**Terahertz Time-domain Spectroscopy in the Split-Florida Helix**

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**Introduction**

THz time-domain spectroscopy (TTDS) is a method used for exploring the electronic and quantum properties of two dimensional electron and hole gases by tracing the effect of these materials on the amplitude and phase of THz radiation. We have developed a gas plasma based THz time–domain spectrometer coupled with an air-biased coherent detection (ABCD) system, to study ultrafast dynamics in the 25 T Split-Florida Helix magnet at the National High Magnetic Field Laboratory (NHMFL)[1-3].

**Experimental**

The experimental setup utilizes a 5 mJ, 25 fs titanium:sapphire amplifier operating at 1 kHz and is depicted in **Fig. 1**. We generate far- infrared THz pulses using a modified four-wave mixing technique, producing terahertz pulses with energies of several nJ and with frequencies reaching 10 THz. The near-infrared beam is split into a THz generating beam, a gate beam that passes through an optical delay line and acts as the probe signal, and a pump signal that photo-excites the sample. The ABCD system uses a high voltage modulator to generate frequencies at the second harmonic and is then detected by the PMT. The usable bandwidth in our experiment continuously covers the bandwidth from 0.2 to approximately 7 THz, where the upper limit is the result of the reststrahlen bands of the gallium arsenide substrate used in our experiment.

**Results and Discussion**

 We have used this new instrument to study the ultrafast dynamics of excitons and free carriers in a series of gallium arsenide samples; we will highlight one result in this report.. The sample in this example is an 18 nm (100) oriented bulk gallium arsenide quantum well grown via molecular beam epitaxy. Figure 1 shows the resulting dynamics after photoexcitation with an above the band gap optical pulse. The complex series of dynamics over the first two picoseconds after the arrival of the optical pump pulse reflect the generation of short-lived quasi-particles with energy within the bandwidth of the terahertz pulse (hν ≤ 40 meV). These lead to both changes in amplitude and phase of the transmitted THz, and manifest in our data as a complex multi-component decay. Onset of additional components in the decay above 5 T and 20 T reflect changes in the underlying band structure and many-body excitations in GaAs quantum wells at high fields.

**Conclusions**

We have used our new broadband ultrafast terahertz spectrometer to measure the dynamics of many-body excitations in GaAs Quantum wells.

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**Fig.1** Ultrafast Dynamics in VA0605 after low fluence photoexcitation in a gallium arsenide quantum well.

**References**

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