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Many-body Interactions in Semiconductors Probed by Optical Two-dimensional Fourier Transform Spectroscopy T. ZHANG, JILA, Univ. Colorado, X. LI, JILA, S. T. CUNDIFF, JILA, NIST, R. P. MIRIN, NIST, I. KUZNETSOVA, Philipps Univ., Marburg, Germany — Optically excited semiconductors with dominant near band-gap features provide an ideal laboratory for the study of fundamental many-body problems in condensed matter physics. Optical two-dimensional (2D) Fourier transform spectroscopy, which correlates the phase evolution of the nonlinear polarization during the initial evolution and final emission periods, has been utilized to investigate the interactions of excitons (the quasi-particles of bound electron-hole pairs) in semiconductor quantum wells. The strength and lineshape of the excitons and continuum states in 2D spectra show the influences of various exciton interactions, including excitation-induced dephasing, excitation-induced shift, biexciton formation, and local field corrections. The 2D spectra are sensitive to experimental conditions such as tuning, excitation density and polarization. The signatures of exciton interactions under different excitation conditions, including co-linear, co-circular and cross-linear polarizations, are identified in a microscopic theory with nonlinearities up to the third order in coherent $\chi^{(3)}$-limit beyond the Hartree-Fock level and achieve qualitative agreement with the experiments.

Tianhao Zhang
JILA

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