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Nano-photonic phenomena in van der Waals atomic layered materials

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Layered van der Waals (vdW) crystals reveal diverse classes of light-matter modes (polaritons) including: surface plasmon polaritons in graphene, hyperbolic phonon polaritons in boron nitride, exciton polaritons in MoS2, Cooper pair plasmon polaritons in high-Tc cuprates, topological plasmon polaritons and many others. Polaritons in vdW materials are of considerable technological interest. For example, polaritonic modes enable sub diffractional focusing and imaging in infrared frequencies. Applications apart, infrared nano-imaging of propagating polaritons facilitates experimental access to new physics of vdW materials not attainable with conventional spectroscopic methods. I will discuss two recent experiments performed in our group that utilize unique virtues of polaritons. Nano-imaging of plasmon polaritons in moire superlattices formed in graphene on boron nitride has allowed us to establish the important features of the electronic structure of this interesting from of graphene. Pump-probe hyper-spectral images of non-equilibrium plasmon polaritons in graphene revealed novel aspects of carrier relaxation.