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Novel Instrumentation for 2D Characterization: Combined Magneto-Optical Magneto-Transport

Raman spectroscopy, imaging, and mapping are powerful non-contact, non-destructive optical probes of quasiparticles and fundamental physics in graphene and other related two-dimensional (2D) materials, including layered, quantum materials. An amazing amount of information can be quantified from the Raman spectra, including layer thickness, disorder, edge and grain boundaries, doping, strain, thermal conductivity, magnetic ordering, and unique excitations such as magnons and charge density waves. Most interestingly for quantum materials is that Raman efficiently probes the evolution of the electronic structure and the electron-phonon, spin-phonon, and magnon-phonon interactions as a function of laser energy and polarization, temperature, and applied magnetic field. Our unique magneto-Raman spectroscopic capabilities will be detailed, enabling spatially resolved optical measurements while simultaneously measuring electrical transport in a back-gated graphene Hall bar device. Raman and electrical data from an hBN-graphene-hBN device operating in the quantum Hall regime will demonstrate our novel capabilities. In addition, unconventional quantization plateaus from a PNP junction created via spatial photodoping by the Raman laser will be presented.