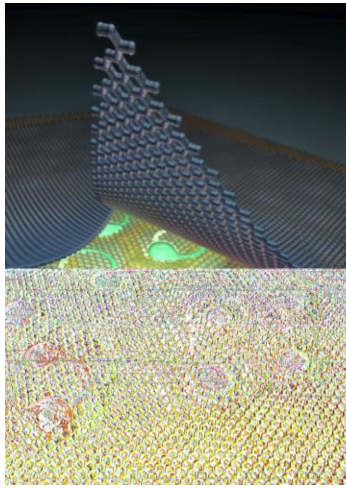
ICFO Massachusetts Institute of Technology

Schools on the Frontiers of Light. Symposium on “Emergent phenomena in Moiré materials”

HOT TOPICS SESSION

18:00 – 19:00 CEST

Join In



18:00 Simulating twisted bilayers w8ith ultra-cold atoms, by Alejandro González-Tudela

18:15 Collective excitations in twisted bilayer graphene, by Niels Hesp

18:30 Signatures of fragile topology in the Hofstadter spectrum of twisted bilayer graphene, by Xiaobo Lu

18:45 Simulating twistronics without a twist, by Debraj Rakshit

Schools on the Frontiers of Light. Symposium on "Emergent phenomena in Moiré materials"

HOT TOPICS SESSION

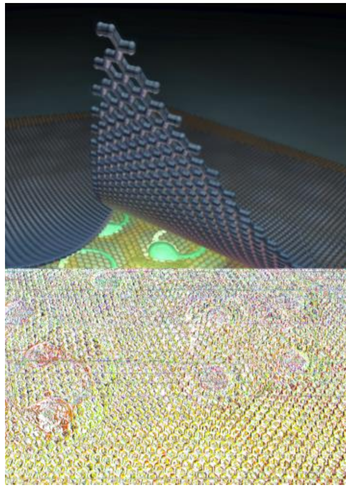
18:00 – 19:00 CEST

Join In

18:00 Simulating twisted bilayers with ultra-cold atoms

By Alejandro González-Tudela
Institute of Fundamental Physics-CSIC

The possibility of creating crystal bilayers twisted with respect to each other has led to the discovery of a wide range of novel electron correlated phenomena the full understanding of which is still under debate. Here we propose and analyze a method to simulate twisted bilayers using cold atoms in state-dependent optical lattices. Our proposed setup can be used as an alternative platform to explore twisted bilayers which allows one to control the inter-and intralayer coupling in a more flexible way than in the solid-state realizations. We focus on square geometries but also show how it can be extended to simulate other lattices which show Dirac-like physics. This setup opens a path to observe similar physics, eg, band narrowing, with larger twist angles, to rule out some of the mechanisms to explain the observed strongly correlated effects, as well as to study other phenomena difficult to realize with crystals.



Reference: Phys. Rev. A 100, 053604

ICFO Massachusetts Institute of Technology

Schools on the Frontiers of Light. Symposium on “Emergent phenomena in Moiré materials”

HOT TOPICS SESSION

18:00 – 19:00 CEST

Join In

18:15 Collective excitations in twisted bilayer graphene close to the magic angle

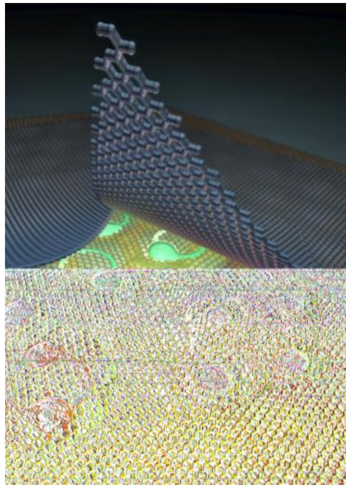
By Niels Hesp

Quantum Nano-Optoelectronics at ICFO

In this work, we unveil, via near-field optical microscopy, a collective plasmon mode in charge-neutral TBG near the magic angle, which is dramatically different from the ordinary single-layer graphene intraband plasmon. In selected regions of our samples, we find a gapped collective mode with linear dispersion, akin to the bulk magnetoplasmons of a two-dimensional (2D) electron gas. We interpret these as interband plasmons and associate those with the optical transitions between quasi-localized states originating from the moiré superlattice.

Surprisingly, we find a higher plasmon group velocity than expected, which implies an enhanced strength of the corresponding optical transition. This points to a weaker interlayer coupling in the AA regions.

These intriguing optical properties offer new insights, complementary to other techniques, on the carrier dynamics in this novel quantum electron system.



ICFO Massachusetts Institute of Technology

Schools on the Frontiers of Light. Symposium on “Emergent phenomena in Moiré materials”

HOT TOPICS SESSION

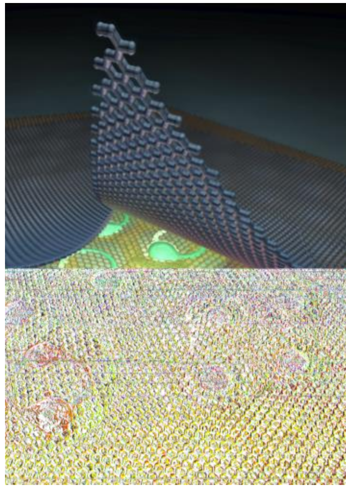
18:00 – 19:00 CEST

Join In

18:30 Signatures of fragile topology in the Hofstadter spectrum of twisted bilayer graphene

By Xiaobo Lu
Low-Dimensional Quantum Materials at ICFO

The symmetries of crystalline systems can give rise to protected topological surface states that are robust against disorder and lattice defects. A new, ‘fragile’ version of crystalline band topology, formulated in terms of obstructions to the Wannier representation, has recently been theoretically identified. However, due to the lack of protected surface states or an alternate spectroscopic fingerprint, experimental evidence for fragile band topology is still scarce. Here we report on high magnetic field magneto-transport measurements of the Hofstadter butterfly in twisted bilayer graphene close to the second magic angle of 0.5°. Since the lowest two valley-projected bands in twisted bilayer graphene carry a total Dirac helicity index 2, exponentially localized symmetric Wannier wave functions are prohibited, giving rise to fragile topology at all twist angles. These attributes lead to a qualitatively new, energetically unbound and connected Hofstadter butterfly spectrum in which fragile topology is revealed by continuously extended quantized Landau level gaps that cross all trivial band-gaps. The fragile topology experimentally unveiled enlarges the family of topological states and provides a new perspective for understanding the novel quantum phases in twisted bilayer graphene.



ICFO | Massachusetts Institute of Technology

Schools on the Frontiers of Light. Symposium on “Emergent phenomena in Moiré materials”

HOT TOPICS SESSION

18:00 – 19:00 CEST

Join In

18:45 Simulating twistronics without a twist

By Debraj Rakshit
Quantum Optics Theory at ICFO

Recent studies of twisted bilayer materials reveal fascinating strong correlations effects. In this talk we will propose a highly tunable scheme to synthetically emulate twisted bi-layer systems with ultracold atoms trapped in an optical lattice. In our scheme, neither a physical bilayer nor twist is directly realized. Instead, two synthetic layers are produced exploiting coherently-coupled internal atomic states, and a supercell structure is generated *via* a spatially-dependent Raman coupling. Our proposal opens the route towards the controlled study of strongly-correlated flat-band physics, and is expected to find far reaching applications in the fields of quantum technology.