Atomic-scale structure and electronic properties of twisted double bilayer graphene

Presenter:
Carmen Rubio Verdú
(Physics Department, Columbia University)

Authors:
Carmen Rubio Verdú
(Physics Department, Columbia University)

Simon Eli Turkel
(Physics Department, Columbia University)

Larry Song
(Physics Department, Columbia University)

Dante Kennes
(Dahlem Center for Complex Quantum Systems and Fachbereich Physik, Freie Universität Berlin)

Lede Xian
(Max Planck Institute for the Structure and Dynamics of Matter)

Hector Ochoa
(Physics Department, Columbia University)

Angel Rubio
(Center for Computational Quantum Physics (CCQ), The Flatiron Institute)

Abhay Pasupathy
(Physics Department, Columbia University)

The fundamental properties of 2D materials are dramatically modified when they are brought next to each other to form a vertical heterostructure. The electronic characteristics of such van der Waals materials can be further controlled by the twist angle degree of freedom, inducing electronic flat bands that lead to emergent phases such as correlated insulating (CI) and superconducting (SC) states in twisted bilayer graphene. Such phenomenology is expected in higher order heterostructures where the vertical stacking order plays a major role. Recent works showed that double bilayer graphene (tDBG) at a twist angle of ~1.3° hosts displacement field tunable CI and SC states, as well as ferromagnetic order. We show real-space imaging of tDBG moiré superstructure by means of Scanning Tunneling Microscopy/Spectroscopy (STM/STS). STS reveals the presence of van Hove singularities whose spatial distribution within the moiré unit cell is determined by the inequivalent stacking sites. Tuning carrier density and displacement field reveals long-range broken symmetries that emerge when the Fermi level is brought in the vicinity of such flat bands. Our results shed light into the underlying mechanisms behind electron-electron correlations in tDBG and the emergent ferromagnetic order.