Integer and Fractional Quantum Hall Effects at Zero Magnetic Field in Moiré Systems

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Abstract: Integer and fractional quantum Hall effects (IQHE and FQHE) have attracted lots of attention back from 1980s. Normally the realization of FQHE needs a large magnetic field (at order of 20 Tesla). Theorists proposed realization of FQHE without any magnetic field in a flat Chern band, but it is apparently quite challenging in the traditional solid state systems. In this talk I will introduce theoretical and experimental efforts in the last six years in the new field of moiré materials, which eventually achieved this goal. A moiré superlattice can be generated by simply twisting two two-dimensional layers such as graphene by a small angle. Quite amazingly strongly correlated physics such as quantum Hall physics can emerge from such a simple setup. I will especially emphasize our theory of quantum anomalous Hall crystals in explaining the QHE observed in pentalayer graphene by Long Ju's group at MIT.

Biography: Yahui Zhang joined the department of physics and astronomy at JHU as an assistant professor in 2022. He obtained his PhD in physics from MIT in 2019 and then he was a postdoc scholar at Harvard university during 2019-2021. Yahui is working on condensed matter theory with a focus on strongly correlated physics. Some recent research interests include (1) Pseudogap metal and strange metal in hole doped cuprates; (2) New physics in t-J model with spin-one holes; (3) Spin liquids and topological phases in moiré systems; (4) Quantum hall multilayers; (5) Various exotic quantum criticalities with emergent gauge fields. Both analytical methods (quantum field theory, parton theory) and numerical methods (DMRG, quantum Monte Carlo) are employed in his research.