ENERGY DISSIPATION AND MULTIFRAGMENT DECAY IN LIGHT-ION-INDUCED REACTIONS

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Multifragment emission data from the ^{3}He + Ag reaction at 3.6 GeV (Ref. 1) have been examined in the framework of a hybrid model that treats the reaction dynamics in terms of an intranuclear cascade calculation,[2] followed by decay from an expanding, emitting source.[3]

The INC calculations demonstrate that the average excitation of the excited residues formed in central collisions increases rapidly with bombarding energy; for more peripheral collisions this increase is much more gradual. The important role of the Δ resonance in producing highly excited residues is illustrated by the calculations. This mechanism provides a rapid, efficient means of energy dissipation that would appear to be essential in forming the highly excited species required for multifragmentation in light-ion-induced reactions. The results suggest that multifragmentation studies, when complemented by pion emission probabilities, may provide valuable insight into the question of pion reabsorption in the nuclear medium.[4] The INC calculations also show that $p_{\|}$ and $p_{\perp}$ are comparable for excitation energies above about 500 MeV; these calculated values are in good agreement with source velocities derived from a rapidity analysis of the spectra for high multiplicity events in the ^{3}He + Ag system.

Fits to the 3.6-GeV ^{3}He + Ag multiplicity data with the combined INC/EES model require a relatively soft equation of state (K = 144). This value also described the charge distribution data best. Calculations with stiffer equations of state or without Δ excitations in the cascade severely underpredict the high mulitplicity data; in fact, the calculations are quite sensitive to all parameters. In order to describe the data with a stiffer equation of state, the probability for Δ excitation and/or pion absorption in the INC code would need to be increased significantly in order to enhance the probability for high excitation energy residues. The importance of employing a realistic excitation energy distribution in multifragmentation calculations is also stressed by this work. If the EES calculations are performed with the average INC excitation energy instead of the full distribution, the data are significantly underpredicted. Comparison of the INC/EES calculations with experimental kinetic energy spectra accounts for the major features of the data as shown in Fig. 1. The calculations successfully predict changes in IMF spectral shapes for bombarding energies below and above about 1 GeV, i.e., broadening of the Coulomb peaks toward lower energies and flattening of the spectral tails at high projectile energies, as observed in the data.[1] In the context of the EES model, this behavior is explained in terms of energetic IMFs being emitted early in the expansion, where the expansion velocity is large, and low energy IMFs being emitted from nuclear matter at low density. While the quantitative agreement with the spectra is not perfect, the qualitative features of the data are successfully described.

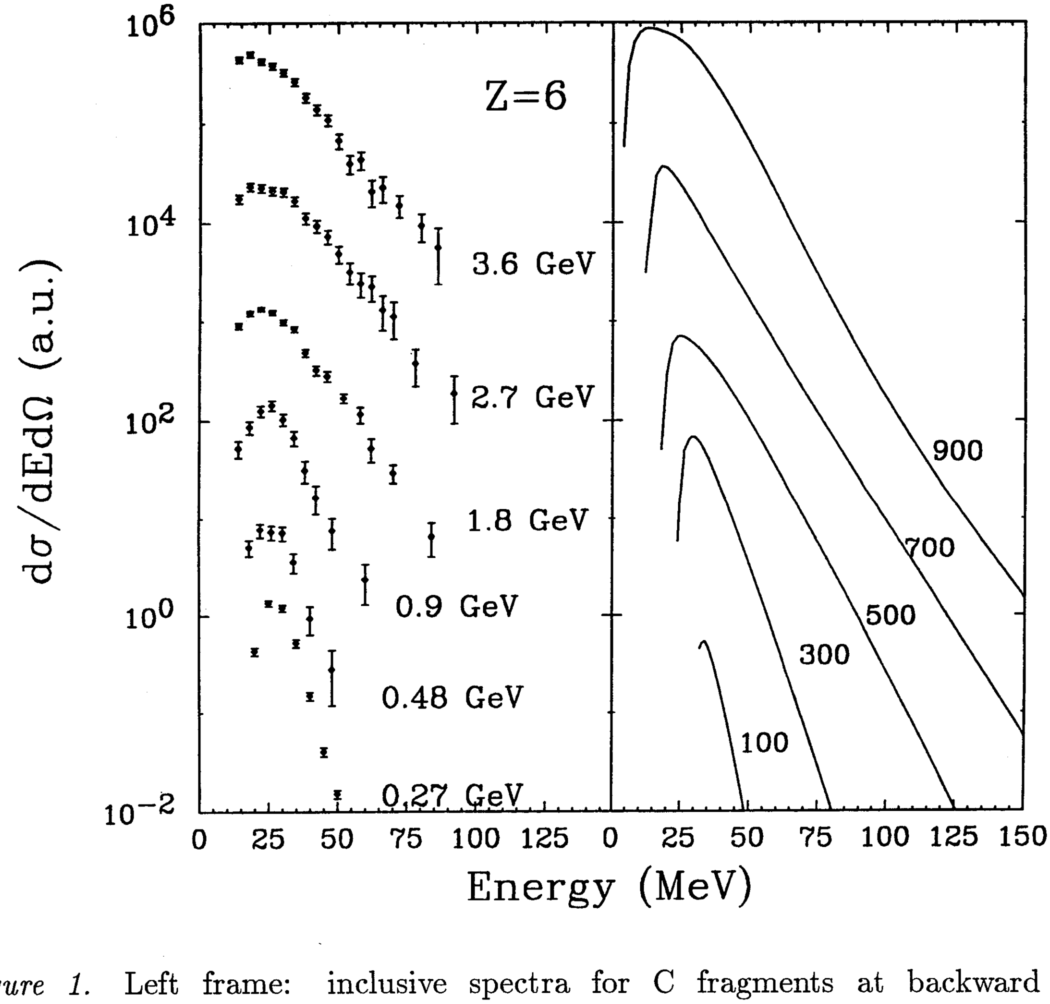

Figure 1. Left frame: inclusive spectra for C fragments at backward angles for $^{3}He+^{nat}Ag$ reaction (Ref. 1) as several bombarding energies. Right frame: Spectral shapes predicted by EES model for emission of Z=6 fragments at 117° for several residue excitation energies, as indicated on figure.

