

RELATIVE STRENGTHS OF EQUILIBRATED AND NON-EQUILIBRATED
SOURCES OF IMFs IN $E/A = 20\text{--}50$ MeV ^{14}N -INDUCED REACTIONS

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Excitation functions were measured for the $^{14}\text{N}+\text{Ag}$ and $^{14}\text{N}+\text{Au}$ systems at the National Superconducting Cyclotron Laboratory at Michigan State University using ^{14}N beams of $E/A = 20, 30, 40$ and 50 MeV.

In Fig. 1 representative angular distributions for $Z=8$ fragments provide an indication of the relative importance of equilibrated and non-equilibrated emission mechanisms in these reactions. At all bombarding energies a strong enhancement of the fragment yields is observed at forward angles. This pre-compound-like component grows in importance with increasing projectile energy. In contrast, the backward-angle data ($\theta \geq 90^\circ$) exhibit a behavior reminiscent of fission following complete fusion at $E/A = 20$ MeV; for the gold target this effect is even more pronounced. Previous coincidence studies of the $E/A=35$ MeV $^{14}\text{N} + ^{232}\text{Th}$ reaction have demonstrated that these backward-emitted fragments originate from a source which possesses nearly the entire momentum of the beam.¹

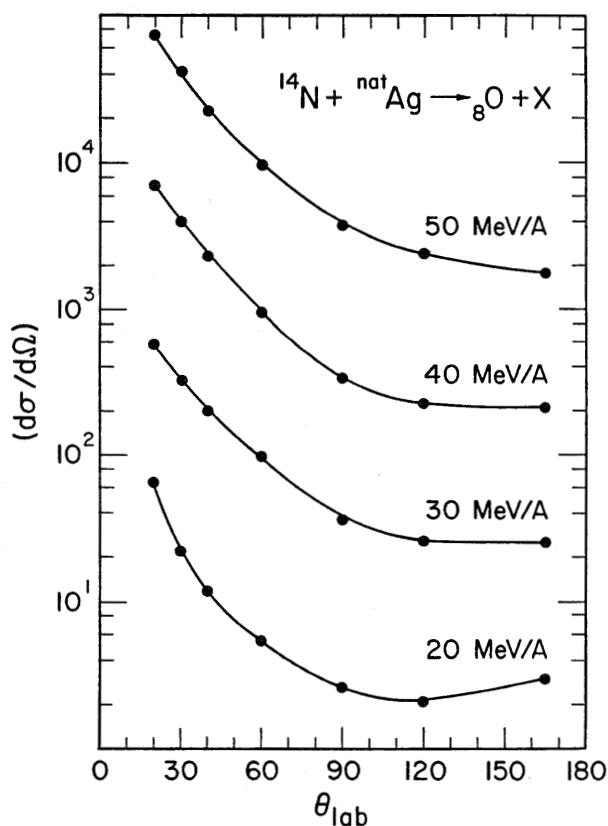


Figure 1. Angular distributions for $Z=8$ fragments as a function of projectile E/A .

Figure 2. Ratio of equilibrated to total IMF yields as a function of projectile E/A.

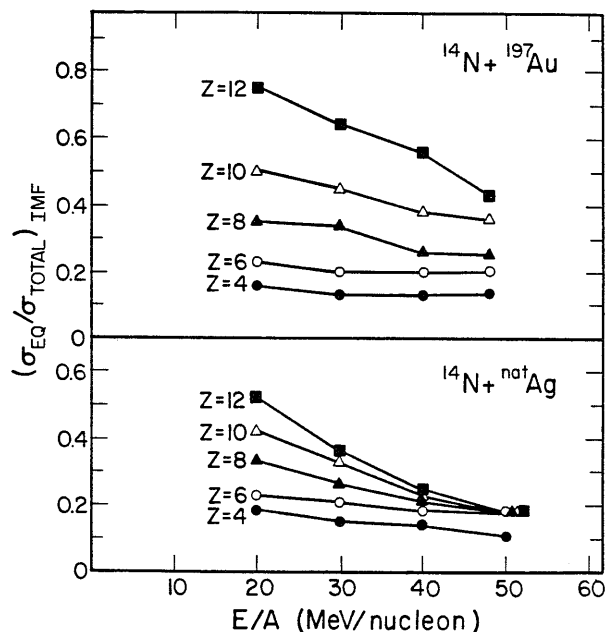


Fig. 2 presents results of a decomposition of these angular distributions into (1) an equilibrated component (σ_{eq}) based on the backward-angle data and (2) a non-equilibrated (σ_{neq}) source as implied by the forward-angle data. The basic assumptions of this decomposition are: 1) the differential cross sections at $\theta \geq 120^\circ$ in the center-of-mass system arise only from a fully equilibrated source which follows a $1/\sin\theta$ angular distribution and 2) the remainder of the cross section ($\sigma_{total} - \sigma_{eq}$) arises from non-equilibrium mechanisms. It is apparent in Fig. 2. that the equilibrated component decreases in importance at higher bombarding energies and for lighter ejectiles. Nonetheless, some equilibrated species persist, even at the highest energies.

The relative importance of equilibrated/non-equilibrated emission mechanisms depends upon the mass of both the target and ejectile. For light ejectiles ($Z=4,6$), the ratio of $\sigma_{eq}/\sigma_{total}$ varies only weakly as a function of target mass (as well as projectile energy). In contrast, for heavier fragments ($Z \geq 8$), the fraction of equilibrated emission increases strongly as a function of fragment Z . Significantly larger ratios are also observed for the gold target relative to silver, implying a greater probability for thermalization of the projectile energy with the heavier nucleus. While the relative strength of equilibrated to non-equilibrated sources changes rapidly with bombarding energy, the excitation functions for IMF emission show only moderate increases in cross section between $E/A=30$ and 50 MeV. In addition, the slope "temperatures" for all spectra remain essentially constant over this same energy regime.

In conclusion, these data demonstrate that in the energy region between $E/A=20$ and 50 MeV there is a distinct transition in the reaction mechanism which produces IMFs. Non-equilibrated processes, relative to those which are fully equilibrated, are shown to become increasingly dominant as a function of projectile energy.

1. M. Fatyga et al., Phys. Rev. Lett. **58**, 2527 (1987).