NONEQUILIBRIUM SLOPE TEMPERATURES FOR IMF EMISSION IN THE E/A = 20–100 MeV $^{14}$N + $^{197}$Au REACTION

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Nonequilibrium slope parameters, $T_{NEQ}$, have been measured for intermediate mass fragments formed in the $^{14}$N + $^{197}$Au reaction at energies between E/A = 20 and 100 MeV. The values of $T_{NEQ}$ are found to be essentially independent of IMF atomic number and bombarding energy above E/A = 30 MeV [Fig 1 (top)]. For natAg targets, all values are consistent with $T_{NEQ} \approx 20$ MeV (except at E/A = 20 MeV, where nonequilibrium yields are poorly defined). Similar results have been observed by Trockel et al., for $^{16}$O-induced reactions. Similarly, a bombarding-energy independence has been reported for the slope parameters associated with pion spectra from heavy-ion-induced reactions in the energy range E/A $\approx 30–100$ MeV, where values of $T_{\pi} \approx 20 – 22$ MeV are found. In contrast, a distinct dependence of $T_{NEQ}$ on bombarding energy over this same energy range has been reported in Ref. 3 for light charged particles (LCP) and intermediate mass fragments (IMF) emitted in E/A = 42–151 MeV Ne- and Ar-induced reactions on $^{197}$Au. The fitting procedure in Ref. 3 employed a single isotropic emission source and the detector configuration emphasized forward-angle IMF emission with detector thresholds of E/A $\approx 3.5$ MeV. To illustrate the sensitivity of $T_{NEQ}$ on the IMF component to the completeness of the data set, Fig. 1 (bottom) shows values of $T_{NEQ}$ for fits to our data performed over the angular range $30^\circ \leq \theta \leq 130^\circ$ with detector thresholds for IMF’s of E/A = 4 MeV, identical to those in the measurements of Ref. 3. Here one observes a systematic increase in $T_{NEQ}$ with bombarding energy, in contrast to the energy-independent values of $T_{NEQ}$ derived from the full data set. These results emphasize that extracted nonequilibrium temperature parameters are dependent upon the experimental conditions under which the data were obtained. Data taken over a limited angular range or with thresholds well above Coulomb energy do not adequately account for equilibrium emission and thereby produce anomalous values of $T_{NEQ}$.

Figure 1. Values of $T_{NEQ}$ for $Z = 8$ fragments from the $^{14}N + ^{197}Au$ reaction as a function of bombarding energy. Top: fit results for angle $20^\circ \leq \Theta \leq 160^\circ$ and detector threshold of 8 MeV; bottom: fit results for same parameterization, but $30^\circ \leq \Theta \leq 130^\circ$ and detector threshold of 64 MeV.