GLOBAL STUDIES OF THE MASS, ENERGY AND ANGULAR DISTRIBUTIONS IN THE 200 MeV ^{4}He + ^{28}Si REACTION

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Energy and angular distributions have been measured for the 117.3 MeV and 198.5 MeV α + ^{28}Si systems. Cross sections for all fragments from A = 6 to A = 29 were determined using the time-of-flight technique at the Indiana University Cyclotron Facility. The mass resolution ranged from 0.4 mass units for the lighter fragments to about 0.8 mass units for A ⩾ 25; the total energy spectrum was measured down to ~1 MeV.

Energy spectra at both 117.3 MeV and 198.5 MeV are characterized by a broad peak at low energies followed by an exponential tail which becomes systematically steeper as a function of both increasing angle and fragment mass. Similar behavior is observed in reactions of ^{4}He with ^{12}C at 160 MeV and protons with ^{27}Al at 180 MeV.[1,2] The angular distributions are all forward-peaked and become increasingly more forward-peaked as the mass increases (Fig. 2). This feature is again observed in α + ^{12}C reactions. In contrast, the heavier fragments from the p + ^{27}Al reaction at 180 MeV show a two-component type of angular distribution, one associated with fusion-like products and a second with peripheral recoils.

The total isobaric cross sections at both energies are rather similar in shape (Fig. 3) and exhibit maximum yields for A ≈ 24. All the α-nuclei yields are substantially enhanced, presumably due to nuclear binding energy effects. Some preliminary calculations have been performed based on the intranuclear cascade (INC) model, using the code CLUST[3] which is a modified version of VEGAS.[4] The predicted angular distributions are small at 0° and peak around 30°. One possible explanation for the low calculated cross sections at 0°

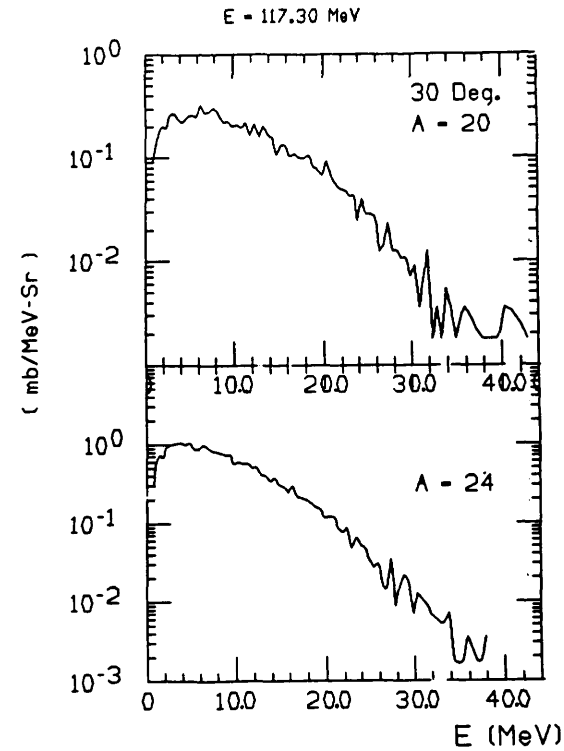

Figure 1. Energy spectra of A = 20 and 24 products from the reaction of 117.3 MeV ^{4}He ions with ^{28}Si, observed at an angle of 30 degrees.

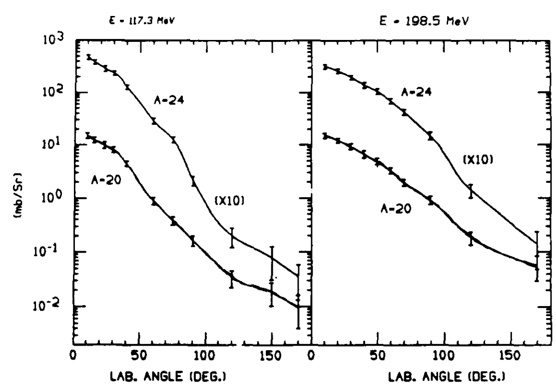

Figure 2. Angular distributions for A = 20 and 24 fragments from the reaction of 117.3 and 198.5 MeV ^{4}He with ^{28}Si. Dotted lines represent results of an intranuclear cascade code calculation.

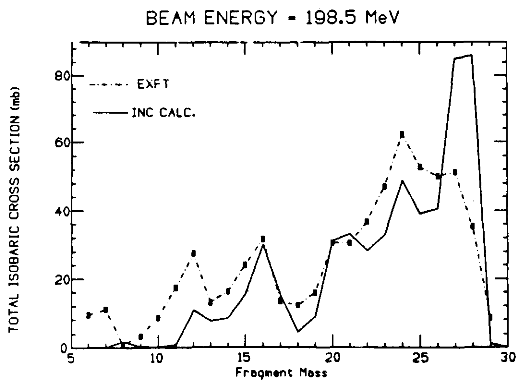

Figure 3. Isobaric yields for various reaction products from 117 MeV (dashed line) ^{4}He ions with ^{28}Si. Solid curve is the result of an intranuclear cascade calculation.

is that the cascade model suppresses large linear momentum transfers to the target-like residual nuclei. The qualitative agreement at the intermediate angles suggests that the model is more successful in predicting peripheral processes.

The INC model overpredicts the dominance of (α,α') and (α,2p2n) types of reactions, whereas experimentally we observe the major yield to occur for reactions which result in the removal of 4 mass units from the target. The underprediction of the isobaric cross-sections becomes more severe for the lighter masses. If we assume that energy deposition is proportional to the number of nucleons removed, the INC model is underpredicting the energy deposited by the projectile by a signficiant amount.

1) A. Gokmen et al., Phys. Rev. C 29, 1595 (1984).

2) K. Kwiatkowski et al., Phys. Lett. 50, 1648 (1983).

3) G.J. Mathews et al., Phys. Rev. C 25, 2181 (1982).

4) K. Chen et al., Phys. Rev. 166, 949 (1963).