Re-entrant correlated insulator at 2π magnetic flux in magic-angle twisted bilayer graphene

Ipsita Das
Cheng Shen, Alexandre Jaoui, Jonah Herzog-Arbeitman, Aaron Chew, Chang-Woo Cho, Kenji Watanabe, Takashi Taniguchi, Benjamin A. Piot, B. Andrei Bernevig & Dmitri K. Efetov
ICFO - Institut de Ciencies Fotoniques, Castelldefels, 08860, Spain
ipsita.das@icfo.eu

The discovery of flat bands with non-trivial band topology in magic angle twisted bilayer graphene (MATBG) has provided a unique platform to study strongly correlated phenomena including superconductivity [1, 2], correlated insulators [3], Chern insulators [4] and magnetism. A fundamental feature of the MATBG, so far unexplored, is its high magnetic field Hofstadter spectrum. We report on a detailed magneto-transport study of a MATBG device in external magnetic fields of up to B = 31 T, corresponding to one magnetic flux quantum per moiré unit cell Φ_0. At Φ_0, we observe a re-entrant correlated insulator at a flat band filling factor of ν = +2, and interaction-driven Fermi surface reconstructions at other fillings, which are identified by new sets of Landau levels originating from these. These experimental observations are supplemented by theoretical work that predicts a new set of 8 well-isolated flat bands at Φ_0, of comparable band width but with different topology than in zero field [5]. Overall, our magneto-transport data reveals a qualitatively new Hofstadter spectrum in MATBG, which arises due to the strong electronic correlations in the re-entrant flat bands.

References

[1] Y. Cao, V. Fatemi, S. Fang, K. Watanabe, T. Taniguchi, E. Kaxiras, and P. Jarillo-Herrero, *Nature*, **556**, (2018) 43.
[2] X. Lu, P. Stepanov, W. Yang, M. Xie, M. A. Aamir, I. Das, C. Urgell, K. Watanabe, T. Taniguchi, G. Zhang, et al., *Nature*, **574**, (2019) 653.
[3] Y. Cao, V. Fatemi, A. Demir, S. Fang, S. L. Tomarken, J. Y. Luo, J. D. Sanchez-Yamagishi, K. Watanabe, T. Taniguchi, E. Kaxiras, et al., *Nature* **556**, (2018) 80
[4] I. Das, X. Lu, J. Herzog-Arbeitman, Z. Song, K. Watanabe, T. Taniguchi, B. A. Bernevig and D. K. Efetov, *Nat. Phys.*, **17**, (2021) 710–714.
[5] J. Herzog-Arbeitman, A. Chew, D. K. Efetov, and B. A. Bernevig, Magnetic Bloch theorem and re-entrant flat bands in twisted bilayer graphene at 2π flux, To be published.

Figure

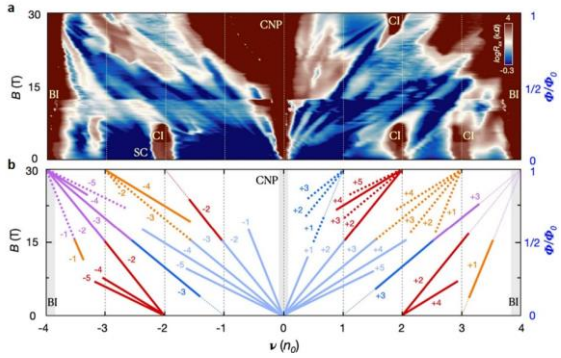

Figure 1: a) shows the colour plot of R_{xx} as a function of B and ν, for the full magnetic phase space from B = 0 T to B = 31 T and ν from -4 to 4. **b)** Schematics of all the LL gaps emerging from different fillings of the band from both zero magnetic field and one flux quantum of the moiré unit cell Φ_0. Different colours correspond to the new set of LL and reconstruction of Fermi surface.