The heavy-ion reactions $^{238}U+^{238}U$ and $^{238}U+^{248}Cm$ revisited

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Recent theoretical work by Zagrebaev et al. [1,2] has renewed interest in radiochemically determined isotope distributions in reactions of ^{238}U projectiles with actinide targets that had previously been published only in parts [3,4]. These data have been revisited. The cross sections σ(*Z*) below the uranium target have been determined as a function of incident energy in thick-target bombardments. These are compared to predictions by a diffusion model [5] whereby consistency with the experimental data is found in the energy intervals 7.65 – 8.30 MeV/u and 6.06 – 7.50 MeV/u, see Fig. 1. In the energy interval 6.06 – 6.49 MeV/u, the experimental data are lower by a factor of 5 compared to the diffusion model prediction indicating a threshold behaviour for massive charge and mass transfer close to the barrier.

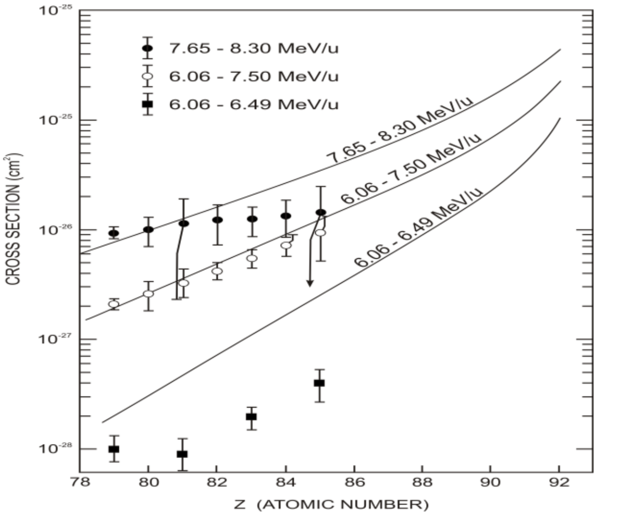

Fig. 1 Element yields P(*Z*) in the $^{238}U+^{238}U$ reaction in three different bins of laboratory energies defined by the incident projectile energy and the effective target thickness. For the higher energy bins and for the higher atomic numbers the cross sections are increasingly depleted by sequential fission. The solid lines are diffusion model predictions [5].

For the intermediate energy interval, the missing mass between the primary fragment masses deduced from the generalised Q_{gg} systematics including neutron pair-breaking corrections δn and the centroid of the experimental isotope distributions as a function of *Z* have been used to determine the average excitation energy as a function of *Z.* From this, the *Z* dependence of the average total kinetic-energy loss has been determined. This is compared to that measured in a thin-target counter experiment at 7.42 MeV/u [6]. For small charge transfers, the values of of this work are typically about 30 MeV lower than in the thin-target experiment with the difference decreasing with increasing charge transfer developing into even slightly larger values in the thick-target experiment for the largest charge transfers. This is the expected behaviour which is also found in a comparison of the partial cross sections for quasi-elastic and deep-inelastic reactions in both experiments. The cross sections for surviving heavy actinides, e.g., $_{98}Cf$, $_{99}Es$, and $_{100}Fm$ indicate that these are produced in the low-energy tails of the dissipated energy distributions, however, with a low-energy cutoff on the order of 35 MeV. A comparison of the survival probabilities

$$\prod_{i=1}^{x}\langle \Gamma_n/\Gamma_{tot}\rangle$$

of the target-like residues of equal charge and neutron transfers in the reactions of ^{238}U projectiles with either ^{238}U or ^{248}Cm targets is consistent with this cutoff as evaporation calculations assign the surviving heavy actinides to the x=3 and/or x=4 neutron evaporation channels.

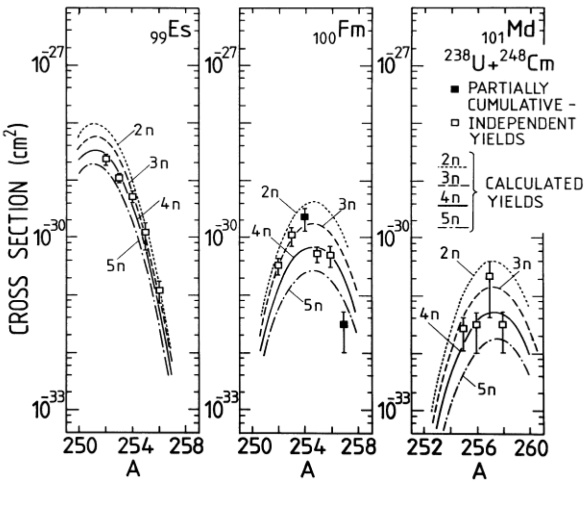

Fig. 2 Comparison of the measured (symbols [4]) and calculated (curves) for the isotope populations in the $^{238}U+^{248}Cm$ reaction at 7.4 MeV/u

References

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