Topological and quantum nanophotonics with 2d materials

Frank Koppens[1,2]

[1]*ICFO-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

We discuss the extraordinary topological and quantum properties of novel two-dimensional materials. In particular, we address effects of Berry curvature and electron interactions on infrared and Terahertz collective excitations. THz and infrared near-field imaging and spectroscopy techniques have been exploited to directly spatially visualize the topological interfaces, plasmon propagation and effects of disorder.

Several two-dimensional materials are model systems with tunable topological electronic bands that exist only in a few exotic materials. In particular, gapped bilayer graphene can exhibit interesting topological phenomena such as collective charge density oscillations (plasmons) that are protected from disorder as they can live in separate Valleys. Gapped graphene also exhibits the valley hall effect where a Hall voltage is generated with circular polarized light, even at zero magnetic field. Here, we will discuss the progress and prospects of topological nanophotonics with two-dimensional materials.

We envision that topological nano-photonics is a new paradigm for novel quantum materials and will enable novel future applications in miniaturized photonic isolators, diodes and logic circuits and could lead to completely new concepts for communication systems, optical transistors and optical information processing.