Quantum plasmonics, polaritons and strong light-matter interactions with 2d material heterostructures

Frank Koppens[1,2]

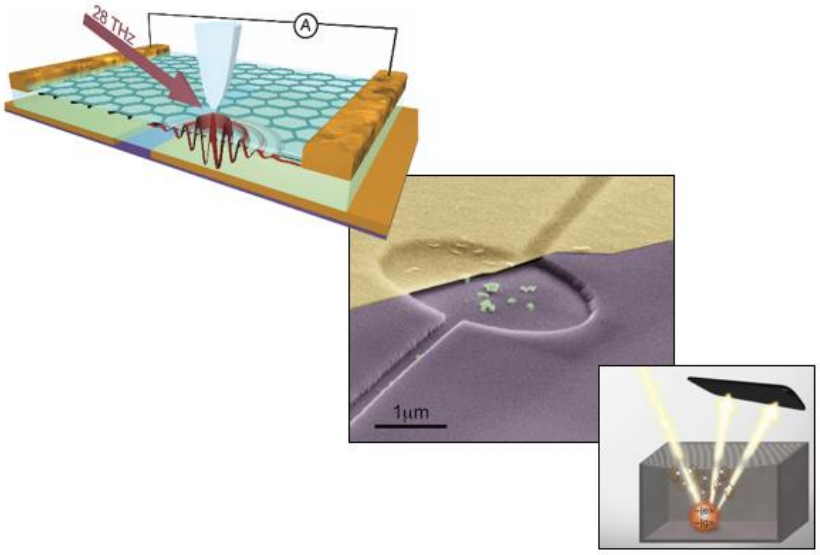
1ICFO-Institut de Ciencies Fotoniques, The Barcelona Institute of Science and Technology, 08860 Castelldefels (Barcelona), Spain
[2]ICREA – Institució Catalana de Recerça i Estudis Avancats, Barcelona, Spain.
Frank.koppens@icfo.eu

The control of polaritons are at the heart of nano-photonics and opto-electronics. Two-dimensional materials have emerged as a toolbox for in-situ control of a wide range of polaritons: plasmons, excitons and phonons. By stacking these materials on top of each other, heterostructures of these materials can be controlled at atomic scale, with extremely high quality and clean interfaces.

In this talk, we will show several examples of 2d material heterostructure devices with novel ways of exciting, controlling and detecting polaritons [1,2,3]. We challenge the limits of quantum light-matter interactions [5,6] as well as extremes in propagating plasmon confinement, down to the scale of a few nanometers.

The advances on ultra-high quality materials allow for plasmon propagation at extremely small electron densities, with de Broglie wavelength above 50 nm. This is an excellent platform for testing quantum theories of the dynamic response of the electron system, including spatial dispersion and electron-electron correlation effects.

Finally, we present novel results on Super-Planckian energy transfer between hot electrons and hyperbolic phonon polaritons [7]. Future directions on new directions in quantum materials will be addressed.



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