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**Berry phase, Orbital Magnetization, and Anomalous Hall/Nernst Effect**

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It is now well recognized that the Berry phase of the electronic wave function plays an important role in the dynamics of Bloch electrons. For instance, the electron will acquire an anomalous velocity term transverse to the applied electric field, giving rise to an intrinsic contribution to the anomalous Hall effect. We have recently discovered that the Berry phase also modifies the phase-space density of states in the presence of a magnetic field. This surprising result has a number of implications, such as a field-dependent Fermi sea volume, Berry phase correction to the orbital magnetization, and linear (in field) magnetoresistance. Based on a general, finite-temperature, formula for orbital magnetization, we are able to develop a satisfactory theory for anomalous transport in ferromagnets driven by statistical forces (the gradient of temperature or chemical potential). Here a charge Hall current arises from the Berry-phase correction to the orbital magnetization rather than from the anomalous velocity, which does not exist in the absence of a mechanical force. We provide an explicit expression for the off-diagonal thermoelectric conductivity, establish the Mott relation between the anomalous Nernst and Hall effects, and reaffirm the Onsager relation between reciprocal thermoelectric conductivities. A first-principles evaluation of our expression is carried out for the material $CuCr_2Se_{4-x}Br_x$ , obtaining quantitative agreement with a recent experiment. This work is done in collaboration with Q. Niu, J.-R. Shi, Y.-G Yao, Z. Fang.

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