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Penetration through Smooth And Random Potentials

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ABSTRACT

The Challenges in the recent experiments of the spatial pattern of electron flux, the electrons follow narrow branches rather than a diffusive spreading pattern. What might be the reason for these branches? How can we characterize and confirmed this by theoretical predictions? Our assumptions for these branches is - "The Reason for these branches might be the result of small-angle scattering off of a weak, smooth disordered background potential, generated by the layer of donor atoms in the 2DEG crystal".

Keywords: 2DEGs, micron-scale, quantum-mechanical systems, electron flux, inverse Green's function, eigenstates and eigenvalues.

1. INTRODUCTION

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The theoretical study of micron-scale quantum-mechanical systems generally begins with two assumptions about the potential,

- That there is no background potential
- And that any confining potential is hard-walled.

In this paper, we will look at a phenomenon that is seen when these assumptions are not made, in the context of electron conductance through two-dimensional electron gasses (2DEGs).

2. SOLUTIONS TO STUDY THE SYSTEMS

- ✓ The discrete variable representation method treats closed systems, where one is solving for eigenstates and eigenvalues.
- ✓ The inverse Green's function method treats open systems, where one is solving for the scattering matrix and steady-state electron flux.

The latter method: that, we will apply to the case of 2DEG conductance.

3. CHALLENGES

In the recent experiments of the spatial pattern of electron flux, the electrons follow narrow branches rather than a diffusive spreading pattern. What might be the reason for these branches? How can we characterize and confirmed this by theoretical predictions?

4. CONFIRMATION

Our study is motivated by the recorded experiments which probed the spatial pattern of electron flux. In agreement with these experiments, we confirmed that the electrons follow narrow branches rather than a diffusive spreading pattern.

5. ASSUMPTIONS

"The Reason for these branches might be the result of small-angle scattering off of a weak, smooth disordered background potential, generated by the layer of donor atoms in the 2DEG crystal".

6. THE DEMAND OF THE NEW PREDICTIONS

- ❖ We should consider the experimentally observed interference fringes, which persist to the ranges of several microns.
- ❖ We present a novel model that explains the persistence and character of these fringes, relying only on first-order

scattering off of the sharp potentials generated by impurities in the crystal.

- ❖ We then turn to the methods of classical mechanics to study the branching pattern. Using classical trajectory stability analysis, we show that the locations of branches can be predicted by a projection of the
- ❖ We also consider the scaling laws for various statistical aspects of the classical flow (for example, the momentum-relaxation time).

7. CHALLENGES

We confirmed that, these properties of the branched flow adhere to our theoretical predictions. Finally, we find what one-dimensional maps can tell us about the dynamics in these systems. The map gives us an understanding of the observed correlation between branch stability properties and turning points in the evolving manifold.

8. ACKNOWLEDGEMENT

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