

Floquet-Drude Conductivity in Dressed Quantum Hall Systems

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Interactions between light and matter have dragged research attention in the fields of optoelectronics, sensing, energy harvesting, quantum computing, bio-information, and in many branches of recent technologies. For many years, the foremost aims for examining the characteristics of dressed fermion systems were focused on the different types of atomic and molecular arrangements. These researches of extreme electron-light engagements introduced an astonishing scope of twentieth-century physics namely quantum optic physics.

I. INTRODUCTION

Interactions between light and matter have dragged research attention in the fields of optoelectronics, sensing, energy harvesting, quantum computing, bio-information, and in many branches of recent technologies. For many years, the foremost aims for examining the characteristics of dressed fermion systems were focused on the different types of atomic and molecular arrangements. These researches of extreme electron-light engagements introduced an astonishing scope of twentieth-century physics namely quantum optic physics.

On the other hand, in nanostructures that are applicable in electronic devices, the investigations with the help of quantum optic were centered on polaritonic and excitation influences on nanostructures and material characteristics of dressed electrons in two-dimensional(2D) materials and quantum wires. When considering the transport characteristics of dressed nanostructures, they are still expecting extensive analysis.

Therefore, transport properties of nanostructures exposed to a high intensity periodic electromagnetic fields have been explored theoretically in this study. The dressing field is analyzed non perturbatively using the Floquet theory whilst the probing field is examined perturbatively by applying the linear response method using the Kubo formula. The general Floquet-Drude conductivity has been derived in a fully closed analytical form in most recent research [1,2], introducing a novel type of Green's functions namely four-times Green's functions. As a consequence, the established formalism introduces a novel approach to manipulate the transport characteristics of nanostructures by an intense dressing field. From an empirical sense, this study applies directly to various nanostructures illuminated by a high-intensity electromagnetic field. In this research we have developed a robust mathematical model for dressed two-dimensional electron gas(2DEG) exposed to another stationary magnetic field and that will enable efficient manipulation of transport characteristics in nanoscale electronic devices.

When a stationary magnetic field applied perpendicularly across the surface of 2DEG systems, the orbital motion of electrons becomes completely quantized and

the energy spectrum becomes discrete by creating Landau levels. Such a singular system known as a quantum Hall system and in this study we explicitly calculate the diagonal $(\sigma_{xx}, \sigma_{yy})$ components of the conductivity tensor in the periodically driven quantum Hall systems.

Although there already exist a number of advanced theories devoted to the calculation of conductivity tensor elements in a quantum Hall systems [3-5], they have not been applied to the optically manipulation the magneto-electric properties of the quantum Hall systems. However K. Dini et al. [6] have recently investigated the one directional conductivity behaviour of dressed quantum Hall systems, they have not used the state of art model to describe the conductivity in a quantum Hall system. In their study they used the conductivity models from T. Ando et al. [3,4] and as mentioned in A. Endo et al. investigation [5] those models are far less accurate representation of the experimentally observed Landau levels because they present a semi-elliptical broadening.

In this study we develop a generalized mathematical model to describe transport properties of dressed quantum Hall systems using Floquet-Drude conductivity [1,2]. In addition, we demonstrate that our generalized model is agreed with the state of art conductivity model [5] for specialized quantum Hall system which has been considered without the external dressing field. Therefore this theory describes that the dressing field can be used as a tool to utilize transport properties in various 2D nanostructures which serve as a basis for nano-optoelectronic devices.

II. SCHRÖDINGER PROBLEM FOR LANDAU LEVELS IN DRESSED 2DEG

Our system consist of a two-dimensional free electronic gas (2DEG) confined in the (x,y) plane in the three-dimensional coordinate space.

III. FLOQUET THEORY

Considerable research effort in recent years has been devoted to synthesizing materials whose thermal con-

ductivity.

IV. FLOQUET FERMI GOLDEN RULE

Considerable research effort in recent years has been devoted to synthesizing materials whose thermal conductivity.

V. INVERSE SCATTERING TIME ANALYSIS

Considerable research effort in recent years has been devoted to synthesizing materials whose thermal conductivity.

VI. CURRENT OPERATOR IN LANDAU LEVELS

Considerable research effort in recent years has been devoted to synthesizing materials whose thermal conductivity.

VII. FLOQUET-DRUDE CONDUCTIVITY IN QUANTUM HALL SYSTEMS

Considerable research effort in recent years has been devoted to synthesizing materials whose thermal conductivity.

VIII. MANIPULATE CONDUCTIVITY IN QUANTUM HALL SYSTEM

Considerable research effort in recent years has been devoted to synthesizing materials whose thermal conductivity.

IX. CONCLUSIONS

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Appendix A: Appendixes

Appendix B: A little more on appendixes

[1] R. P. Feynman, Phys. Rev. **94**, 262 (1954).