

Massachusetts Institute of Technology  
Department of Physics

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Condensed Matter Theory Seminar

“Correlated insulators in twisted bilayer graphene at integer fillings”

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**Abstract:** In magic angle twisted bilayer graphene, electron-electron interactions play a central role resulting in correlated insulating states at certain integer fillings. Identifying the nature of these insulators is a central question and potentially linked to the relatively high temperature superconductivity observed in the same devices. Our approach relies on identifying a limit in which the problem can be mapped to a pair of 4-layer quantum Hall systems in opposite magnetic fields. In this limit, the problem is characterized by a  $U(4) \times U(4)$  symmetry which restricts the possible insulating phases at integer filling to a manifold of low-energy states whose competition is settled by smaller symmetry breaking terms. In the absence of strain, magnetic field or substrate alignment, these terms select a unique ground state at even integer fillings which we call the Kramers intervalley-coherent (K-IVC) insulator. The K-IVC state has an unusual order corresponding to a pattern of alternating circulating currents which triples the graphene unit cell leading to an "orbital magnetization density wave". Although translation and time reversal symmetry are broken, a combined "Kramers" time reversal symmetry is preserved. Our analysis is corroborated with a comprehensive Hartree-Fock numerical calculation which includes the effect of remote bands. In addition, we show how perturbations such as strain, magnetic field, or substrate alignment can stabilize other insulating or semimetallic states and discuss the nature of charged excitations in the K-IVC state as well as potential connections to superconductivity.

**12:00pm noon**  
**Tuesday, February 18, 2020**  
**Duboc Seminar Room (4-331)**