

SEMINAR ANNOUNCEMENT

DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING
COLLEGE OF DESIGN AND ENGINEERING
Website: <https://cde.nus.edu.sg/ece>

Area: Microelectronic Technologies & Devices (MTD)

Host: Prof Yang Hyunsoo

TOPIC	:	Toward terahertz spin-orbitronics
SPEAKER	:	Prof Tobias Kampfrath Professor, Department of Physics, Freie Universität Berlin, Germany
DATE	:	Friday, 4 September 2026
TIME	:	11:00AM-12:00PM
VENUE	:	E3-06-01

ABSTRACT

In future electronics, the charge of electrons as well as their spin and orbital angular momentum will serve as information carriers. This spin-orbitronic approach has led to fascinating functionalities that include the electric transport and detection of electron spin and the electric writing of magnetic information up to megahertz and gigahertz frequencies. However, to be competitive and compatible with electronics, spin-orbitronic operations need to ultimately work at extremely high frequencies approaching the terahertz range. In this talk, I will first discuss how terahertz spin-orbitronic circuits can be realized by using ultrafast spin-orbitronic batteries, conductors and detectors. Our circuits are driven by femtosecond laser pulses (down to 10 fs) and interrogated by the electric-field transients (0.3-30 THz) they emit. This approach provides new insights into spin-orbital transport and spin-charge conversion in, e.g., magnetic and topological materials, all on the femtosecond scale of electronic relaxation processes. In a second, reciprocal scheme, we use ultrashort terahertz electric-field pulses to induce and reveal the first steps of spin-orbital accumulation, spin-orbit torques and spin-Hall magneto-resistance. By pushing the terahertz field to amplitudes of ~1 MV/cm, we can even write an antiferromagnetic bit, fully electrically and within picoseconds. Finally, we take advantage of spin-orbitronic effects to develop new sources and detectors of ultrabroadband terahertz radiation for photonic and sensing applications down to the nanoscale.

BIOGRAPHY

Tobias Kampfrath is Professor of Experimental Physics at Freie Universität Berlin, where he leads the research group "Terahertz Physics of Quantum Materials." His research focuses on ultrafast processes in complex materials, including terahertz dynamics and transport of charge, energy, and angular momentum in nanostructures and at interfaces, as well as terahertz photonics. Before joining Freie Universität Berlin, he headed the Terahertz Physics group at the Fritz Haber Institute of the Max Planck Society. He previously held postdoctoral positions at Freie Universität Berlin and AMOLF in Amsterdam. Professor Kampfrath has authored more than 110 journal articles and holds one patent, with over 90 invited conference presentations. His research has been recognized by multiple European Research Council grants, including an Advanced Grant in 2024, a Proof of Concept Grant in 2023, and a Consolidator Grant in 2015. Since 2025, he has served as Dean of Research in the Department of Physics at Freie Universität Berlin.

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