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Fusion and competitive fission modes in the cold synthesis of super-heavy nuclei

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One of the long-standing topics in nuclear physics is the competition between the symmetric and asymmetric modes of quasi-fission in collisions of heavy and very heavy nuclear systems. The separation of these modes from the excited compound nucleus fission is quite difficult experimentally. Theoretical calculations may give valuable insight into ascertaining contributions from these various processes. And may be used to evaluate fusion probabilities for the synthesis of super-heavy elements.

In this talk, a new method for predicting quasi-fission and fusion-fission yields will be presented. The approach uses a random walk algorithm, in which the shape evolution is governed by the density of states above the multidimensional potential energy surface (PES). The PESs were calculated within the latest version of the Warsaw macroscopic-microscopic model [1], with rotational energy taken into account.

Three cold fusion reactions will be discussed in detail: ^{208}Pb+^{48}Ca, ^{208}Pb+^{50}Ti and ^{208}Pb+^{54}Cr. The influence of angular momentum and excitation energy on ratios of symmetric and asymmetric divisions will be demonstrated. The absorbing nature of the second minimum, leading to a very symmetric mode, will also be shown.

[1] P. Jachimowicz, M. Kowal, and J. Skalski, At. Data. Nucl. Data. Tables. 138, 101393 (2021).

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