Low-Energy Fusion of Magic Nuclei: the Case of $^{16}O+^{48}Ca$

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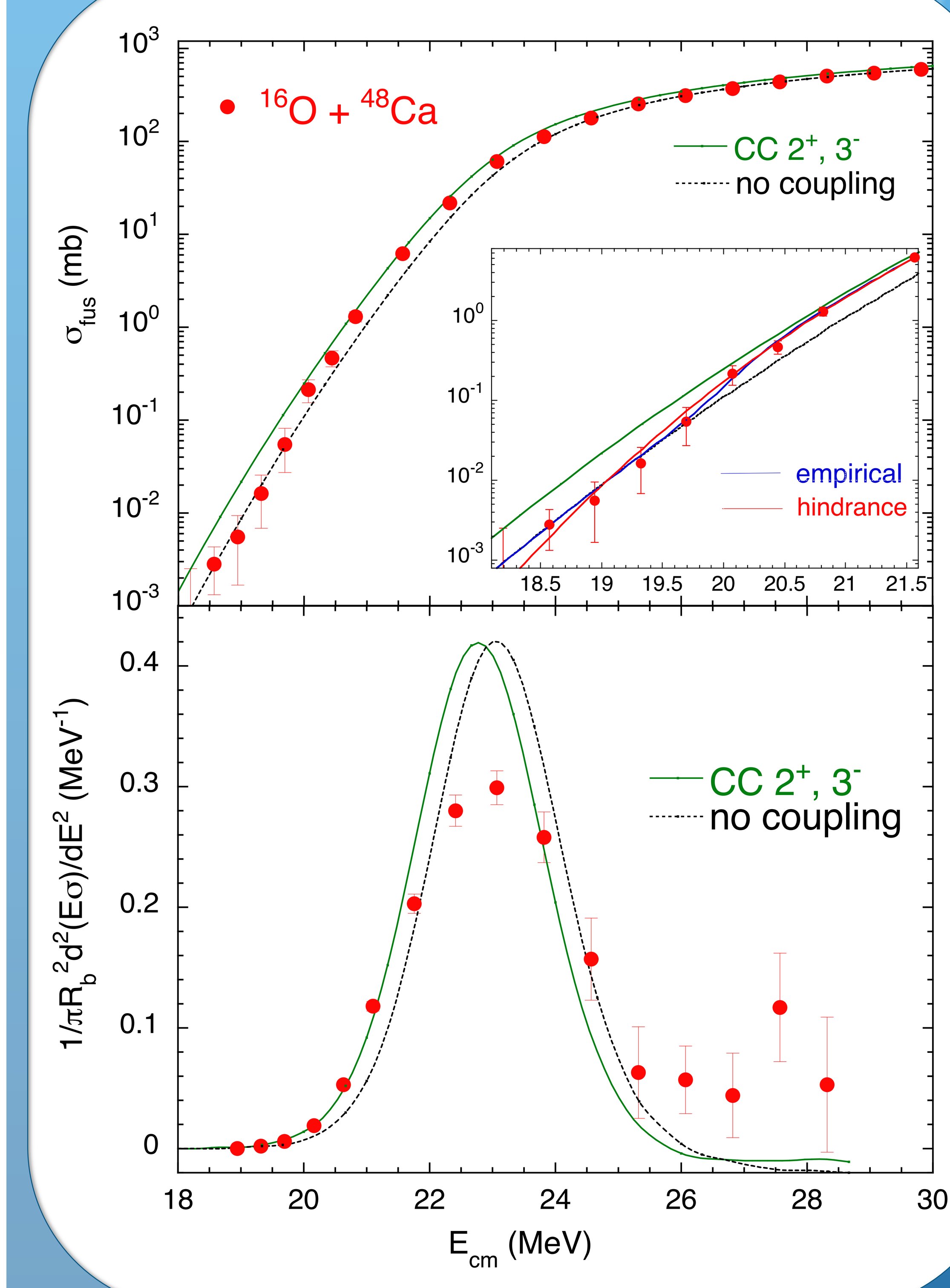
