Post - scission neutron emission and transformation of fission fragments yield: are there regularities?

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The study of fission products provides valuable information about the nature of nuclear matter stability. In practice, there are problems of their exact determination because a post-scission ensemble is a dynamic system influenced by the nuclear particle emission from the fission fragments. The number of either neutron (prompt, delayed) or beta particles depends on the time after nuclear fission: more nuclear particles will be emitted for a longer time interval.

In this report, the "many ensembles" method is proposed to investigate the influence the post-scission nuclear particle emission on mass and charge distributions of fission products. The post fission approximation had been used; each of these ensembles consists of the fission fragments after emission of chains of different lengths, both the beta particles and neutrons. The proposed theory allows one to find the most probable two fragment clusters of fission products and study their evolution after the post-scission emission of nuclear particles. The isotope ^{232}Th was chosen as an example, the fission fragments of which are intensively studied in the experiment. It is shown that the post-scission emission of nuclear particles eventually leads to the convergence of the asymmetric peaks, which looks like enhanced symmetric fission mode over asymmetric one for fission product yields, Table 1. A comparison of the theoretical results and experimental data for the 232Th fission fragments indicates their good matching.

Table 1. The evolution of five the most probable post-scission two fragment clusters, M=1–5, after emission the neutrons of different chains' lengths: n defines all their sets from the ranges (0, n). There is no beta particles emission

M\n	0	+1	+2	+3	+4
1	$\{^{100}_{40}Zr, ^{132}_{50}Sn\}$	$\{^{100}_{40}Zr, ^{130}_{50}Sn\}$	$\{^{96}_{40}Zr, ^{132}_{50}Sn\}$	$\{^{96}_{40}Zr, ^{130}_{50}Sn\}$	$\{^{96}_{40}Zr, ^{130}_{50}Sn\}$
2	$\{^{102}_{40}Zr, ^{130}_{50}Sn\}$	$\{^{98}_{40}Zr, ^{132}_{50}Sn\}$	$\{^{94}_{38}Sr, ^{134}_{52}Te\}$	$\{^{96}_{40}Zr, ^{132}_{50}Sn\}$	$\{^{102}_{40}Zr, ^{132}_{50}Sn\}$
3	$\{^{101}_{40}Zr, ^{131}_{50}Sn\}$	$\{^{100}_{40}Zr, ^{132}_{50}Sn\}$	$\{^{98}_{40}Zr, ^{130}_{50}Sn\}$	$\{^{94}_{38}Sr, ^{134}_{52}Te\}$	$\{^{94}_{38}Sr, ^{134}_{52}Te\}$
4	$\{^{104}_{40}Zr, ^{128}_{50}Sn\}$	$\{^{101}_{40}Zr, ^{130}_{50}Sn\}$	$\{^{100}_{40}Zr, ^{130}_{50}Sn\}$	$\{^{104}_{40}Zr, ^{128}_{50}Sn\}$	$\{^{98}_{40}Zr, ^{130}_{50}Sn\}$
5	$\{^{99}_{39}Y, ^{133}_{51}Sb\}$	$\{^{101}_{40}Zr, ^{130}_{50}Sn\}$	$\{^{97}_{40}Zr, ^{132}_{50}Sn\}$	$\{^{98}_{40}Zr, ^{130}_{50}Sn\}$	$\{^{97}_{40}Zr, ^{130}_{50}Sn\}$