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Interplay of charge-clustering and weak binding in direct reactions of 8Li

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A critical problem affecting studies and uses of light weakly-bound nuclei is the suppression of above-barrier complete fusion (e.g. [1]). The cause of suppression is uncertain, particularly for exotic neutron-rich radioactive nuclei. The suppression is thought to be related to their low thresholds for breakup into charged clusters. The observation of fusion suppression in the neutron-rich radioactive nucleus 8Li [2] is therefore puzzling: breakup into 7Li+n has the lowest breakup threshold, and cannot contribute to fusion suppression as 7Li retains all the projectile charge, while breakup into charged particles has a much higher threshold. Studies of breakup in reactions of 6,7Li and 9Be show that transfer into unbound states of neighbouring nuclei ("transfer triggered breakup") forms a significant portion of the total breakup yield [3,4], but no such study has yet been performed for neutron-rich radioactive weakly bound nuclei.

Here we present the full characteristics of 8Li direct reactions in collisions with 209Bi, which were investigated at energies slightly above the coulomb barrier using the SOLEROO radioactive beam capability at the Australian National University. Through measuring coincidences and correlations between charged fragments, we show for the first time the diversity of breakup modes for the neutron rich radioactive isotope 8Li, and that the breakup occurs too slowly (> few 10^-21 s) to result in suppression via the commonly assumed mechanisms.

Our work conclusively demonstrates that the almost universally assumed mechanism for complete fusion suppression –fast charged-cluster breakup –is not correct in reactions of 8Li, and provides evidence that it is clustering in the ground-state that is the crucial factor in fusion suppression. This work identifies a new mechanism for fusion suppression that must be investigated, and motivates further studies of fusion suppression in neutron rich nuclei.

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