TRANSPORT OF ENERGY THROUGH LONG DISORDERED HARMONIC CHAINS

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We study the energy current in a model of heat conduction, first considered in detail by Casher and Lebowitz. The model consists of a one-dimensional disordered harmonic chain of n i.i.d. random masses, connected to their nearest neighbors via identical springs, and coupled at the boundaries to Langevin heat baths, with respective temperatures T_1 and T_n. Let $E[J_n]$ be the steady-state energy current across the chain, averaged over the masses. We prove that $E[J_n]$ scales like $(T_1 - T_n)n^{-3/2}$ as the length n of the chain approaches infinity, as has been conjectured by various authors over the time. The proof relies on a new representation of the (effectively) delocalized normal modes of the chain in terms of monotonous random walks on a circle. Using our methods it is also possible to prove anomalous scaling behavior of $E[J_n]$ when the heat baths are modeled by colored stationary noise.