Massachusetts Institute of Technology
Department of Physics

Condensed Matter Theory Seminar

"Moire is different: Mott insulating behavior and superconductivity in twisted bilayer graphene"

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Abstract: Remarkable recent experiments have observed Mott insulating behavior and superconductivity in moire superlattices of twisted bilayer graphene near a magic twist angle. However, the nature of the Mott insulator, origin of superconductivity and an effective model remain to be determined. I will present our understanding of these phenomena. We propose a Mott insulator with intervalley coherence that spontaneously breaks U(1) valley symmetry, and describe a mechanism that selects this order over the competing magnetically ordered states favored by the Hunds coupling. We also identify symmetry related features of the nearly flat band that are key to understanding the strong correlation physics and constrain any tight binding description. First, although the charge density is concentrated on the triangular lattice sites of the moire pattern, the Wannier states of the tight-binding model must be centered on different sites which form a honeycomb lattice. Next, spatially localizing electrons derived from the nearly flat bands necessarily breaks valley and other symmetries within any mean-field treatment, which is suggestive of a valley-ordered Mott state, and also dictates that additional symmetry breaking is present to remove symmetry-enforced band contacts. Tight binding models describing the nearly flat mini-band are derived, which highlight the importance of further neighbor hopping and interactions. We discuss consequences of this picture for superconducting states obtained on doping the valley ordered Mott insulator. We show how important features of the experimental phenomenology may be explained and suggest a number of further experiments for the future.

12:00pm noon
Tuesday, April 10, 2018
Duboc Room (4-331)

Host: Itamar Kimchi