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Probing ultrafast spin transport with terahertz electromagnetic pulses

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Spintronics research takes advantage of the charge and the spin of the electrons in solids to explore and develop future information-processing functionalities. Topological features play an important role in spintronic transport phenomena such as the anomalous Hall effect, the spin Hall effect [1] and anisotropic magnetoresistance [2]. A possible approach to address the relevance of topological features is to probe these effects with ultrashort electromagnetic pulses covering the terahertz (THz) frequency range.

For example, by measuring anisotropic magnetoresistance from 0 to 30 THz, one probes electron transport at rates both slower and faster than the average time between two collision events of conduction electrons. In this way, both extrinsic (i.e. scattering-related) and intrinsic (i.e. scattering-unrelated) contributions [3] are addressed, the latter including topological effects [2].

In this tutorial, I will introduce the methodology of terahertz spectroscopy and its application to spintronic transport phenomena including the anomalous Hall effect [4], anisotropic magnetoresistance [3] and the inverse spin Hall effect [5]. Besides their fundamental relevance, spintronic transport effects have interesting applications such as the efficient generation of broadband THz pulses [6].

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