Public Abstract
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Title:MAGNETIC INTERACTIONS IN THE SPIN-ORBIT COUPLED ELECTRON GAS

The exchange interaction between two localized magnetic moments embedded in a host material is fundamental to the description of the magnetic behavior of solids and chiral order in magnetic structures. This interaction was originally found by Ruderman, Kittel, Kasuya and Yosida (RKKY). It is currently an area of considerable interest. The potential spintronics applications of chiral magnetic structures, originating from the competition between RKKY and Dzyaloshinsky-Moriya (DM) interactions caused by broken symmetries and the presence of the spin-orbit interaction, have stimulated lots of recent theoretical studies. In the standard spin-degenerate electron gas, it leads to the well-known RKKY interaction. In this dissertation, we study RKKY and DM interactions in the spin-polarized electron gas in one, two and three dimensions. In addition to the Heisenberg form of interaction, we found an Ising-like term appears in the magnetic interaction for the spin-polarized gas.
The anisotropic interaction is due to the broken time-reversal symmetry, based on the fact that spin polarization is in the z direction.

Furthermore, we study RKKY and DM interactions in a spin-polarized two-dimensional electron gas in the presence of both Rashba and Dresselhaus spin-orbit coupling (SOC). We find that in addition to the scalar RKKY interaction, there are also vector and tensor interactions between the two localized moments. Analytical expressions are found for each term of the total magnetic interaction, and their oscillatory behaviors are studied and compared to the numerical results. We also use our model to find energy of Neel and Bloch magnetic walls. Using our theoretical results we are able to predict which wall is preferred.

In the last chapter, we study impurity states in the kagome lattice. The kagome lattice is a 2D lattice that has been of recent interest owing to its graphene-like band structure, the existence of flat band states and exotic quasiparticle excitations. In this chapter, we study the electronic states introduced by impurities in the system by applying the Green’s function approach within a tight-binding model Hamiltonian. The impurities introduce localized states close to the Dirac point, in many ways similar to graphene, which will be discussed.