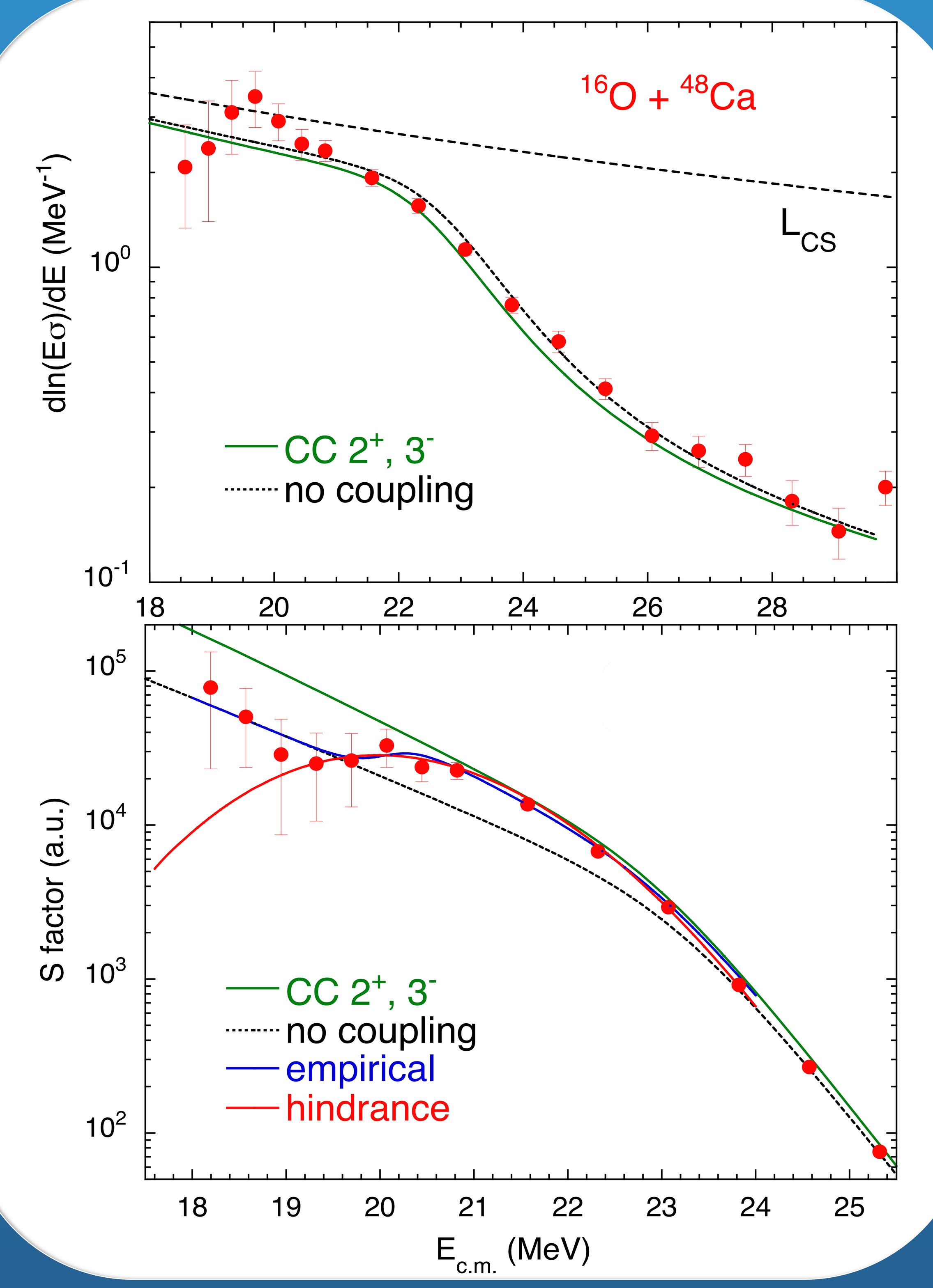
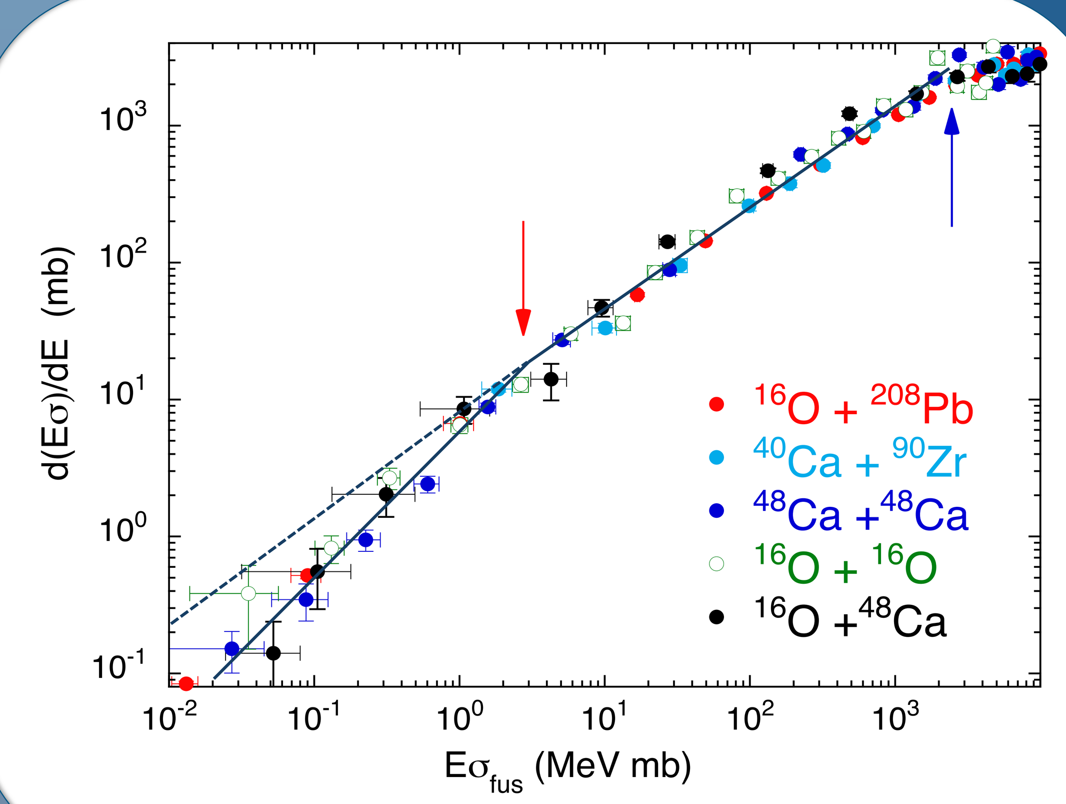


