MASS DISTRIBUTIONS OF INTERMEDIATE-MASS FRAGMENTS IN LIGHT-ION-INDUCED REACTIONS

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Discrete nuclide distributions have been measured for intermediate-mass fragments produced in the reaction of 270-MeV ^{3}He ions with ^{nat}Ag and ^{197}Au targets. Fragments were detected with a time-of-flight telescope consisting of channel-plate fast-timing detectors for start and stop signals. Particle Z identification was accomplished with a gridded gas ionization chamber ΔE element and a 300 μm silicon surface barrier E element. These were backed up by a 5 mm lithium-drifted silicon detector for detection of energetic light ions.

In Fig. 1 the energy spectrum for ^{12}C fragments observed at a laboratory angle of 10 deg is shown. The fragment energy spectra exhibit a Maxwellian-like distribution which extends out to energies of 180 MeV. The maximum energies correspond to a momentum approximately 1.6 times that of the incoming beam, or nearly twice the momentum expected for Coulomb accel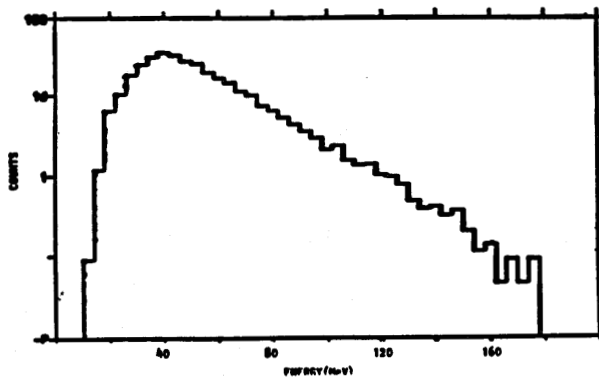eration. The most probable emission energy, however, is consistent with values expected on the basis of a simple touching-spheres model. Based on earlier studies on this system at 200 MeV, it has been argued[1] that both equilibrium and non-equilibrium sources contribute to these yields. Using procedures described in Ref. 1, apparent temperatures have been derived for the non-equilibrium component as a function of Z. These are plotted in Fig. 2 for both the 200-and 270-MeV ^{3}He + ^{nat}Ag data, showing a rather constant value of kT $\cong$ 8 MeV for the IMFs. This analysis also gives a value for the source velocity of $\beta \approx 0.75\beta_{CN}$ for the equilibrium components and $\beta \approx 3\beta_{CN}$ for the non-equilibrium fragments.

In Fig. 3, spectra obtained for Be fragments at 20 deg. and 160 deg. are compared for ^{nat}Ag and ^{197}Au targets. These data demonstrate the importance of target N/Z ratio (N/Z = 1.34 for Ag and 1.49 for Au) on

Figure 1. Energy spectrum observed for ^{12}C fragments emitted in the reaction of 270-MeV ^{3}He ions with ^{nat}Ag at 10 deg. in the laboratory system.
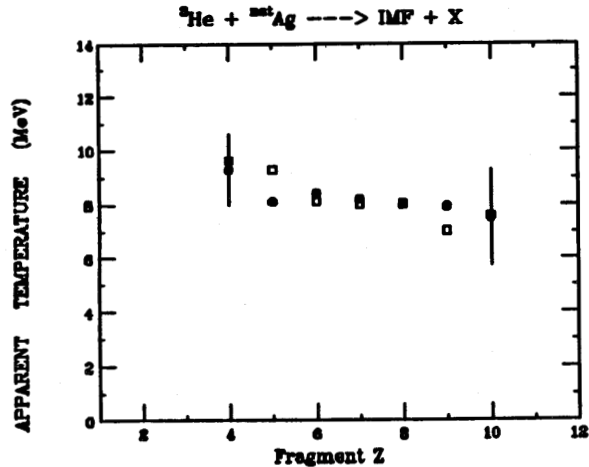

