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Structure and Formation of Heavy Shell-Stabilized Nuclei[1]

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The heaviest nuclei represent systems at the limits of stability in charge, spin and excitation energy. They can exist only because the shell-correction energy lowers the ground-state energy, thereby creating a barrier against fission. The formation of these shell-stabilized nuclei is accompanied by electromagnetic emission. Despite minuscule cross sections ($<1\mu$b), in-beam γ-spectroscopic measurements have been possible, by combining large γ-ray detector arrays with mass analyzers, which uniquely identify the emitting nuclei. Measurements of the γ-ray total energy and multiplicity provide a measure of the fission barrier (>5 MeV) and also show that the nuclei can survive up to high angular momentum ($\sim 30\hbar$), although they are delicately bound. Hence, high partial waves are important in the synthesis of superheavy nuclei. The shell-correction energy arises from gaps in the single-particle energy spectrum. Hence, information on the latter is critical for understanding the heaviest nuclei, and is provided by the moments of inertia of rotational bands, the quasiparticle energies of odd-A nuclei and high-K isomers. The spectroscopic results on the heaviest nuclei (mainly on ^{252,253,254}No, from experiments at Argonne and Jyväskylä) will be summarized and compared with the predictions of self-consistent relativistic mean-field theory. This comparison gives a picture of our current understanding about single-particle properties and pairing in the heaviest nuclei.

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