Electron transport and emergent spin electrodynamics in magnetization textures

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ABSTRACT

In this lecture, we discuss electron transport in the presence of magnetization textures in ferromagnetic metals[**?**, **?**]. It is discussed that electrons in the presence of slowly-varying magnetization texture acquires a quantum mechanical phase, which is equivalent to an effective electromagnetic field (spin gauge field) that couples to electron spin in the adiabatic limit. Such spin electromagnetic field was discussed in the context of a voltage generated by a canting of a driven domain wall [**?**], and mathematically rigorous formulation was given by Volovik [**?**]. When a spin-polarized electric current is applied, the adiabatic spin gauge field leads to spin-transfer torque [**?**] and moves the magnetization structure. The idea of effective gauge field can be extended to the cases with spin relaxation [**?**], Rashba interaction [**?**, **?**, **?**, **?**]. It was recently shown that an antisymmetric exchange interaction (Dzyaloshinskii–Moriya interaction) is caused by the spin gauge field in the presence of intrinsic spin current [**?**]. Moreover, optical properties of Rashba conductors such as directional dichroism when a magnetic field is applied turned out to be described by the effective gauge field generated by the Rashba interaction [**?**].

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