FROM MAHAN EXCITONS TO LANDAU LEVELS AT HIGH MAGNETIC FIELDS: 2DFT SPECTROSCOPY REVEALS HIDDEN QUANTUM CORRELATIONS

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Two-dimensional electron gases have been the subject of research for decades. Modulation doped GaAs quantum wells in the absence of magnetic fields exhibit interesting many-body physics such as the Fermi edge singularity or Mahan exciton and can be regarded as a collective excitation of the system. Under high magnetic fields Landau levels form which have been studied using transport and optical measurements. Nonlinear coherent two-dimensional Fourier transform (2DFT) spectroscopy however provides new insights into these systems. We present the 2DFT spectra of Mahan Excitons associated with the heavy-hole and light-hole resonances observed in a modulation doped GaAs/AlGaAs single quantum well. These resonances are observed to be strongly coupled through many-body interactions. The 2DFT spectra were measured using co-linear, cross-linear, and co-circular polarizations and reveal striking differences. Furthermore, 2DFT spectra at high magnetic fields performed at the National High Magnetic Field Lab will be discussed. The spectra exhibit new features and peculiar line shapes suggesting interesting underlying physics.

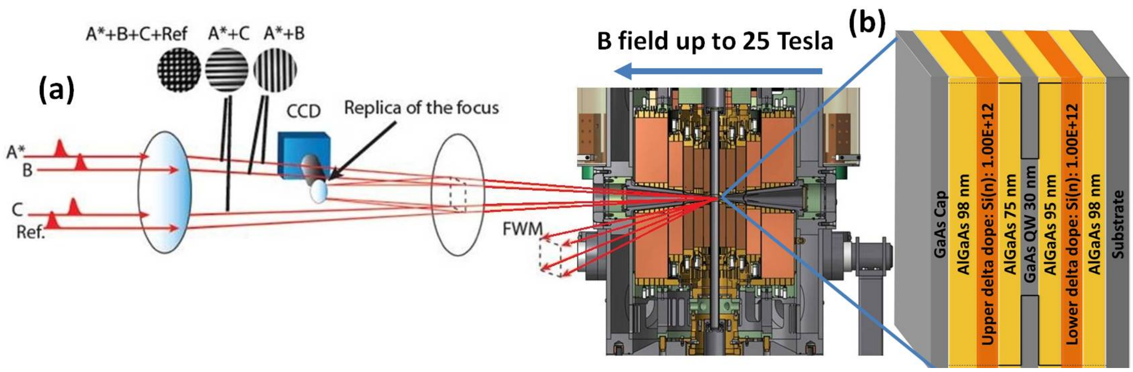

Fig. 1: ***(a)*** *Four phase stabilized laser pulses are obtained the multidimensional nonlinear spectrometer (MONSTR) operational at USF. Three beams A*, B, and C are used to generate the FWM signal. Heterodyne detection can be achieved by splitting a portion of the laser pulse and combining the signal (FWM) with reference (Ref) beam. By dispersing the heterodyned signal into the spectrometer and after Fourier transforming 2DFT spectra can be obtained.* ***(b)*** *Sample held at cryogenic temperatures and in magnetic field. The magnet shown is a realistic drawing of the 25 Tesla split coil magnet in Tallahassee, which became operational in 2011.*

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