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Stacking and twisting 2D materials for quantum nano-optoelectronics

We discuss 2D-material heterostructures as a novel toolbox for controlling light and electrons at the atomic scale. In particular, we will show nano-optoelectronic devices that demonstrate the exciting properties of 2D polaritons1,2,3,4,5, such as plasmon, phonon and exciton polaritons. We challenge the limits of quantum light-matter interactions and study the fundamental limits of optical field confinement and optical non-linearities and topological properties down to the length-scale of single atoms2. In addition, quantum confined status can be probed through intersubband transitions in few-layer semi-conducting 2D materials5.

We will also present studies on twisted bilayer graphene using scanning near-field optical microscopy. Twisted bilayer graphene near the magic angle (MABG) exhibit strongly correlated phases have been observed, including superconductivity and the Mott-like insulating state6,7. We studied plasmon excitations associated to vertical transitions between the flat bands and the first excited bands close to the K point of the Moiré lattice Brillouin zone8.

Some device applications, such as detectors for infrared and THz light will also be discussed9.

References

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Figures