Max-Planck-Institut für Struktur und Dynamik der Materie

Max Planck Institute for the Structure and Dynamics of Matter

IMPRS UFAST Call for PhD applications 2025/2026

NH2 – Nonlinear IR/THz spectroscopy of phonon- and spin dynamics in topological insulators

Title of PhD Project	**Nonlinear IR/THz spectroscopy of phonon- and spin dynamics in topological insulators**
Type	Experimental
Supervisor(s)	Nils Huse
Affiliation(s):	UHH
Number of positions:	1
Abstract:	TIs are an emerging class of materials that are generating considerable interest. TIs exhibit an insulating bulk and highly conductive surface states.[1,2] Owing to the very high spin-orbit coupling, these topological surface states (TSS) exhibit spin-momentum locking, providing protection against back-scattering, a process that traditionally imparts electrical resistance and heating leading to inefficiency and material failure. Such materials have the potential to enable new device methodologies, particularly in spintronic applications, quantum computing based on Majorana zero modes, and spin-plasmonics. THz radiation is the ideal tool to study many key properties of TI materials. In this project, we will employ multi-dimensional non-linear spectroscopy[3] by combining THz pulses with excitations at (1) IR-excitations below the bulk bandgap to only excite surface carriers, (2) Raman probes that can monitor Raman active phonons after pumping of IR-active phonons, and (3) X-ray pulses that can probe dynamical changes of the crystal structure after THz excitation. The project closely involves our partners at University of Leeds, who are part of the Henry Royce Institute which is world-leading in fabriacting wafer-scale TI materials. 1. S. Scheitz et al, *ACS Appl. Mater. Interfaces.* **14**, 32625 (2022) https://doi.org/10.1021/acsami.2c04380 2. C. Nweze et al, *Adv. Mater. Interfaces.* **11**, 2301109 (2024) https://doi.org/10.1002/admi.202301109 3. T. B. Gill et al, *ACS Photonics* **11**, 1447, (2024) https://doi.org/10.1021/acsphotonics.3c01522
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