MAX PLANCK INSTITUTE
FOR THE STRUCTURE AND DYNAMICS OF MATTER

Date & Time: **THURSDAY, APRIL 30, at 11:00**

Location: **MPSD, 900 EG 136**

Speaker: **XIAOYANG ZHU**

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qcmd - Seminar

mpsd

Glimpse of a Beauty: a Fractional Topological Insulator

One of the most profound discoveries in condensed matter physics is the fractional quantum Hall (FQH) effect [1], which changed our understanding from single particle band structure to many-body correlation in emerging physical properties, e.g., fractional charge excitations and anyon statistics. It has long been proposed that the FQH effect may be realized without magnetic field in lattices, as exemplified by the Haldane model [2]. Here nontrivial topology replaces magnetic field in breaking time-reversal-symmetry (TRS). The resulting quantum states are Chern Insulators (CIs) and, in the presence of correlation, fractional Chern Insulators (FCIs) [3]. A more exotic quantum phase predicted from the lattice models is the fractional topological insulator (FTI), which can be considered as two bound copies of FCIs with opposite chirality, thus preserving TRS [4,5]. FCIs and the associated fractional quantum anomalous Hall (FQAH) effects were recently discovered in twisted bilayer MoTe2 (tMoTe2) [6–9] and in multilayer graphene aligned with hBN [10]. Is it possible to realize an FTI in moiré systems? Among the FCIs in tMoTe2, the most robust is at a hole filling of per moiré unit cell. Our transient optical sensing [11] revealed a correlated state at , which is 2x the filling factor for the FCI. This arithmetic has turned out to reveal a hidden beauty.

Using transient circular dichroism (CD), we find that the state exhibits an unusual Ising antiferromagnet behavior. The state with no net magnetization undergoes first order phase transitions at low magnetic fields of $|\mu_0 H| \sim$ 2-6 mT to partially valley polarized (PVP) states. This behavior is notably absent for all other correlated states in tMoTe2. The observed magnetic signature is consistent with a proposed FTI, consisting of two copies of FCIs with opposite chirality in the valleys. The experimental results are supported by interacting continuum model calculations that reveal the extreme closeness in energy ($\Delta E < 1$ meV) between the putative FTI (and) and PVP states (and). Our findings [12]

present a candidate FTI with TRS and call for advanced transport and imaging measurements to establish the quantized helical edge modes.

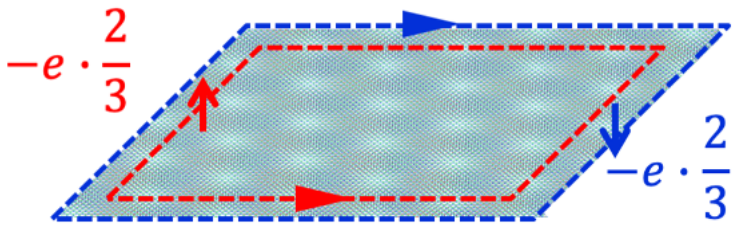

Fig.: Illustration of a fractional topological insulator in twisted $MoTe_2$ bilayer moiré superlattice

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