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The deformation dependence of level densities in the configuration-interaction shell model

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The dependence of statistical nuclear properties such as level densities on intrinsic deformation is an important input to models of fission. The auxiliary-field quantum Monte Carlo (AFMC) method has enabled the microscopic calculation of nuclear level densities from the underlying Hamiltonian. However, AFMC is applied within the rotationally invariant framework of the configuration-interaction (CI) shell model, while deformation arises in the framework of a mean-field approximation that breaks rotational invariance. We have introduced a novel method to study deformation in the CI shell model without invoking an intrinsic frame or a mean-field approximation. We have calculated the axial quadrupole distribution in the laboratory frame using AFMC, and showed that this distribution carries a model-independent signature of deformation [1,2]. Using a Landau-like expansion of the logarithm of the distribution of the quadrupole tensor in the so-called quadrupole invariants, we can determine the dependence of this distribution on intrinsic deformation [3,4]. The temperature-dependent expansion coefficients are determined by the expectation values of the quadrupole invariants, which in turn are calculated from moments of the axial quadrupole in the laboratory frame. We can then calculate the dependence of nuclear level densities on intrinsic deformation [4]. The method is demonstrated for an isotope chain of samarium nuclei.

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[3] Y. Alhassid, G.F. Bertsch, C.N. Gilbreth and M.T. Mustonen, arXiv:1801.06175 (2018).

[4] M.T. Mustonen, C.N. Gilbreth, Y. Alhassid, and G.F. Bertsch, in preparation (2018).

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