LOCATIONS OF BREAKUP IN REACTIONS NEAR THE FUSION BARRIER

E. C. Simpson[1], K. J. Cook[1], M. Dasgupta[1], Sunil Kalkal[1], D. H. Luong[1], I. P. Carter[1] and D. J. Hinde[1]
[1]Department of Nuclear Physics, Research School of Physics and Engineering, The Australian National University, Canberra, ACT 2601 Australia

Above barrier fusion of light, weakly-bound projectiles (^{6,7}Li, ^{9}Be) with heavy targets is known to be suppressed by 25-35%, presenting a major challenge to our understanding of fusion. Direct breakup into cluster constituents (e.g., ^{6}Li = α+d) was thought to play a role in significantly reducing the probability for fusion of the entire projectile. Though breakup does occur, ANU experiments have shown that it is, in fact, predominantly triggered by nucleon transfer reactions. These produce unbound neighbouring nuclei such as ^{5}Li and ^{8}Be, which then disintegrate into clusters.

Understanding the detail of these processes is crucial to inferring their influence on fusion. In particular, breakup must occur prior to the reactants reaching their mutual barrier in order to suppress fusion. If narrow, long-lived resonances are populated (e.g., ^{6}Li 3^{+} $\tau \approx 3\times10^{-20}$ s, ^{8}Be 0+ $\tau \approx 10^{-16}$ s), the projectile-like nucleus will remain intact until it reaches the barrier, and so cannot suppress fusion. Short lived states (e.g., the ^{8}Be 2^{+}) disintegrate soon after production, but with $\sim10^{-21}$ s collision timescales, whether their disintegration is fast enough to influence fusion is not yet clear.

Here we discuss recent Australian National University measurements of sub-barrier breakup. At these energies fusion of the charged fragments is minimal, and the reaction can be analysed in detail. We interpret these results using a classical dynamical model that has been extended to account for the energies and lifetimes of resonant states, and discuss what the angular correlations of the fragments may reveal about the location of breakup.