

Particle evaporation following multinucleon transfer processes with radioactive beams

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(Received 8 May 1995)

The possibility of creating exotic nuclei by means of multinucleon transfer processes in reactions with radioactive beams has been explored. In this paper we estimate the magnitude of the modifications in the population patterns for the different mass partitions that take place as the newly formed systems get rid of their excitation energy by particle emission.

PACS number(s): 25.60.+v

In a recent publication [1] the possibility of creating exotic nuclei by means of multinucleon transfer processes in a reaction with radioactive beams was explored. Specifically, concrete estimates for the production rates of the heaviest isotopes of selected elements were given. It was pointed out in Ref. [1] that considerable excitation energy is associated with the formation of nucleides that are far removed from the original target in the NZ plane. Therefore, an appreciable modification of the primal formation rates could result before the novel systems have a chance to get to a detector.

We provide here information to judge the magnitude of these effects. To this end, attention is focused on the distribution of excitation energies predicted by the formalism of Ref. [2]. Here two aspects are specially noteworthy. On the one hand, the transfer of nucleons is naturally inhibited whenever the final state of a transition enters in conflict with the binding energy of the corresponding systems. Besides, the cross sections for those systems that are actually produced are corrected to account for the changes in mass-partition that take place as the hot nucleides get rid of their excitation energy by particle emission. We assume for simplicity that neutron evaporation is the predominant channel and follow the redistribution of population over the NZ plane for all events where the excitation level of a reaction product exceeds its neutron separation energy. Because of the extent of the excursions on the NZ plane it is necessary to supplement the experimental mass tables [3] with theoretical calculations such as those of Möller *et al.* [4].

Figure 1 displays what is obtained for the production of polonium and mercury isotopes in the reactions $^{118,136,154}\text{Xe} + ^{208}\text{Pb}$, i.e., the same case investigated in Ref. [1]. The dashed curves—which incorporate the above corrections—get gradually shifted towards the left as the projectile moves away from the stability line and more exotic systems can be reached. The exponential tails covering the heaviest isotopes are quite similar to those of the full-drawn curves reported in [1]. Thus, the parameter that measures the loss of cross section for each additional isotope is not significantly affected. Insofar as absolute values are concerned, however, to maintain the same magnitude of the cross sections requires a shift towards the lighter isotopes of about $\Delta N \approx 5-10$.

We conclude by pointing out that the redistribution of cross sections due to particle evaporation are largest for combinations of heavy projectiles and targets (such as those used

to illustrate the effect in Fig. 1). Reactions like $\text{Ca} + \text{Pb}$ or $\text{Ca} + \text{Sn}$ used in Ref. [1] involve smaller shifts.

This work was supported in part by the Danish Natural Science Research Council and the EU program ERBCHRX-CT92-0075.

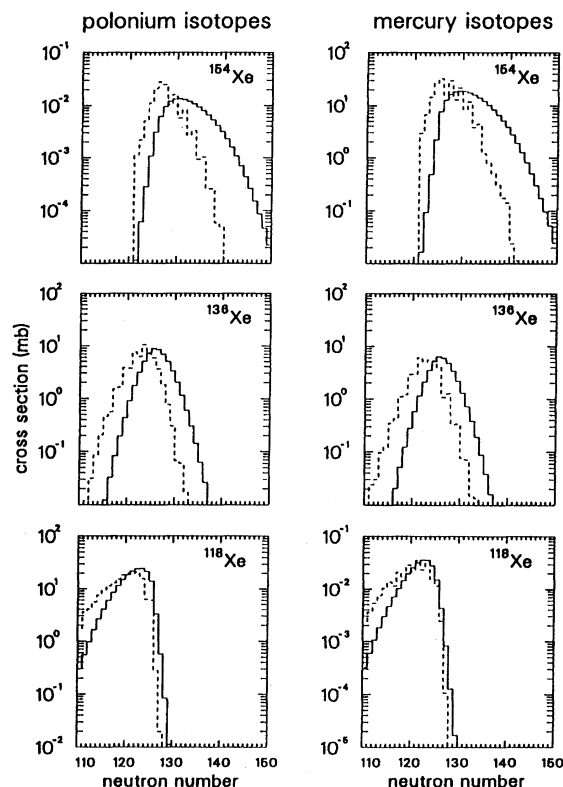


FIG. 1. Total cross sections for the production of different isotopes of polonium (left) and mercury (right) in the reaction $^A\text{Xe} + ^{208}\text{Pb}$ at 700 MeV bombarding energy. From top to bottom the frames correspond, respectively, to $A = 154, 136$, and 118 . The full-drawn histograms are the primal production rates as reported in Ref. [1]. The dashed curves incorporate the changes in the distributions due to subsequent particle evaporation.

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