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Dynamical birefringence: Electron-hole recollisions as a probe of Berry curvature[1] QILE WU, Dept. of Physics, CUHK, HUNTER BANKS, DARREN VALOVCIN, Dept. of Physics, UCSB, SHAWN MACK, Naval research Laboratory, ARTHUR GOSSARD, Material Dept., UCSB, LOREN PFEIFFER, Electrical Engineering Dept., Princeton Univ, RENBAO LIU, Dept. of Physics, CUHK, MARK SHERWIN, Dept. of Physics, UCSB — Electron-hole recollisions and high-order sideband generation (HSG) occur when a near-band gap laser beam excites a semiconductor that is driven by sufficiently strong, THz-frequency electric fields. We report theoretical studies of HSG in GaAs/AlGaAs quantum wells based on recent experimental observations: (1) Sidebands with order greater than 20 are usually stronger when the near-infrared (NIR) electric field is polarized perpendicular to the THz electric field than when they are parallel. (2)Even though the polarization of the exciting NIR laser is nearly linear, the sidebands exhibit significant ellipticity. We call these phenomena dynamical birefringence. With non-Abelian Berry curvature as an essential part, a generalization of the three-step model for high-order harmonic generation is proposed to explain these phenomena. Dynamical birefringence arises from quantum interference between electron-hole recollision pathways associated with electron-hole pairs that were injected with opposite spins. We also carry out quantum simulations to confirm the Berry physics. Our results open the door to direct measurements of the complete electronic structure of semiconductors and insulators near the Γ point, including band structure, scattering rates, and Berry curvature.

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Qile Wu
Chinese Univ of Hong Kong

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