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Disappearance of channel coupling effects in ^{12}C + ^{24}Mg fusion far below the barrier

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Evidence for fusion hindrance in ^{12}C + ^{24}Mg was suggested by a recent experiment where the excitation function was over-estimated by standard CC calculations, and a pronounced indication of an S factor maximum vs energy was observed [1].

This system is slightly heavier than those of astrophysical interest, like ^{12}C + ^{12}C and ^{16}O + ^{16}O. Further measurements on ^{12}C + ^{24}Mg have been performed in the present work, with the purpose of extending the excitation function to lower energies and adding intermediate energy points to better characterise its overall behaviour.

The present experiment has been performed using high-quality ^{24}Mg beams from the XTU Tandem accelerator of INFN - Laboratori Nazionali di Legnaro by directly detecting the fusion evaporation residues (ER) at very forward angles. We have

extended the excitation function down to around 4 μb, and the new data points confirm the presence of hindrance in ^{12}C + ^{24}Mg undoubtedly. The cross-section at the hindrance threshold is indeed found to be remarkably large, in agreement with the result of the previous measurement. The S-factor develops a clear maximum vs energy, that is nicely fitted using both an empirical interpolation in the spirit of the adiabatic model [2], and the hindrance parametrisation.

Coupled-channels calculations have been performed using the same Woods-Saxon potential of the previous paper. The new data far below the barrier may suggest that the coupling strengths gradually decrease and vanish so that the excitation

function seems to be well reproduced by simple one-dimensional tunnelling through the potential barrier in that energy range. On the other hand, the equally good fit obtained with the hindrance model [3] indicates that discriminating between the two

approaches would require further precise cross-section measurements at lower energies.

(please see figure in the attached pdf file)

FIG. 1: (left) Fusion excitation function of ^{12}C + ^{24}Mg measured in [1] (blue dots), and the new present data (red dots), compared to CC calculations (see text). (right) Astrophysical S-factor derived from the two data sets, compared to CC calculations and fitted according to the adiabatic and hindrance model [2, 3].

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