0$, and identifying hindrance requires challenging measurements, so studying slightly heavier cases allows a reliable extrapolation towards the lighter ones. Here, we present the results of recent fusion cross-section measurements for $^{12}\text{C} + ^{28}\text{Si}$, performed at the INFN-Laboratori Nazionali di Legnaro, with the ^{28}Si beams from the XTU Tandem accelerator. We have used the combined set-up of the gamma-array AGATA [3], and two 4" annular DSSD Si detectors to identify and count the fusion evaporation events by coincidences between the prompt gamma-rays and the light-charged particles (p, alpha) evaporated from the compound nucleus. We have used the particle identification method (PID) to distinguish proton and alpha evaporation channels.

Five energies have been measured from 50 to 29.5 MeV. These energy points complete and extend the excitation function previously obtained with the electrostatic deflector setup, which fixes the absolute cross-section scale.

The AGATA-particle coincidence method has allowed us to measure the fusion yields down to $\sigma \sim 100$ nb. The comparison to coupled-channel calculations indicates that the sub-barrier fusion cross-section enhancement is limited, and the hindrance phenomenon shows up at the lowest energies where the cross-sections approach the no-coupling limit. We note that the behaviour of the present system is quite similar to the one of the nearby case $^{12}\text{C} + ^{30}\text{Si}$ [4] measured some years ago, despite the different structure of the two silicon isotopes.

The final experimental results will be presented together with a systematic of several medium-light cases, paving the way to a better understanding of the slightly lighter astrophysical systems.

[1] C.L. Jiang et al., Eur. Phys. J. A57, 235 (2021)

[2] C.L. Jiang et al., Phys. Rev. Lett. 89, 052701 (2002)

[3] J.J. Valiente-Dobón et al., Nuc. Instr. Meth. A1049, 168040 (2023)

[4] G. Montagnoli et al., Phys. Rev. C 97, 024610 (2018)

Consent

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