論文の内容の要旨

Microscopic Theory of Thermoelectric Transport in Magnetic Fields: Application to Dirac Systems

（　磁場中の熱電輸送に関する微視的理論: ディラック系への応用　）

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In this dissertation we study the magnetotransport of Dirac systems. We present a microscopic formalism to calculate transport coefficients in finite magnetic fields in the framework of linear response theory. We distinguish the cases of low magnetic fields and high magnetic fields and study them separately.

At low magnetic fields, we show how the magnetoconductivity can be calculated in the linear order of the magnetic field. Assuming small scattering rates and treating the magnetic field as perturbation we give formulas for the Hall conductivity and longitudinal conductivity. In the lowest order of the scattering rate, we recover the result of the semiclassical Boltzmann transport theory. At the subleading order, we get quantum corrections in terms of the Berry curvature and the orbital magnetic moment. The terms containing the Berry curvature are consistent with the semiclassical theories that include the anomalous velocity, but the terms containing the orbital magnetic moment can not be described with the anomalous velocity. We apply this formalism to tilted Weyl semimetals and study the effects of the tilting on the magnetoconductivity. We show the appearance of a finite linear longitudinal magnetoconductivity and we discuss how the orbital magnetic moment affects this result.

At high magnetic fields, we describe a microscopic theory to calculate thermoelectric transport coefficients using impurity Green's functions calculated in the first Born approximation using screened charged impurities. We employ this formalism to study the transverse magnetoconductivity and magnetothermopower of three-dimensional massive Dirac materials in high magnetic fields. We focus on the effects of the mass term and we show the main differences that arise compared to the massless Dirac fermions. The different behavior is shown to be relevant at high magnetic fields or low charge carrier densities. We show that the electric conductivity is proportional to $\propto B^{-1}$ and this behavior does not change qualitatively in the case of a finite mass term. On the other hand we find that the mass term causes significantly different behavior in the Seebeck and Nernst coefficients that show a $\propto B^{2}$ dependence at high fields.