Anomalous Hall conductivity and quantum friction

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Anomalous Hall effect observed on ferromagnetic systems in absence of the external magnetic field attracted attention for more than century. Nevertheless, some of theoretical descriptions of its properties are still controversial. Anomalous Hall conductivity as function of the longitudinal conductivity shows quite large region independent on the system disorder. Measured values coincide quite well with Kubo formula results applied to pure crystals. Surprisingly at higher conductivity region the independence is lost and it starts to increase with decreasing scattering events. Using a two-dimensional network model it will be shown that the Hall conductivity comprises two parts: one which reflects the bulk properties as obtained by the Kubo formula and another which is sensitive to boundary conditions imposed on the network. In fully coherent limit the latter scales with the width of the conducting channel while for real-world samples it is controlled by the coherence length. This interpretation of the observed behavior in the clean limit is based on the quantum friction in analogy with classical friction in viscous fluids responsible for Couette flow [1].

[1] https://arxiv.org/abs/2206.03470