

Probing THz-Driven Excitons in Magnetic and Conventional Semiconductors

Meg Verano¹, Juan Gaitan^{2,3}, Qile Wu^{2,3}, Nick Agladze^{2,3}, Mark Sherwin^{2,3}

1. Physics Department, New Mexico State University, Las Cruces, NM, 88003, USA

2. Physics Department, University of California, Santa Barbara, CA, 93106, USA

3. Institute for Terahertz Science and Technology, University of California, Santa Barbara, CA, 93106, USA

When a terahertz field is driven into a material, it is theorized that excitons in conventional semiconductors, such as gallium arsenide, will first ionize and then stabilize with increasing field strength. This adiabatic stabilization is something we aim to observe using absorption spectroscopy techniques. We first predict to see the exciton peak broaden and suppress asymmetrically as a result of the THz coupling to and disrupting the exciton. Following this broadening, the peak should again narrow, indicating an increase in exciton lifetime. The ionization rate can be extracted from fitting the Fano resonance to the absorption line shapes. In preparation for this planned THz experiment, control data has been taken on bulk and quantum well gallium arsenide using absorption spectroscopy with near infrared LED in the range of 820 - 870 nm. Nickel phosphorus trisulphide is another material of interest. As a Mott insulator, the excitons pair in different ways than a conventional semiconductor. NiPS₃ excitons rely on the antiferromagnetic ordering of the material to survive, and this ordering is only present below 150 K. These excitons are far more robust, with a binding energy of a few hundred meV, and do not arise out of conventional band theory. We hope to use THz pump along with spectroscopy as a probe to observe magnon-exciton coupling by observing how the exciton spectrum changes under resonant pumping of magnon mode at 300 GHz in the absorption data, and phonon-exciton coupling in photoluminescence data. NiPS₃ samples have been prepared using an exfoliation and stacking technique using tape and a polymer stamp, as this Van der Waals material can be stripped down to atomically thin layers. This work is supported by NSF DMR 2333941.