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Terahertz spin currents in magnetically ordered thin films

Shortly after the recent discovery of the spintronic emission of short pulses of terahertz (THz) radiation [1], new prospects for a phase- and frequency-resolved detection of ultrashort spin currents have emerged [2]. The analysis of emitted THz pulses has provided both fundamental and application relevant insights into the generation [3], propagation [4,5] and conversion [6] of picosecond-long spin currents in magnetically ordered thin films.
In the lecture, we will overview the spintronic emission of THz radiation as compared to traditional THz sources and explain the detection and extraction of ultrafast spin currents in the in-plane and out-of-plane geometries. In the follow-up seminar, we illustrate these techniques on our real recent experimental results and propose a strategy to transfer the ultrafast spintronic functionalities into fully compensated magnetic systems [7]. Such a transfer could open pathways towards ultra-dense, ultra-fast and energy-efficient non-volatile memories that are beyond the reach of the established ferromagnetic technology.

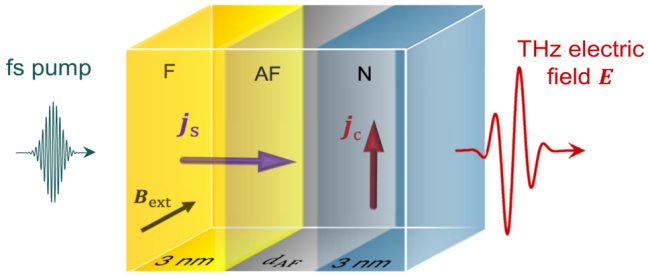

Fig.1. The spintronic emission of pulses of terahertz (THz) radiation. The ultrashort laser pulse excites the ferromagnetic layer (F) and launch the ultrashort spin current $j_s(t)$ into the adjacent spacer layer (AF). After its propagation through AF, it is converted into the inplane charge current $j_c(t)$ via the inverse spin Hall effect in heavy non-magnetic metal (N). Subsequently, the electric dipole radiation due to j_c emits a THz pulse $E(t)$. By detecting and analyzing it, the ultrafast temporal dynamics $j_s(t)$ can be reconstructed.

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[3] R. Rouzegar et al., Phys. Rev. B **106**, 144427 (2022).
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[5] J. Jechumtál et al., arxiv 2310.12082v2 (2023).
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