

Public Abstract

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Title:MANY-BODY CONTRIBUTIONS TO SPIN RELAXATION IN SEMICONDUCTORS

Spintronics has the potential to play a significant role in future electronic devices. The primary goal of this field is to utilize the magnetic properties of materials to enhance our current use of their electronic properties. This may allow for smaller, faster, and more power efficient devices in the future. The success of the field hinges on our ability to maintain and propagate spin signals (the magnetic orientation of particles) over various length scales and periods of time. Spin relaxation is a measure of how well these spin signals can be maintained in the presence of various interactions.

In this dissertation, we take a theoretical approach to studying the spins of electrons in semiconductors. We work in the microscopic limit so that electrons are treated largely individually. The interactions between electrons and their environment are studied in detail to understand the primary causes of spins changing orientation. We derive analytic formulas that can be applied by experimentalists to compare results with current theory. We also demonstrate an interesting link between spin relaxation and the rate at which electrons diffuse in a material. Finally, we make predictions about how spins reach an equilibrium state when a material moves between magnetic and non-magnetic phases.

By taking a theoretical, microscopic approach to this problem, we further our basic knowledge of how electrons behave under the influence of electronic and magnetic interactions. The concepts and derivations provided here should provide researchers in the field with the tools necessary to study spin relaxation in more novel materials. The implications of this work are equally important to basic physical phenomena in condensed matter systems and the advancement of circuits in electronics devices.