TOPOLOGICALLY DRIVEN ϕ_0-JOSEPHSON JUNCTIONS IN MATBG

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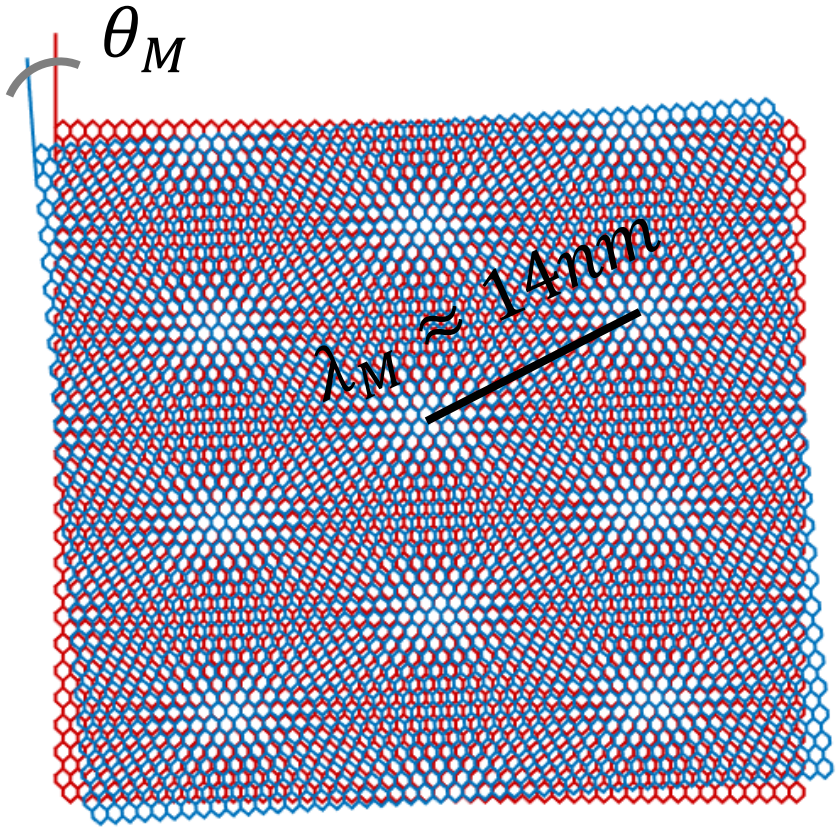
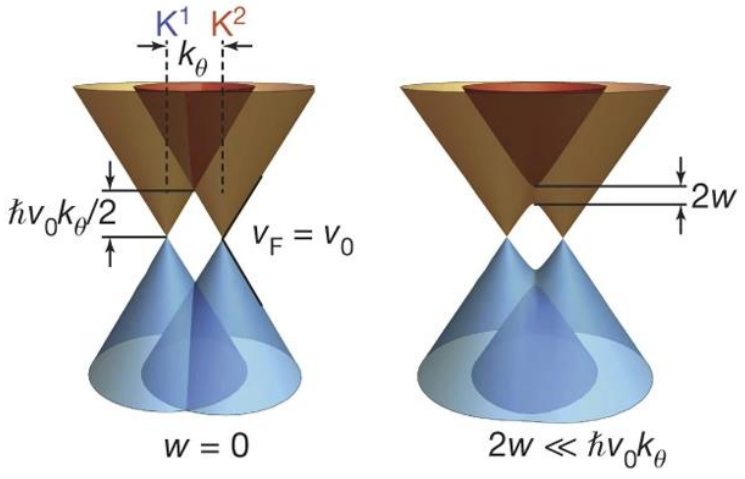
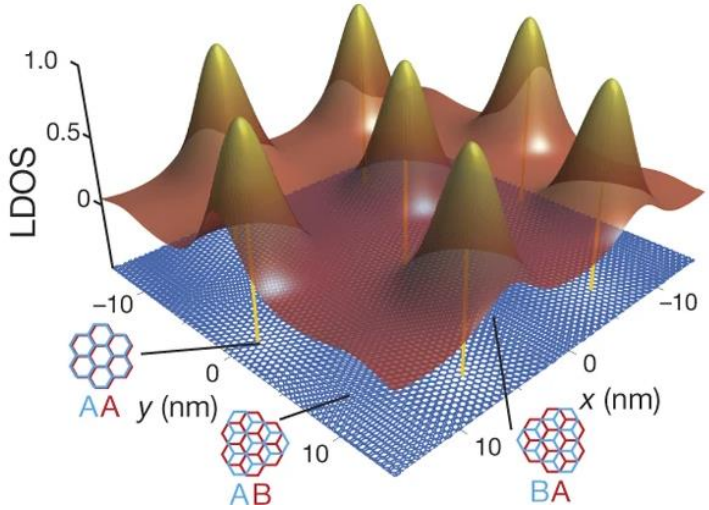
I. INTRODUCTION: twisted bilayer graphene





