Study of near-stability nuclei populated as fission fragments in heavy-ion fusion reactions

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There is a long history of studies of nuclear structure by identifying the prompt discrete lines from fission fragments, a technique used frequently in the study of neutron-rich and near-stability nuclei that cannot be studied as evaporation residues in heavy-ion fusion reactions since they cannot be populated with stable beam-target combinations in such reactions. Especially useful is the complementary fission fragment technique that enables assigning of γ-rays and high-spin states to neutron-rich and near-stability fission fragments for which no high-spin spectroscopic information exists by establishing γ-γ coincidences between these γ-rays and previously known γ-rays of one or more complementary fission fragments.

Examples will be presented to illustrate the power of prompt γ-ray spectroscopy of fission fragments from compound nuclei with $A \sim 200$ formed in fusion-evaporation reactions in experiments using the Gammasphere Ge-detector array. Complementary methods, such as Coulomb excitation and deep-inelastic processes, have also been used in some cases. In other cases we have also developed a technique that uses $(n, xn\gamma)$ reactions on stable isotopes to complement assignments of γ-rays. This technique is based on establishing of neutron excitation functions for γ-rays using a pulsed "white"-neutron source, like the one at the Los Alamos Neutron Science Center facility, coupled to a high-energy-resolution germanium-detector array (see, for instance, the assignment of transitions to ^{135}Xe in Ref. [1] using the GEANIE Ge-detector array). Results from all these methods will be discussed.

The observation of high spin states in all these complementary methods bridges the gaps in the systematics between the neutron-deficient and neutron-rich nuclei. Moreover, several nuclei studied in these methods are located near shell or sub-shell closures where the experimental results can be easily compared with predictions from shell-model calculations.

[1] N. Fotiades *et al.*, Phys. Rev. **C 75** 054322 (2007); and references therein.