Anomalous Hall conductivity induced by magnetic textures on topological insulator surfaces

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Hall transport in magnetic materials has been an important idea both for scientific interests and for spintronics applications of materials. When the spins in magnets form a spatial texture, the texture gives rise to an additional contribution to the Hall transport of the electrons via its real-space Berry curvature. Such an effect is known as the topological Hall effect (THE), which is often observed as signature of the formation of magnetic skyrmions. On the other hand, magnetically-doped surface states of topological insulators (TIs) exhibit the (quantized) anomalous Hall effect intrinsically even in the absence of magnetic textures, due to the momentum-space Berry curvature characteristic to the gapped Dirac surface state.

This talk introduces our theoretical idea on the interplay between magnetic textures and TI surfaces, especially on their effect on the electron transport [1]. We focus on the interface between a TI and a magnetic insulator (MI) with bubble-like magnetic textures on the top (see Fig. 1), and take into account the exchange interaction between the electron spin on the TI and the local magnetization in the MI. We calculate the transport coefficients with the Boltzmann transport theory, by estimating the electron scattering rate at a single magnetic texture. The system obtains an additional contribution to the anomalous Hall conductivity due to the scattering skewness by the textures, arising from the geometric phase acquired through the electron transmission process at its boundary. This mechanism is distinct from that of the THE in non-topological magnets. We also discuss the applicability of our analysis to magnetic skyrmion textures.

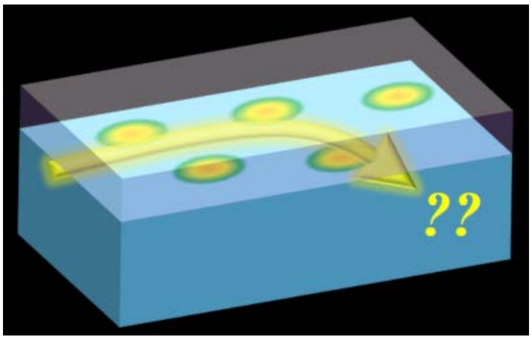

Fig. 1: Schematic image of the heterostructure system of a topological insulator and a magnetic insulator that we take in the present analysis.

[1] Y. Araki and K. Nomura, Phys. Rev. B **96**, 165303 (2017).