Motivated by the doubly magic nature of the system $^{16}O + ^{48}Ca$, we have measured [1] its fusion excitation function from above to far below the barrier at the Laboratori Nationali di Legnaro of INFN. We have used the ^{16}O beams from the XTU Tandem accelerator. The fusion cross sections were measured down to a few μb by identifying the evaporation residues in a detector telescope, downstream of an electrostatic beam deflector.

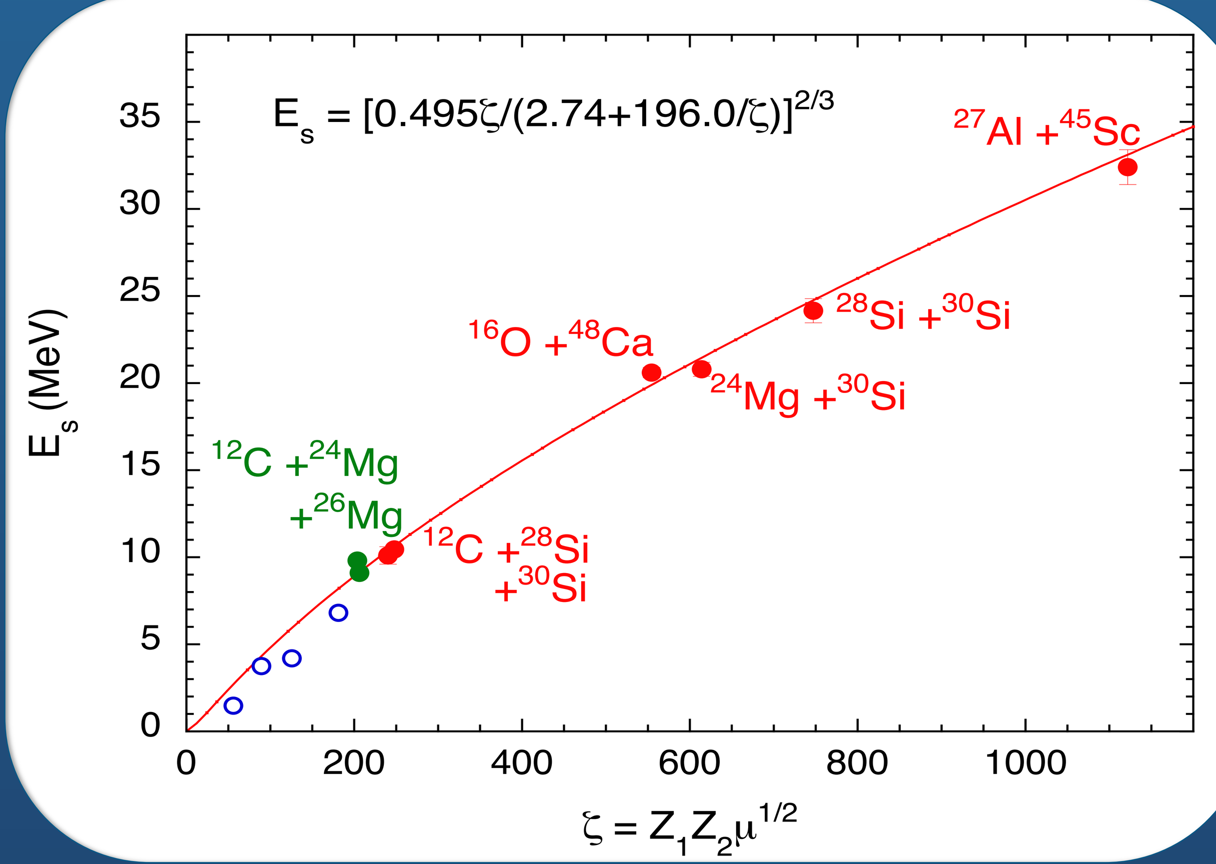
CC calculations with the Akyuz-Winther potential, including the lowest 2^+ and 3^- states of ^{48}Ca, well fit the data down to $\sigma_{fus} \approx 0.8$ mb. At lower energies, the hindrance effect shows up. The fusion barrier distribution shows a single main peak.



At lower energies, the data are consistent with pure one-dimensional tunnelling, as observed for $^{12}C + ^{24}Mg, ^{30}Si$ [2]. The logarithmic slope reaches the L_{CS} value, and the S factor develops a maximum vs energy. The low energy data are well fit by an empirical approach simulating the coupling strength damping (adiabatic model), while the hindrance model fits the S factor maximum but not its increase at the lowest energies.



Doubly-magic systems were previously investigated, and the present case $^{16}O + ^{48}Ca$ does not show significant differences when the various Coulomb barriers are considered. The Eσ-range between the red and blue arrows indicates the total width of the barrier distribution.



The phenomenological systematics proposed for heavier stiff systems several years ago [3], have required adjusting the fit parameters (see figure), leading to updated hindrance predictions for the light systems of astrophysical interest.

[1] A.M. Stefanini et al., to be published
[2] G. Montagnoli et al., J. Phys. G 49, 195101 (2022); Phys. Rev. C 97, 024610 (2018)
[3] C.L. Jiang et al., Phys. Rev. C 79, 044601 (2009)