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Schrödinger Operators with an Electric Field and Random or Deterministic Potentials

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Abstract. We prove that the Schrödinger operator $H=-\frac{d^2}{dx^2}+V(x)+F\cdot x$ has purely absolutely continuous spectrum for arbitrary constant external field F, for a large class of potentials; this result applies to many periodic, almost periodic and random potentials and in particular to random wells of independent depth for which we prove that when $F=0$, the spectrum is almost surely pure point with exponentially decaying eigenfunctions.

I. Introduction

This paper presents exact results on the behaviour of electrons in the presence of an electric field. We discuss below the physical aspects of the problem and of our results and then we present the mathematical aspects and the organisation of our paper.

The Physics of the Problem and of the Results

The problem of an electron in a random potential has been receiving a great deal of attention for quite a while, both from the physical and the mathematical point of view. The case of almost periodic potentials has also recently attracted a lot of workers in the field. A challenging question is the following: what is the behaviour of such systems when a constant electric field is turned on? The more the states are localized for zero field the more interesting is the problem: the most extreme case deals with one-dimensional systems for which an arbitrarily small degree of disorder implies the exponential localization of all states in the absence of electric field. Mathematically this corresponds to the fact that the associate Schrödinger operator $-\frac{d^2}{dx^2}+V(x)$ has almost surely only pure point spectrum with exponen-

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