COMMENTS

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Comment on "Fragmentation of gold projectiles with energies of 200-980 MeV/nucleon. I. Experimental method, charge yields, and transverse momenta"

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Data for the fragmentation of high energy gold projectiles were recently analyzed by Dreute *et al.* with the assumption that the average A/Z ratio of the residues was equal to that of the projectile. The momenta of the projectile fragments from this analysis were dramatically larger than expected. We point out that the assumption of a constant A/Z is inconsistent with a large body of data and leads to an overestimation of both the fragment mass and the momentum distribution. A better description of the variation of the residue A/Z ratio can be found in the prescription developed by Sümmerer *et al.* based on a broad range of data.

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Dreute and co-workers recently reported the surprising result that projectile fragments from the reaction of ^{197}Au ions ($E/A = 200-980$ MeV) in plastic track detectors have significantly larger transverse momenta than both model predictions and extrapolations of measurements of light-ion fragments [1]. In addition, their results indicated different magnitudes for the transverse momentum distributions of light and heavy fragments. In the present discussion we will concentrate on the results for the heavy residues. Importantly, the particles were identified by measuring the energy loss in a plastic track detector and only the nuclear charge Z of the fragment was determined. Some assumption was needed to relate the mass number to the nuclear charge in order to calculate the linear momenta of the fragments; the authors chose to scale the measured Z values by the mass-to-charge ratio of the projectile. While this is the simplest assumption, it also gives the largest fragment mass values and hence the largest momenta. Such an assumption was previously used by Brady *et al.* to analyze another set of projectile fragments identified only by Z from ^{139}La induced reaction ($E/A = 1.2$ GeV). This also gave unexpectedly large transverse momenta [2].

The fragmentation of target and projectile nuclei in peripheral relativistic heavy-ion reactions takes place via a single reaction mechanism. Studies of the target and projectile products have proceeded along somewhat different lines due to differences in experimental techniques needed to observe the residues but the bulk of the data and derived kinematic quantities have been shown to be consistent [3]. The linear momentum distributions of both projectile and target residues have been found to be Gaussian shaped with a low energy tail. The centroid of the distribution lies near the initial projectile (or target) momentum with a small downshift (or upshift) that depends linearly on the observed mass loss. The widths of the momentum distributions are larger than the mag-

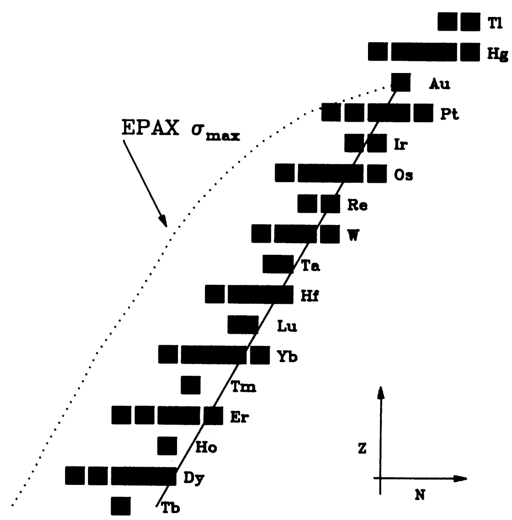

FIG. 1. Segrè diagram with the predicted variation of the centroid of the isotopic cross section in the near-projectile reigon. Stable nuclei are identified by solid squares, nuclei with $A/Z = 197/79$ lie along the solid line, and the most probable nuclei in the empirical parametrization [7] lie along the dotted curve.

nitudes of the shifts and depend approximately linearly on the square root of the observed mass loss. It has been shown some time ago that this functional form comes directly from momentum conservation in a variety of models [4,3]. Thus, it is indeed surprising that the first momentum measured "directly" for very heavy projectiles would deviate from the predictions and other indirect measurements.

Recent measurements of "completely identified" projectile residues from the reaction of ^{86}Kr ions at $E/A=200$ MeV have normal momentum distributions [5]. Moreover, the projectile-residue cross sections clearly show that the maximum value of the isotopic distribution does not coincide with $A/Z=86/36$. The observed products are more neutron deficient than the beam, as expected for decay products from excited heavy nuclei, because the emission of protons is suppressed relative to neutrons by the Coulomb barrier. The average A/Z ratio of residues from very light ions, e.g., ^{12}C and ^{16}O, does remain equal to that of the beam [6]. This observation should not be taken as evidence of a general phenomenon but rather a reflection of the special situation in which proton and neutron emission can compete almost equally.

The cross sections from the krypton induced reaction are in good agreement with the predictions of an internuclear cascade code [5] and are also in agreement with the systematic variation of both projectile and target fragment cross sections as parametrized by Sümmerer *et al.* in the EPAX formula [7]. Figure 1 indicates the difference between the assumption that fragments from the gold beam will have an average $A/Z=197/79$ (solid line) and the most probable A/Z ratio from the empirical systematics (dotted curve). The difference between the two curves grows to 12 neutrons after $\Delta Z=5$. The EPAX prediction remains on the neutron-deficient side of the line of stability for lighter products, so the difference remains large.

It is beyond the scope of this Comment to reanalyze the data presented by Dreute *et al.* However, it should be noted that the comparison of the widths of the extracted momenta of previous results and models relies on the assumed mass of the fragment twice. Consider the $M=1$ products in Fig. 9 from Ref. [1]; if the calculated mass number and momentum of the fragment are systematically smaller, then the new results would move on both coordinates of the figure towards the predictions. The extent of the change can only be determined by careful reanalysis.

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