Dual Hidden Landscapes for Anderson Localization in Discrete Lattices

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The localization subregions of stationary waves in continuous disordered media have been recently demonstrated to be governed by a hidden landscape that is the solution of a corresponding Dirichlet problem with the strength of Anderson localization confinement continuously decreasing as the energy eigenvalue increases. However, this picture has to be reformulated in discrete lattices where the eigenmodes near the top of the band are as localized as the low energy ones. Here, we demonstrate that there is a dual hidden landscape in discrete lattices that is responsible for the localization of the high energy modes. We illustrate this feature using the one-dimensional tight-binding Hamiltonian with random on-site potentials as a prototype model. We show that, besides unveiling the subregions of Anderson localization, both at low and high energies, these dual landscapes provide an overall estimate of the localization length over the entire energy spectrum.