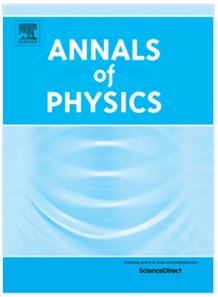
Accepted Manuscript



Moving walls and geometric phases

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PII: S0003-4916(16)30063-X
DOI: http://dx.doi.org/10.1016/j.aop.2016.05.007
Reference: YAPHY 67109

To appear in: *Annals of Physics*

Received date: 1 April 2016
Accepted date: 9 May 2016

Please cite this article as: P. Facchi, G. Garnero, G. Marmo, J. Samuel, Moving walls and geometric phases, *Annals of Physics* (2016), http://dx.doi.org/10.1016/j.aop.2016.05.007

Moving Walls and Geometric Phases

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Abstract

We unveil the existence of a non-trivial Berry phase associated to the dynamics of a quantum particle in a one dimensional box with moving walls. It is shown that a suitable choice of boundary conditions has to be made in order to preserve unitarity. For these boundary conditions we compute explicitly the geometric phase two-form on the parameter space. The unboundedness of the Hamiltonian describing the system leads to a natural prescription of renormalization for divergent contributions arising from the boundary.

Keywords: geometric phases, quantum boundary conditions, time-dependent systems
PACS: 03.65.Vf, 03.65.Db

1. Introduction

The case of a non-relativistic quantum particle confined in a one dimensional box with moving walls subject to Dirichlet boundary conditions has been investigated in great detail in [1]. In this paper we consider more general boundary conditions and study the geometric phases that emerge. The boundary conditions we focus on are those consistent with the unitarity of the dynamics as well as with dilation symmetry.

Geometric phases were investigated by Berry and Wilkinson [2] who considered the behaviour of the eigenfunctions of the Laplacian in a two-dimensional region with a triangular boundary with Dirichlet boundary conditions, when the shape of the region was varied adiabatically. This study revealed the existence of "diabolical points", shapes which have an accidental degeneracy in the spectrum. Varying the shape of the region in a small circuit around the diabolical point led to a reversal in the sign of the eigenfunction. Similar effects were also noticed earlier in molecular physics [3] as explained in the book by Shapere and

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