Figure 2. Apparent temperatures for the non-equilibrium component of IMFs produced in the reaction of 200- (squares) and 270-MeV ^{3}He with ^{nat}Ag as a function of fragment atomic number.
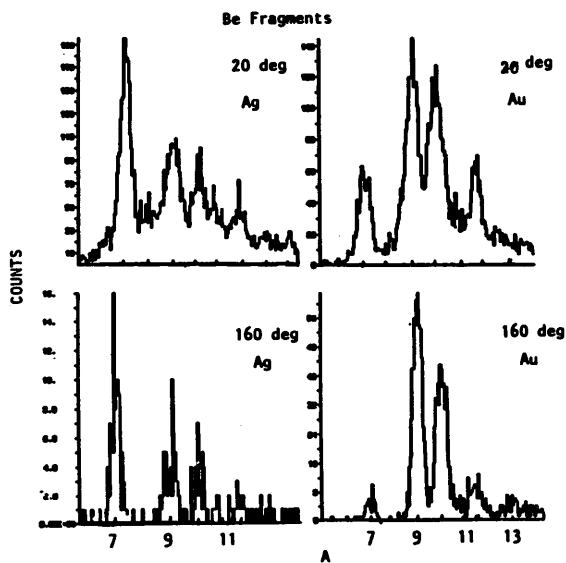
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the observed IMF isotropic ratios. Most evident is the change in the ^{7}Be/^{9}Be ratio for these two systems. On the other hand, the isotopic yields do not seem to depend strongly on angle. The energy spectra do, however, appear to depend on neutron number, as shown in Fig. 4 for ^{12}C, ^{14}C and ^{16}C fragments observed at 20 deg. with the Au target. These data suggest an evolution from Maxwellian to Gaussian with increasing neutron number, i.e. an increasingly steep slope is observed as a function of mass number.

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1) K. Kwiatkowski et al., Phys. Lett. B171 41 (1986).

Figure 3. Mass distributions for Be fragments emitted at 20 deg. and 160 deg. for 270-MeV ^{3}He incident on ^{nat}Ag and Au.
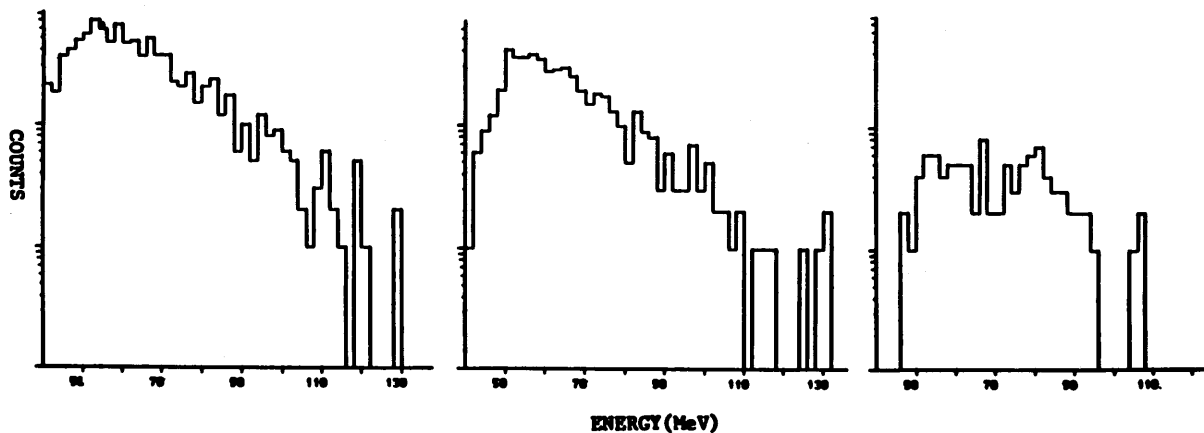

Figure 4. Energy spectra for carbon fragments observed at 20 deg. for the reaction of 270-MeV ^{3}He and ^{197}Au.