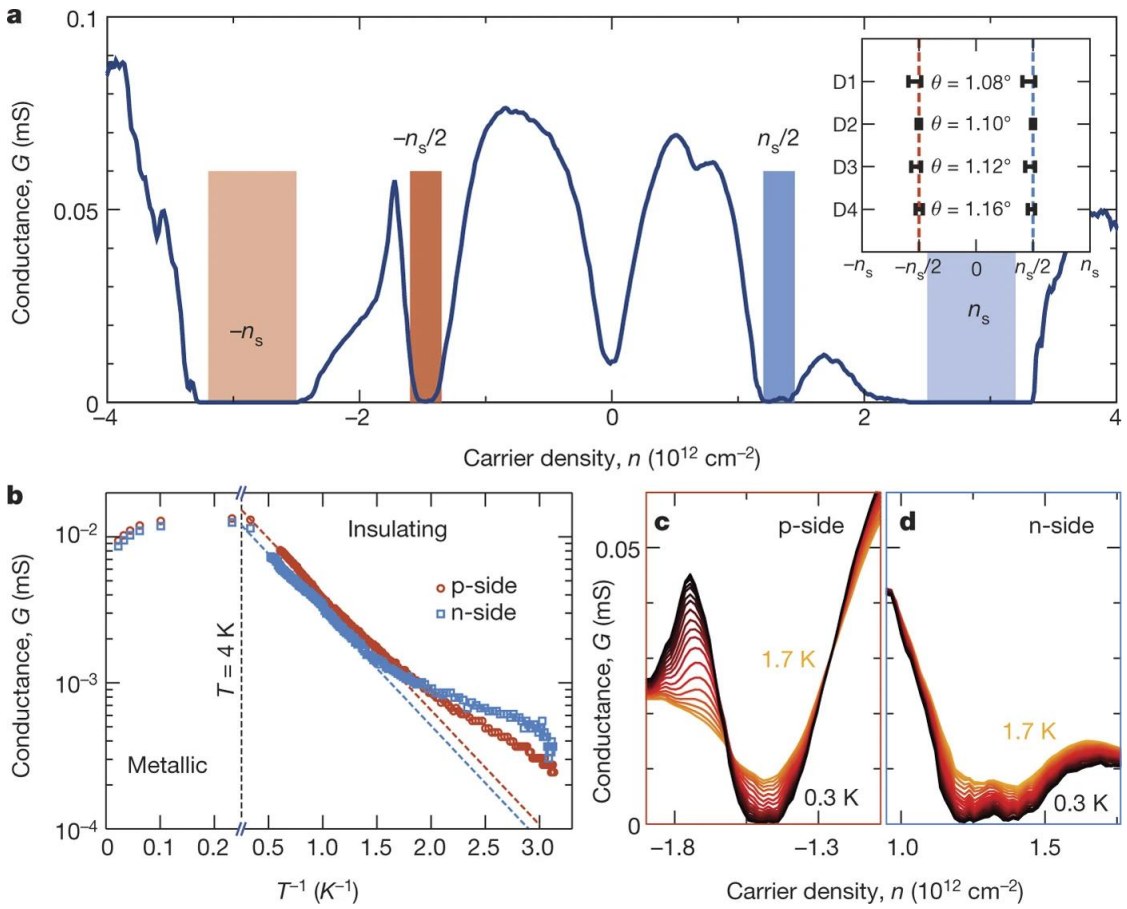
Flat bands



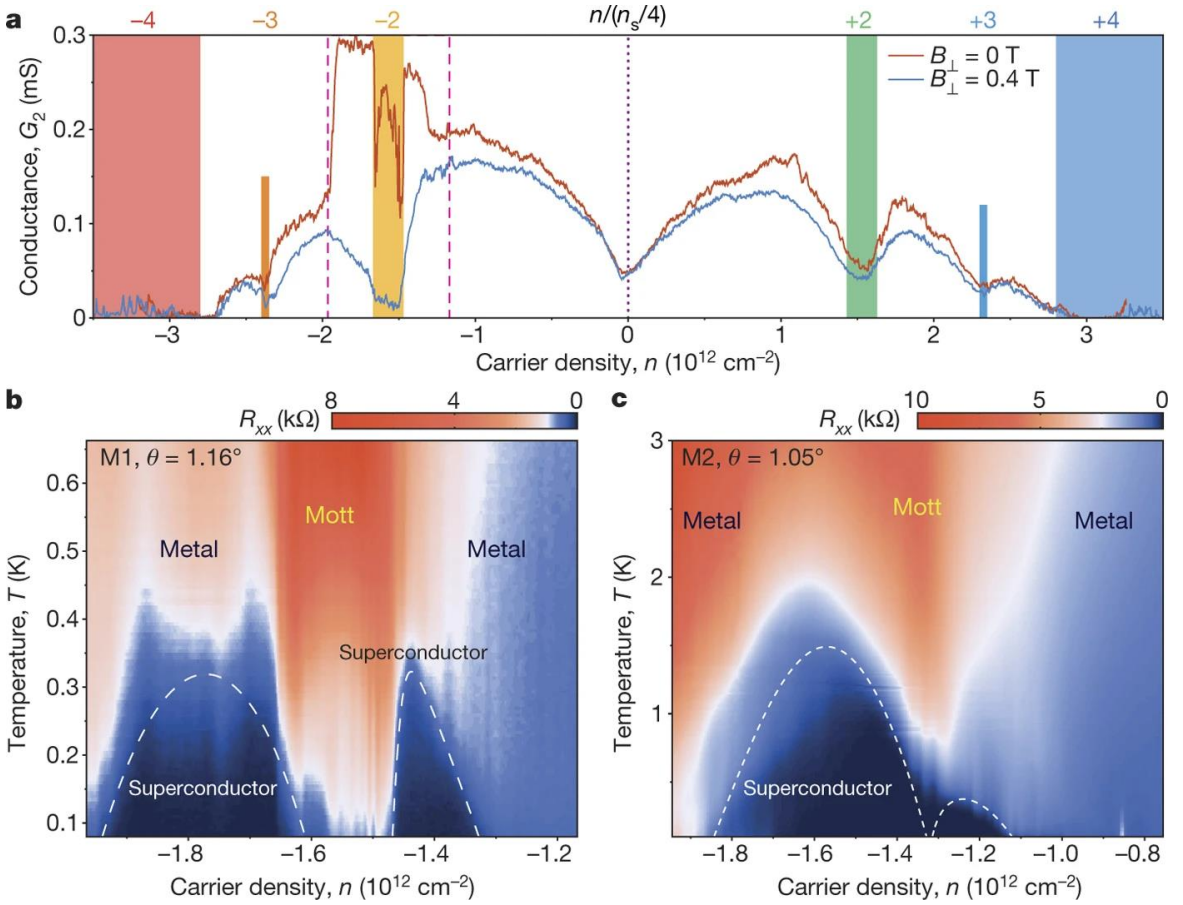
Emergent symmetries

Y. Cao et al., Nature **556**, 80 (2018)

