Statistical properties of nuclei by the shell model Monte Carlo method

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We use quantum Monte Carlo methods in the framework of the interacting nuclear shell model to calculate the statistical properties of nuclei at finite temperature and/or excitation energies. With this approach we can carry out realistic calculations in much larger configuration spaces than are possible by conventional methods.

A major application of the methods has been the microscopic calculation of nuclear partition functions and level densities, taking into account both correlation and shell effects. Our results for nuclei in the mass region $A \sim 50$–70 are in remarkably good agreement with experimental level densities without any adjustable parameters and are an improvement over empirical formulas. We have recently extended the shell model theory of level statistics to higher temperatures, including continuum effects. We have also constructed simple statistical models to explain the dependence of the microscopically calculated level densities on good quantum numbers such as parity. Thermal signatures of pairing correlations are identified through odd-even effects in the heat capacity and in the moment of inertia.

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