Keynote

Electrical control and detection of nanoscale optical fields with 2d materials

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In this talk, we use 2d materials to tailor novel nano-optoelectronic capabilities, exploiting strong-light matter interactions at the nanometer scale.

First, we will discuss the strong near-field interactions between graphene and nanoscale light-emitters [1,2]. Because graphene is gapless with tunable carrier density, it can effectively behave as a semiconductor, a dielectric, or a metal. We exploit this to electrically control optical emitter relaxation pathways [2]. Specifically, we control whether emitter excitations are converted into either photons, electron-hole pairs, or plasmons with confinement to the graphene sheet below 15 nm. Additionally, we electrically detect the transferred energy from the emitter into the graphene, enabling all-electrical detection of the diamond NV center spin [3].

Second, we address the highly confined optical fields (plasmons) [4,5] in heterostructures of graphene and hexagonal boron nitride [6]. We find unprecedented low plasmon damping, while the device structures enable even stronger field confinement than for earlier graphene plasmon devices. Based on these results, we address new configurations to electrically control and detect plasmons, and develop a detailed understanding of their decay mechanisms and coupling to electronic excitations. Finally, we discuss the carrier dynamics in graphene from a broader perspective, evaluating the potential for new classes of opto-electronic devices [7].

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