

Detecting Spin Currents by the Emission of THz Radiation

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The generation of spin currents by a laser pulse is a proposed mechanism contributing to ultrafast demagnetization. The spin Hall effect in an adjacent nonmagnetic layer provides an efficient way to detect the injected spin current via its THz emission characteristics [1]. We demonstrate for a variety of ferromagnetic/non-magnetic heterostructures that excitation with femtosecond pulses (10-80 fs) centered at 800 nm leads to THz radiation emitted from the film. The electric field of this radiation can experimentally be measured as a function of time through electro-optic sampling, from which the Terahertz frequency currents inside the films can be inferred [2]. The broadband nature (1 THz-30 THz) of this emission additionally makes it a potential tool for spectroscopy, particularly in the difficult to access region between (5-10 THz).

[1] Seifert, T., Jaiswal, et al. Efficient metallic spintronic emitters of ultrabroadband terahertz radiation. *Nature Photonics* **10**, 483–488 (2016).

[2] Kampfrath T., Battiato M., et al. Terahertz spin current pulses controlled by magnetic heterostructures. *Nature Photonics* **8**, 256–260 (2013).