lecture 3

Waves in strongly disordered systems

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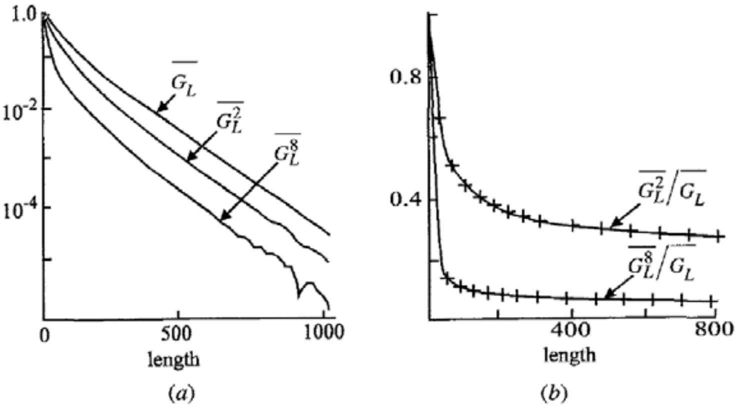
The statistics of disordered 1D systems: The transfer matrix approach to transport in one-dimensional systems is reviewed in detail with emphasis on the role of symmetrized products. First, the concept of a transfer matrix is introduced, and then generalized through the introduction of symmetrized products. The resulting formalism is successively applied to the problem of averaging: resistance, density of states, conductance (i.e. transmission coefficient), phases of transmission and reflection, and frequency response. Finally the problem of l/f noise in disordered systems is addressed in the language of symmetrized transfer matrices.



(a) Moments of GL calculated by averaging over 9,259,648 1D samples of various lengths. The system had a bandwidth of 4, the energy for these calculations was E = 1, and the disorder of site energies was uniform with a width of 1. (b) Ratios of the moments of GL: (+), theoretical predictions. Note the slow approach to the asymptotic value, approximately as l/L.

The transmission coefficient and all its moments belong to the same symmetry class and therefore have the same asymptotic behaviour (see the figure above). This implies that the length of sample tends to infinity, the transmission coefficient is either of order zero or of order unity – the so called 'Maximal fluctuation theorem'. This conclusion generalizes to higher dimensions, irrespective of whether the system is localised or delocalised, a result recently confirmed by the Twente group.

Disordered 3D systems

(i) weak disorder: The transfer matrix approach can be extended to 3D systems. In the case of weak disorder the transfer matrix equivalent of the maximally crossed diagrams is identified

(ii) strong disorder: A theory of strong disordered systems in higher dimensions is developed. We present a novel theory of Anderson localisation based on transfer matrices which accurately predicts the critical disorder and gives a good estimate of the critical exponent. The theory can be generalised to any dimension.