INTERPLAY BETWEEN FUSION AND BREAKUP IN REACTIONS INVOLVING WEAKLY BOUND NUCLEI

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The study of the reaction dynamics involving weakly bound nuclei became one of the most intriguing and challenging problems in low energy Nuclear Physics. The cross section enhancement generally observed at sub-barrier energies is understood in terms of dynamical processes arising from couplings to collective inelastic excitations of the target and/or projectile [1]. However, in the case of reactions where at least one of the colliding nuclei has a sufficient low binding energy, the breakup becomes an important process. Some of the conflicting experimental and theoretical results recently reported in the literature were clarified [2-4]. However the interplay between fusion and breakup processes, which present different behavior depending on the energy regime, still present important opened questions. This question is of fundamental importance in astrophysical processes which occur mostly out from the valley of stability, and consequently involve unstable nuclei.

The investigation of the ^{6,7}Li + ^{12}C, ^{59}Co breakup processes (bu) is used to understand the influence of (bu) on the fusion cross section. These measurements help to establish the effect of the projectile breakup on the fusion process at near-barrier energies and contribute to the determination of how the mass of the target affects the process, as well as the influence of the incomplete fusion yield at energies above the barrier.

It is important to have a clear reference when an enhancement and/or a suppression is defined. In our case, the reaction cross section has been used. Experimental results are compared to prediction of Coupled Channel Calculations.

A final tuning for the coupling of the breakup channel, as well as the correct description of the reaction dynamics, requires the explicit measurement of precise elastic scattering data as well as yields leading to breakup.

The identification of the breakup products has been achieved measuring the three body final state correlations. Coincidence data are used to determine the process Q-value in order to gate exclusively on the projectile breakup channel. Furthermore, the system excitation energy as well as the projectile fragments relative energy are used to identify the exit channel with no ambiguity. Based on those filters, angular correlations are obtained to identify the several processes. This is complemented by measurements of relative energy of the fragments using different rest frame references (target, projectile, target + fragment) in order to disentangle the contribution of breakup, incomplete fusion and/or transfer-reemission process. These experimental results are compared to three body kinematics calculations.

Similar data were taken for ^{6,7}Li+^{115}In. This procedure in unfolding the several light particle emission processes has not been exploited so far in the literature.

References:

1) M. Dasgupta et al., Ann. Rev. Nucl. Part. Sci. 48(1998) 401 and references therein.
2) K. Hagino et al, Phys. Rev. C61, 037602 (2000) and references therein.
3) C. Beck et al., Phys. Rev. C 67 (2003) 54602.
4) A. Diaz Torres et al. Phys.Rev. C 68,44607 (2003).