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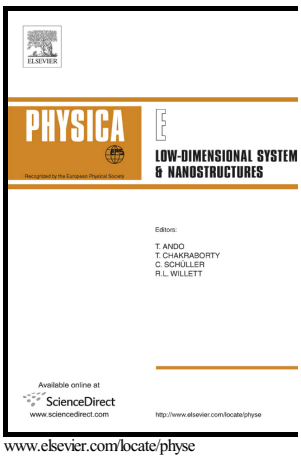

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Scattering approach to scanning gate microscopy

Rodolfo A. Jalabert[a,b], Dietmar Weinmann[a,*]

[a] *Institut de Physique et de Chimie des Matériaux de Strasbourg, Université de Strasbourg, CNRS UMR 7504, 23 rue du Loess, BP 43, F-67034 Strasbourg Cedex 2, France*
[b] *Freiburg Institute for Advanced Studies, Albert-Ludwigs-Universität, Albertstr. 19, D-79104 Freiburg, Germany*

Abstract

We present a perturbative approach to the conductance change caused by a weakly invasive scattering potential in a two-dimensional electron gas. The resulting expressions are used to investigate the relationship between the conductance change measured in scanning gate microscopy as a function of the position of a scattering tip, and local electronic quantities like the current density. We use a semiclassical approach to treat the case of a strong hard-wall scatterer in a half-plane facing a reflectionless channel. The resulting conductance change is consistent with the numerically calculated quantum conductance.

Keywords: Mesoscopic Physics, Quantum transport, Scattering theory, Scanning gate microscopy, Semiclassical approaches

1. Introduction

The scanning gate microscopy (SGM) is an experimental technique detecting the change in the conductance of a nanostructure while the charged tip of an atomic force microscope is scanned over the surface of the device [1, 2, 3, 4, 5, 6, 7, 8, 9]. The interpretation of what are the physical properties actually probed with the SGM technique is still a point of debate (for a review see Ref. [10]).

Our first contribution to this intriguing physical problem [11] was quickly greeted by a short note from Markus Büttiker saying "*Dear Rodolfo, dear Dietmar : You clearly wrote a paper that needed to be written! Since the conductance is proportional to the transmission probability, the change of conductance is the change of the transmission probability due to the variation in the potential. Many years ago, in a paper which I have enclosed, we looked at this quantity.*" And he went on in his scholar style discussing what should be done in order to get his approach [12] to agree with ours in their common regime of applicability (which we could soon establish). Kind notes as this one, that many colleagues

*Corresponding author
Email address: dietmar.weinmann@ipcms.unistra.fr (Dietmar Weinmann)