Resonances in transfer-triggered breakup reactions near the fusion barrier

E. C. Simpson, K. Cook, M. Dasgupta, S. Kalkal, D. H. Luong, I. P. Carter and D. J. Hinde

Department of Nuclear Physics, RSPE, ANU, Canberra, ACT 2601, Australia

Above barrier fusion of light, weakly-bound projectiles such as ^{7}Li is known to be suppressed. Single-barrier penetration model calculations, which accurately model fusion of strongly-bound projectiles such as ^{18}O, overestimate measured fusion cross sections for weakly bound ^{7}Li by 25% [1]. Breakup reactions occurring before the fusion barrier radius is reached is thought to significantly reduce the probability for fusion of the entire projectile. Indeed, the ^{7}Li ground state has a α-triton structure, with an α-t breakup threshold at just Q=-2.467 MeV; direct breakup should expected to be strong. However, non-elastic breakup modes have been found to be very important. In particular, pickup of a proton, leading to unbound ^{8}Be, is the dominant breakup mode in collisions with heavy targets such as ^{208}Pb and ^{209}Bi [2,3].

Understanding the detail of these breakup processes is crucial: only if breakup occurs when the projectile is approaching the target could the disintegration suppress fusion. Measurements made at the ANU Heavy Ion Accelerator Facility have revealed the important role that resonant states play, and highlighted a strong sensitivity to their structure in determining where breakup occurs. Long-lived states such as the ^{8}Be ground state survive until the ejectile is very far from the target, and so cannot suppress fusion. Short-lived states will decay much nearer the target, but even sub-zeptosecond ($<10^{-21}$ s) lifetimes may by be sufficient to alter where the projectile-like nucleus breaks up, and reduce the impact of breakup on fusion. Recent measurements of transfer-triggered disintegration reactions, their interpretation in terms of short-lived resonant states, and associated classical dynamical model simulations, will be discussed.

[1] Dasgupta *et al.*, Phys. Rev. C 70, 024606 (2004).
[2] Luong *et al.*, Phys. Lett. B 695, 105 (2011)
[3] Luong *et al.*, Phys. Rev. C 88, 034609 (2013).