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Stark Effect in Multielectron Systems: Non-Existence of Bound States

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Abstract. We prove non-existence of bound states for a class of N-body systems in homogeneous electric fields. This class includes atoms and Born–Oppenheimer molecules. This result in conjunction with a stability result of [HS] implies existence of resonances for such systems.

1. Introduction

Though the quantum N-body problem was intensively studied for the past 20 years, the field still abounds with many basic problems. For instance, physical intuition suggests that a system placed in an external field which, in a certain direction, pulls it apart overcoming the attraction between particles should not have bound states. In particular, a homogeneous electric field applied to a system containing charged particles of opposite charges should break the bound states of this system. So far this rather obvious statement is proven only for two (one)-particle systems ([T, AH, HS] see also [A]). The purpose of this article is to prove that for a large class of N-body systems including atoms and Born–Oppenheimer molecules, there are no bound states in the presence of homogeneous electric fields. This result coupled with the stability result of [HS] (see also [Hu]) implies the existence of resonances in such systems. It is shown in [Sig] that these resonances have exponentially small (in the inverse of the strength of electric field) width. The latter is determined by the width, in an appropriate Agmon metric, of the barrier that the system has to penetrate. This shows that establishing non-vanishing of this width is a delicate matter.

Note the principal difference between the one (two)-body and N-body problems. In the one-body case, the total potential acting on the particle in question is $V(x) - E\cdot x$, where E is the electric field strength (times the charge of the particle). Hence the force acting on the particle in the E direction is

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