INTRANUCLEAR CASCADE/EXPANDING-EMITTING SOURCE CALCULATIONS OF MULTIFRAGMENT EMISSION PROCESSES

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In order to account for multifragment emission processes in energetic nuclear collisions, a model is required that can describe both the reaction dynamics and subsequent disintegration of the resultant highly excited residues.

For light-ion-induced reactions at energies up to a few GeV per nucleon, intranuclear cascade (INC) calculations[1,2] provide a reasonable approximation to BUU[3] and similar codes. This is due to the very short collision time relative to that for evolution of the mean field. However, since significant excitation due to density compressions is unlikely with light-ion probes, an alternative rapid energy dissipation mechanism is required in order to form highly excited final states. Excitation of delta resonances in central collisions, followed by the subsequent rescattering and reabsorption of the decay pions, provides one such possibility–one that is contained in the INC codes.[1,2]

Coupling the reaction dynamics to an appropriate multifragment decay mechanism presents an additional challenge. Considerable success has been achieved with the expanding-emitting source (EES) model[4] in describing data from heavy-ion-induced reactions. Here we present results of a calculation in which the ISABEL INC code has been combined with the EES model for comparison with multifragment emission data from the ^{3}He + ^{nat}Ag reaction[5,6] at 0.90 and 3.6 GeV.

In Fig. 1 we show the ISABEL prediction for the excitation-energy distribution of residual heavy nuclei formed in the 3.6 GeV ^{3}He + ^{nat}Ag reaction. Two calculations have been performed—one which includes cross sections for delta formation and one in which this cross section is suppressed. The relative importance of the delta resonance is apparent in enhancing high excitation-energy events. For those events which deposit more than 50 MeV of excitation energy, inclusion of the delta produces an excitation energy distribution in which about 33% of the events have excitation energies greater than 500 MeV, the approximate threshold for multifragmentation.[4] Without delta formation, only 12% of the reaction cross section reaches 500 MeV or more.

In Fig. 2 we compare the combined INC-EES calculation with intermediate-mass fragment ($Z \geq 3$) multiplicities inferred from the data of Yennello, *et al.*[6] The solid line represents a calculation with delta formation included in the INC and the EES model with an equation of state with K=144. The data have been normalized to multiplicity M=2, which gives a reaction cross section, σ_R=1900 mb, consistent with the expected value. The dotted line in Fig. 2 shows the result for the INC-EES calculation without delta formation cross sections. This calculation severely underpredicts the data for large multiplicities and overpredicts the M=1 yields. Calculations which include the delta, but use larger values of K (which reduces the expansion rate) give similarly poor fits to the data.

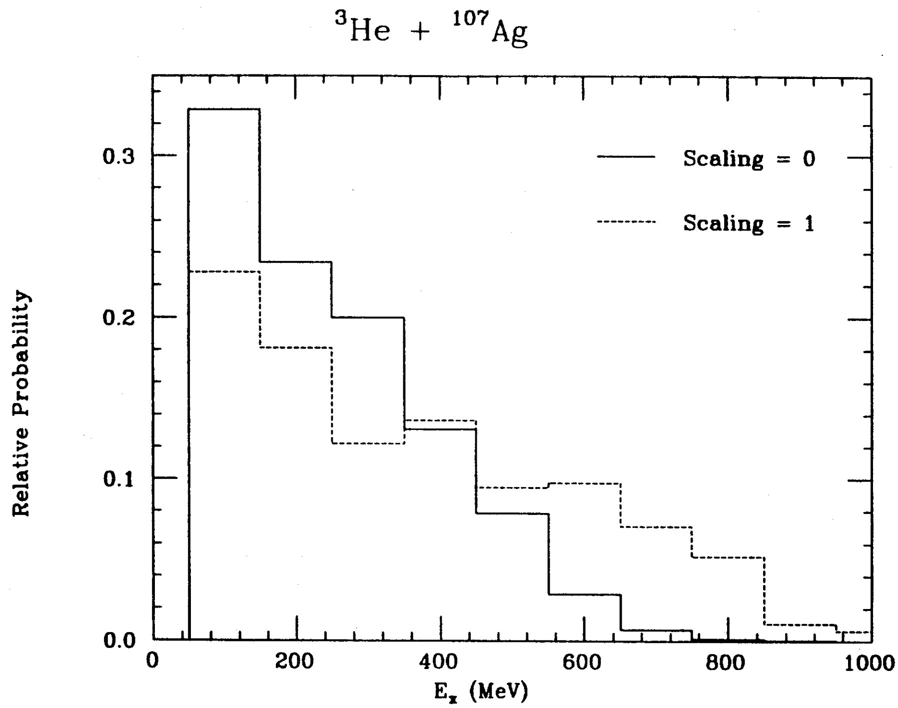

Figure 1. Excitation energy distribution for collisions of 3.6 GeV ^{3}He ions with ^{nat}Ag. Dashed line includes delta formation cross sections, as included in the INC code.[1] Solid line is the result when delta formation is suppressed.

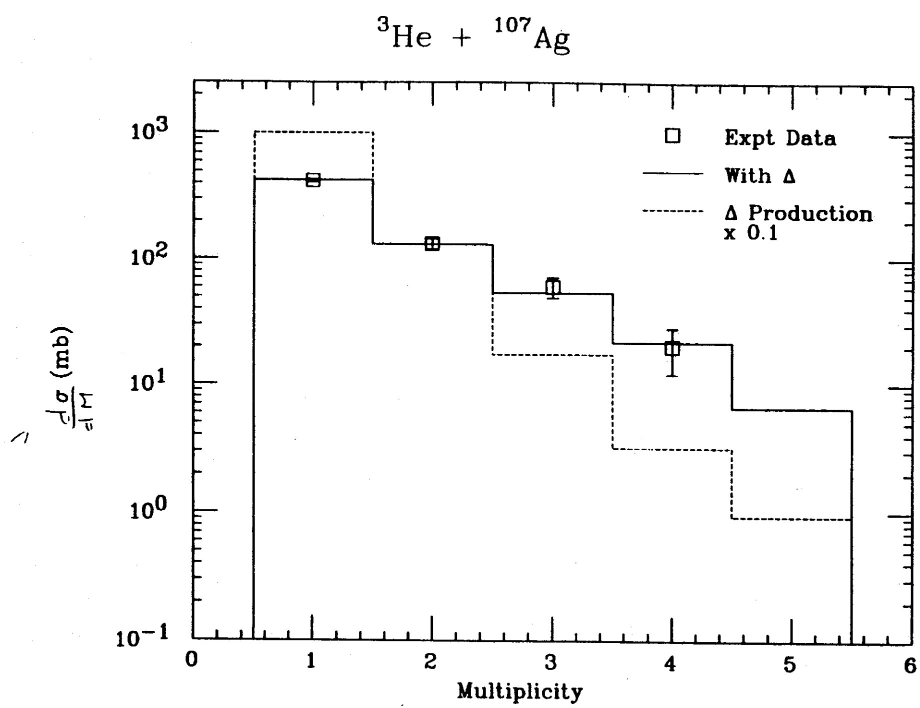

Figure 2. Comparison of INC-EES calculation with multiplicity data of Ref. 6. Solid line includes deltas; dashed line does not, as described in text.

An additional benefit of the EES model is the ability to predict fragment spectra. For the ^{3}He + ^{nat}Ag system, the calculation gives a good qualitative description of the observed spectra.[5,6]

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