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Exploring the stability of super heavy elements

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Super heavy nuclei exist solely due to quantum shell effects, which create a pocket in the potential-energy surface of the nucleus, thus providing a barrier against spontaneous fission. Determining the height of the fission barrier and its spin dependence $B_f(I)$ is therefore important to quantify the role that microscopic shell corrections play in enhancing and extending the limits of nuclear stability. It is also valuable for understanding the formation mechanism of heavy nuclei since these nuclei are generally produced at high spin in fusion-evaporation reactions.

The gamma-ray multiplicity and total energy of the heavy shell-stabilized nucleus ^{254}No produced in the reaction ^{208}Pb(^{48}Ca,2n) have been measured for beam energies of 219 and 223 MeV at the Argonne Tandem Linac Accelerator System. The ^{254}No gamma rays were detected using the Gammasphere array as calorimeter. Coincidences with the detection of fusion-evaporation residues at the focal plane of the Fragment Mass Analyzer separated ^{254}No gamma rays from those emitted by fission fragments and other reaction products, which are more than a million times more intense.

From this measurement, the initial distribution of spin I and excitation energy E^* of ^{254}No was constructed for both bombarding energies. Each point (I,E^*) of this entry distribution is a point where gamma decay wins over fission. The distributions display a saturation in excitation energy, which allows a direct determination of the fission barrier [1].

This is the first time the height of a fission barrier is measured for a nucleus heavier than Cf. This result is compared to theoretical predictions [2-6] and to the situation in ^{220}Th, with 12 protons less, studied in a similar manner.

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