Thermalization of isolated harmonic networks under conservative noise

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We study a scalar harmonic network with pair interactions and a binary collision rule, exchanging the momenta of a randomly-chosen couple of sites. We consider the case of the isolated network where the total energy is conserved. In the first part, we recast the dynamics as a stochastic map in normal modes (or action-angle) coordinates and provide a geometric interpretation of it. We formulate the problem for generic networks but, for completeness, also reconsider the translation-invariant lattices. In the second part, we examine the kinetic limit and its range of validity. A general form of the linear collision operator in terms of eigenstates of the network is given. This defines an action network, whose connectivity gives information on the out-of-equilibrium dynamics. We present a few examples (ordered and disordered chains and elastic networks) where the topology of connections in action spaces can be determined in a neat way. As an application, we consider the classic problem of relaxation to equipartition from the point of view of the dynamics of linear actions. We compare the results based on the spectrum of the collision operator with numerical simulation, performed with a novel scheme based on direct solution of the equation of motion in normal modes coordinates.