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Correlations between the fission fragment yields and the prompt fission gamma-ray spectrum

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The fission fragment yields are intimately connected to the resulting prompt fission γ-ray spectrum (PFGS). In combination with the prompt neutron emission, the fragment yields determine the fission products that are produced, which ultimately emit the majority of the prompt γ rays in fission. We use a Monte Carlo Hauser-Feshbach model to calculate the de-excitation of the fission fragments through the emission of prompt neutrons and γ rays. We vary generic aspects of the fragment yields, such as the location of the peaks and the widths of those peaks, and note the resulting impact on the PFGS. In particular, a measurably softer PFGS results when the fragment yields peak near the N=82 neutron shell closure. We study this effect for multiple fission reactions involving the same compound nucleus, finding that it is more dramatic for some plutonium isotopes where the spontaneous fission reaction results in significantly larger yields near the neutron shell closure. In addition to the spectral changes, we find that the fission fragment yields will directly impact the intensities of low-energy discrete γ-ray transitions. Inferring yields from the intensities of these γ-ray transitions has been studied in the past, but generally relies on certain assumptions about the existence of other contaminating γ rays or the impact of side-feeding transitions. We determine the validity of these assumptions for a selected range of isotopes and calculate the necessary corrections to obtain the true fission product yields.

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