Condensed Matter > Statistical Mechanics

Methods of exploring energy diffusion in lattices with finite temperature

Ping Hwang, Hong Zhao

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We discuss two methods for exploring energy diffusion in lattices with finite temperature in this paper. The first one is the energy-kick (EK) method. To apply this method, one adds an external energy kick to a particle in the lattice, and tracks its evolution by evolving the kicked system. The second one is the fluctuation-correlation (FC) method. The formula for calculating the probability density function (PDF) using the canonical ensemble is slightly revised and extended to the microcanonical ensemble. We show that the FC method has advantages over the EK method theoretically and technically. Theoretically, the PDF obtained by the FC method reveals the diffusion processes of the inner energy while the PDF obtained by the EK method represents that of the kick energy. The diffusion processes of the inner energy and the external energy added to the system, i.e., the kick energy, may be different quantitatively and even qualitatively depending on models. To show these facts, we study not only the equilibrium systems but also the stationary nonequilibrium systems. Examples showing that the inner energy and the kick energy may have different diffusion behavior are reported in both cases. The technical advantage enables us to study the long-time diffusion processes and thus avoids the finite-time effect.

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