It is also of interest to compare the charge distributions predicted by the INC/EES model with the experimental data. In Fig. 2, we present such a comparison with a calculation which employs the standard (with Δ) INC code with the EES model for various values of the compressibility parameter K. The calculation is quite sensitive to the value of K; a value of K = 144 gives the best fit to the data. Thus, the results for the charge distributions are self-consistent with other observables.

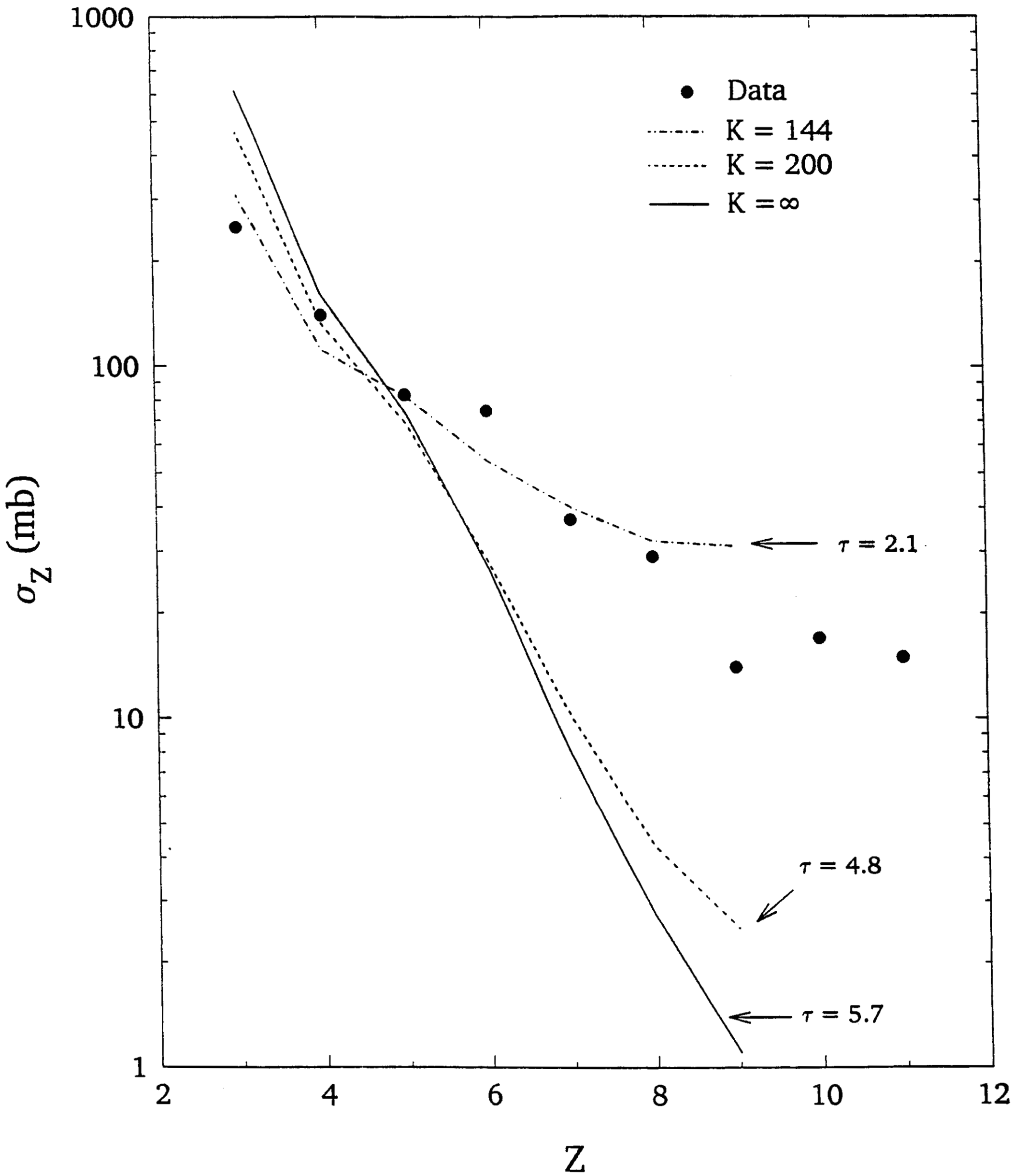

Figure 2. Experimental inclusive charge distribution for 3.6-GeV $^{3}He+^{nat}Ag$ reaction (points) compared with predictions of INC/EES model for K=144, K=200 and K=∞.

These INC-EES calculations provide a physically transparent framework for understanding the basic features of light-ion-induced multifragmentation reactions. The fundamental roles of inelastic N-N scattering and expansion of the nuclear medium are essential in confrontation of this model with the data.

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4. J. Cugnon and M.C. Lemaire, Nucl. Phys. A **489**, 781 (1988).