Anderson (de-)Localization for Continuous Potentials with Arbitrary Correlation Lengths

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In one dimension, Anderson localization is well established for tight binding models with uncorrelated onsite disorder, where the localization length, $L \sim 1/W^2$, only diverges when W the amplitude of the disorder potential is zero. Here we present a new derivation of Anderson localization for continuous potentials with an arbitrary disorder potential (even in the presence of disorder correlations), which is based on the integral solution to Schrodinger's equation. We find a rich new behavior of the localization length as a function of the correlation length of the disorder potential. Indeed, L diverges as $L \sim 1/(lW)^2$, for small correlation lengths l, and diverges exponentially with l, at large correlation lengths. For intermediate correlation lengths, the localization length exhibits resonances at integer ratios of the Fermi wavelength over l. We confirm these analytical results with numerical simulations of the localization length.