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Spectral Properties of Disordered Systems in the One-Body Approximation

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Abstract. The paper considers the Schrödinger equation for a single particle and its discrete analogues. Assuming that the coefficients of these equations are homogeneous and ergodic random fields, it is proved that the spectra of corresponding random operators and their point spectra are dense with probability 1 and that in the one-dimensional case they have no absolutely continuous component. Rather wide sufficient conditions of exponential growth of the Cauchy solutions of the one-dimensional equations considered are found.

1. Introduction

Experimental and theoretical investigation of a large variety of disordered systems has constituted in the recent decades a substantial part of the condensed matter physics. One of the most common and efficient theoretical approaches in this field now is the one-body approximation. In this approximation the solution of a problem is reduced to consideration of different quantities constructed of eigenvalues and eigenfunctions of the one-body Schrödinger equation or its discrete analogues (see [1–3] for physical discussion and numerous references, and [4] for the survey and discussion from a more mathematical point of view).

The usual approach which conforms to the general principles of statistical physics is to consider operators defined by these equations and some selfadjoint boundary conditions in a finite domain V and study, for $V \to \infty$, asymptotic properties of the various physical quantities which are all constructed of eigenelements of corresponding operators.

The random potential that models the influence of a disordered medium should meet the following natural conditions:

a) spatial homogeneity

and

b) absence of statistical correlations between infinitely distant points.

In mathematical terms it means that the potential is realization of a random field (a random process in one-dimensional case) which is

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