CORRELATED INSULATOR BEHAVIOUR



SUPERCONDUCTIVITY



Y. Cao et al., Nature **556**, 43 (2018)
Y. Cao et al., Nature **556**, 80 (2018)

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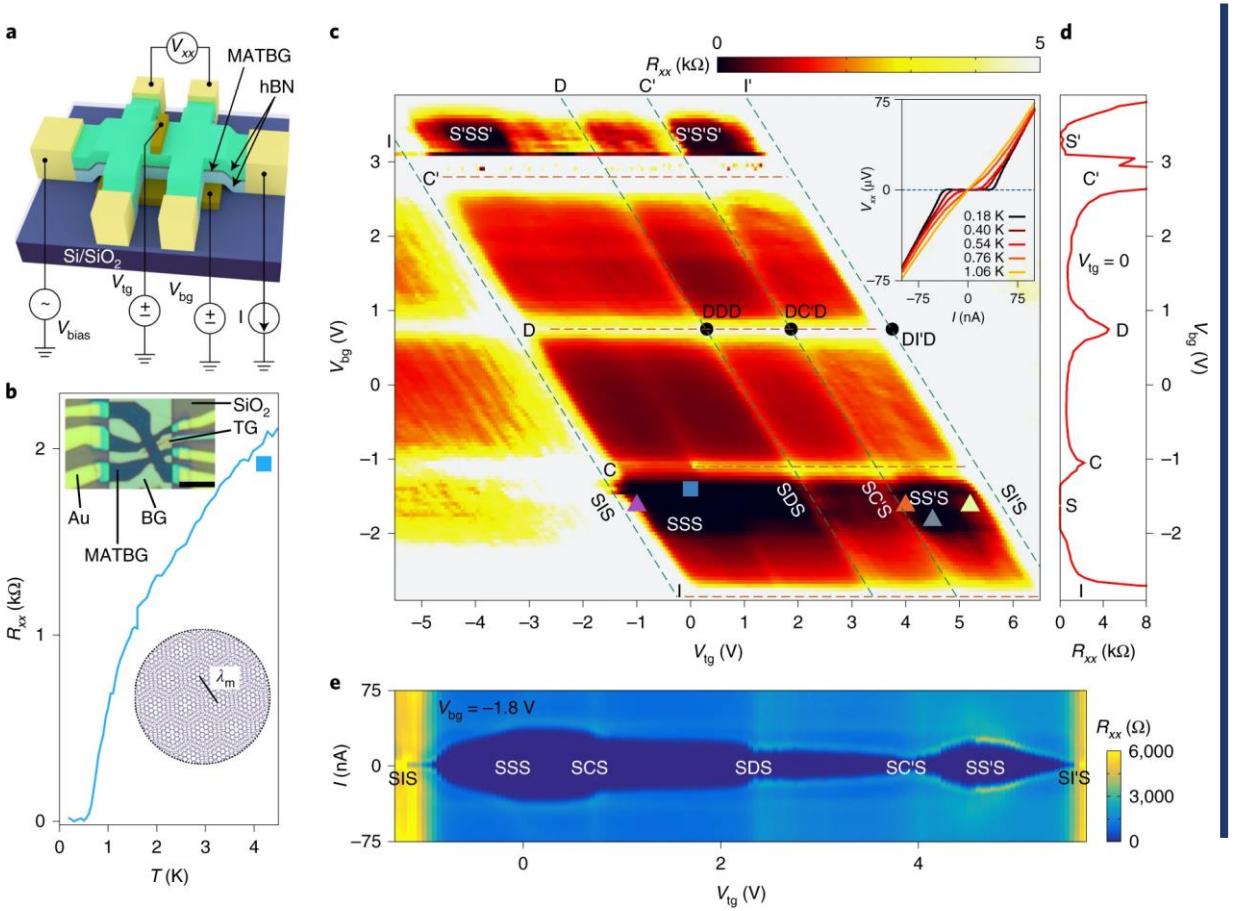
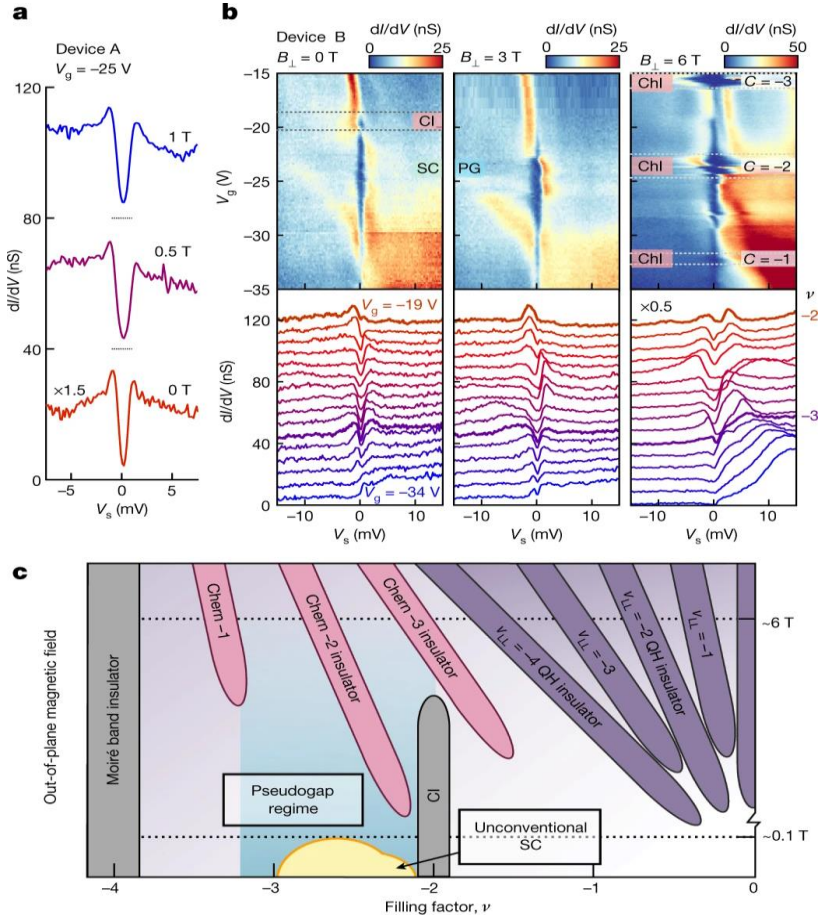
GATED DEFINED JJs



