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Terahertz spectroscopy of two-dimensional electron-hole pairs: probing Mott physics of magneto-excitons QI ZHANG, WEILU GAO, Rice University, JOHN WATSON, MICHAEL MANFRA, Purdue University, JUNICHIRO KONO, Rice University — Density-dependent Coulomb interactions can drive electron-hole ($e-h$) pairs in semiconductors through an excitonic Mott transition from an excitonic gas into an $e-h$ plasma. Theoretical studies suggest that these interactions can be strongly modified by an external magnetic field, including the absence of inter-exciton interactions in the high magnetic field limit in two dimensions, due to an $e-h$ charge symmetry, which results in ultrastable magneto-excitons. Here, we present a systematic experimental study of $e-h$ pairs in photo-excited undoped GaAs quantum wells in magnetic fields with ultrafast terahertz spectroscopy. We simultaneously monitored the dynamics of the intraexcitonic $1s$-$2p$ transition (which splits into $1s$-$2p_+$ and $1s$-$2p_-$ transitions in a magnetic field) and the cyclotron resonance of unbound electrons and holes up to 10 Tesla. We found that the $1s$-$2p_-$ absorption feature is robust at high magnetic fields even under high excitation fluences, indicating magnetically enhanced stability of excitons. We will discuss the Mott physics of magneto-excitons as a function of temperature, $e-h$ pair density, optical pump delay time, as well as magnetic field, and also compare two-dimensional excitons in GaAs quantum wells with three-dimensional excitons in bulk GaAs.

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