Center for Dynamics and Control of Materials: *MRSEC Seminar*

Integer and Fractional Quantum Anomalous Hall Effects in Rhombohedral Graphene

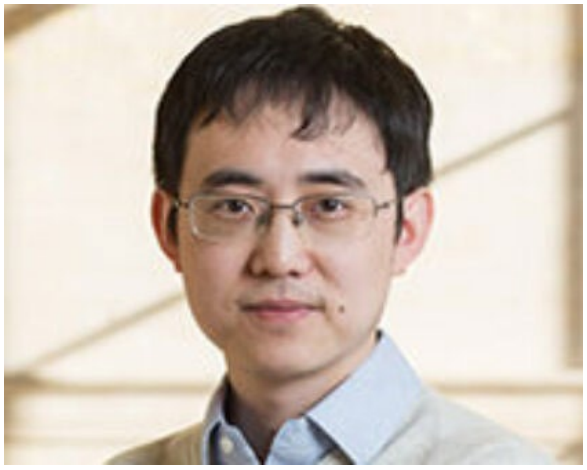
Wednesday, November 8th, 10 am-11 am

EER 2.518, Innovation Center

The fractional quantum anomalous Hall effect (FQAHE), the analog of the fractional quantum Hall effect at zero magnetic field, is predicted to exist in topological flat bands under spontaneous time-reversal-symmetry breaking. The demonstration of FQAHE could lead to non-Abelian anyons which form the basis of topological quantum computation. Graphene-based moiré superlattices are believed to host FQAHE with the potential advantage of superior material quality and high electron mobility. In this talk, I will report the observation of integer and fractional QAH effects in a rhombohedral pentalayer graphene/hBN moiré superlattice. At zero magnetic field, we observed plateaus of quantized Hall resistance Rxy = h/(ve2) at moiré filling factors v = 1, 2/3, 3/5, 4/7, 4/9, 3/7 and 2/5, all within the Jain sequence of fractional quantum Hall states. In addition, at zero magnetic field, Rxy =2h/e2 near v = 1/2 and it varies linearly as the filling factor is tuned—similar to the composite Fermi liquid (CFL) in the half-filled lowest Landau level at high magnetic fields.

In addition to FQAHE induced by the moire effect, I will report the observation of integer quantum anomalous Hall effect in pentalayer graphene without a moire effect. This state features a Chern number C=5 and a distinct mechanism from those of magnetic topological insulators and 2D moire superlattice materials. We believe that the spin-orbital-coupling from the neighboring WS2 plays a key role in deciding the IQAH ground state.

The rich family of FQAH and IQAH states in our high-quality graphene provide an ideal platform for exploring charge fractionalization and exotic quasiparticles for topological quantum computation.



Long Ju (he/him/his) is an assistant professor in the MIT Physics Department. He received his B.S. in Physics in 2009 from Tsinghua University, China, and his Ph.D. in Physics in 2015 from the University of California, Berkeley. He then moved to Cornell University, where he was a Kavli postdoctoral fellow until December 2018. His research focuses on understanding light-matter interactions in novel quantum materials.

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National Science Foundation
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