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Localization-delocalization transition of phonons in disordered solids

We study, theoretically and numerically, a minimal model for phonons in a disordered system that shows rich behavior in the localization properties of the phonons as a function of the density, frequency and the spatial dimension. We use a renormalization-group-type analysis to argue for a localization-delocalization transition in dimensions higher than one. The structure of the modes reflect a divergent percolation length that arises from the disorder in the springs without being explicitly present in the definition of our model. We calculate the speed-of-sound of the delocalized modes (phonons) and corroborate it with numerics. The implications for diffusion in random environments and on the vibrational spectrum of colloidal glasses are discussed.