Anomalous Hall effect and topological phase transitions

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Abstract

To illustrate the close relation of the anomalous Hall conductivity and the orbital momentum, the response to the chemical potential gradient will be described in detail. The obtained result will be compared with that obtained by means of the Kubo formula representing the response to the electric field. The general expressions will be applied to a simple two-dimensional
network model so that the physical origin of the anomalous Hall effect and the topological phase transitions between insulators of different Chern numbers can be clarified. It will be shown that such transitions are accompanied by the space redistribution of local currents.

Finally, the effect of the boundary conditions to the appearance of chiral edge states will be analyzed. It will be argued that changing the boundary conditions the current-carrying edge-state branches can be induced or destroyed, at the particular sample edge. It suggests that, at least in principle, new types of spintronic devices like quasi-one dimensional spin filters and diodes can be prepared.

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