Probing quantum phenomena in graphene and 2D materials by nano-imaging of polaritonics waves

D.N. Basov
Columbia University, New York, NY, USA
db3056@columbia.edu
http://infrared.cni.columbia.edu

Van Der Waals (vdW) reveal a variety of light-matter modes referred to as polaritons including: Dirac plasmon polaritons in graphene, hyperbolic phonon polaritons in hexagonal boron nitride, exciton polaritons in dichalcogenides, Cooper pair plasmon polaritons in high-Tc cuprates and many others. Real space images of polaritonic standing and traveling waves contain rich insights into quantum phenomena occurring in the host material supporting polaritons [1]. Pump-probe nano-imaging of propagating polaritons can be carried out at sub picosecond time scales: a valuable tool for exploring photo-induced dynamics of graphene and other vdW materials [2]. The analysis of polaritonic images allows on one reconstruct local variations of the electronic response occurring at the atomic scale[3,4]. This line of inquiry into fundamental physics through polaritonic observations constitutes an entirely novel approach toward optics-based materials research.

References

[1] D.N. Basov, M.M. Fogler and J. Garcia De Abajo, Science 354, 195 (2016).
[2] G. X. Ni et al. Nature Photonics 10, 244 (2016).
[3] Z. Fei, et al. Nature Nanotechnology 8, 821 (2013).
[4] G.X. Ni et al. Nature Materials 14, 1217 (2015).

Figures

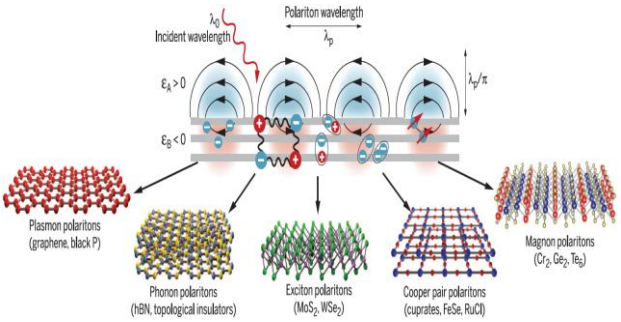

Figure 1: Polaritons—a hybrid of light-matter oscillations—can originate in different physical phenomena: conduction electrons in graphene and topological insulators (surface plasmon polaritons), infrared-active phonons in boron nitride (phonon polaritons), excitons in dichalcogenide materials (exciton polaritons), superfluidity in FeSe- and Cu-based superconductors with high critical temperature Tc (Cooper-pair polaritons), and magnetic resonances (magnon polaritons). The family of vdW materials supports all of these polaritons [1].