Near-field optical characterization techniques of twisted and indirectly nanostructured 2D material heterostructures

Frank Koppens
ICFO – *The institute of Photonic Sciences*
ICREA
Frank.koppens@icfo.eu

Two-dimensional (2D) materials offer extraordinary potential for control of light and light-matter interactions at the atomic scale. In particular, twisted 2D materials has recently attracted a lot of interest due to the capability to induce moiré superlattices and discovery of electronic correlated phases [1,2]. In this talk, we present nanoscale optical techniques such as near-field optical microscopy and photocurrent nanoscopy, and reveal with nanometer spatial resolution unique observations of the optical properties of twisted 2D materials. The freedom to engineer these so-called optical and electronic quantum metamaterials [1,3] is expected to expose a myriad of unexpected phenomena.
As an example for indirectly patterned polaritons, we introduce and demonstrate a novel multimodal reflection mechanism of the ray-like optical excitations in hyperbolic materials, such as hBN. Using near-field microscopy, we observe mid-IR confinement in BIC-based nanocavities with volumes down to 23x23x3 and quality factors above 100 – a dramatic improvement in several metrics of confinement.

References

[1] Song, Gabor et. al., Nature Nanotechnology (2019)
[2] Cao et al., Nature (2018)
[3] Hesp et al., Nature Physics (2021)
[4] Hesp et al., Nature Communications (2020)
[5] Epstein et al., Science (2020)
[6] Herzig Sheinfux et al., (2021)

Figures

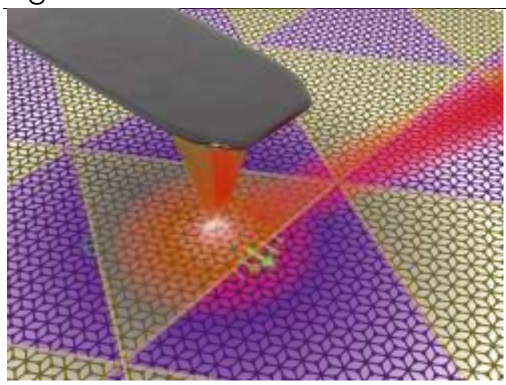

Figure 1: Photocurrent nanoscopy inside the Moiré unit cell of minimally twisted bilayer graphene