SINGLE-SHOT TERAHERTZ TIME-DOMAIN SPECTROSCOPY IN PULSED, HIGH MAGNETIC FIELDS

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In solids placed in high magnetic fields, there are a number of low energy excitations of both spin and orbital origins that occur in the terahertz frequency range however combining access to high magnetic fields with terahertz time-domain spectroscopy (THz-TDS) remains a difficult challenge. Recently, we have developed a minicoil pulsed magnet well suited for time-domain spectroscopy techniques because of direct optical access to the sample via windows [1], and we have demonstrated the ability to perform THz-TDS measurements utilizing a rapid scanning spectrometer up to a few Tesla [2]. In order to more efficiently perform these measurements at higher magnetic fields, we are required to measure the time response utilizing a single shot technique [3].

We have developed a single-shot terahertz time-domain spectrometer to perform optical pump/terahertz probe experiments in pulsed, high magnetic fields. We utilize the tilted-pulse-front excitation method for efficient phase-matched terahertz generation in LiNbO3. The single-shot detection of the terahertz waveform incorporates a reflective echelon to create time-delayed beamlets across the intensity profile of the probe beam before it spatially and temporally overlaps with the terahertz radiation in a ZnTe detection crystal. After imaging the probe beam onto a camera, the terahertz time-domain waveform can be recorded. As a demonstration, we have measured the terahertz response of bulk, intrinsic silicon up to 1 ns after optically exciting carriers at a sample temperature of 10 K and up to magnetic fields of 30 T. This apparatus provides a suitable platform to study high T_c superconductors, multiferroic materials, and magneto-excitonic physics in pulsed, high magnetic fields.

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Category: MO
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