UNCONVENTIONAL SC



M. Oh et al., Nature **600,** 240 (2021)
D. Rodan-Legrain et al., *Nat. Nanotechnol.* **16,** 769 (2021)

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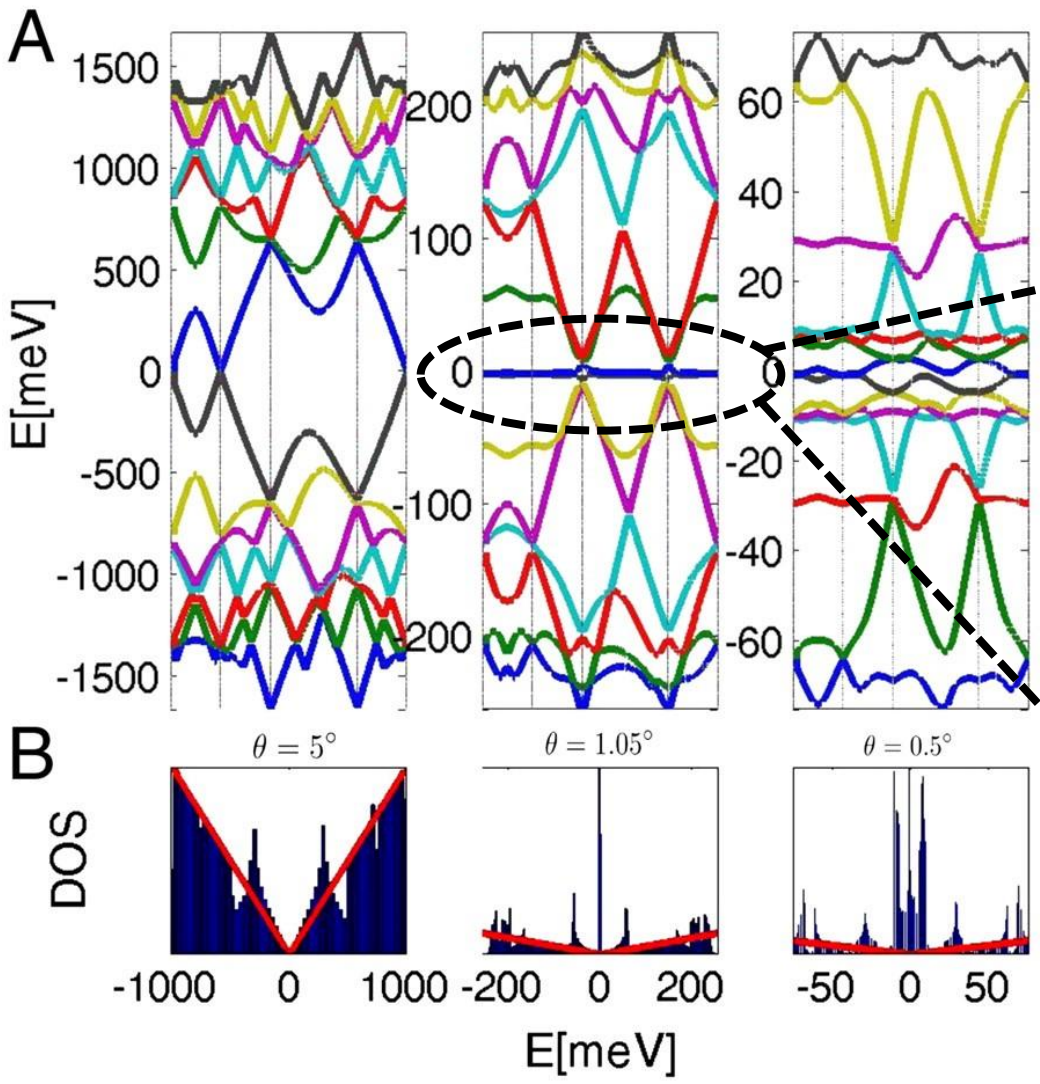
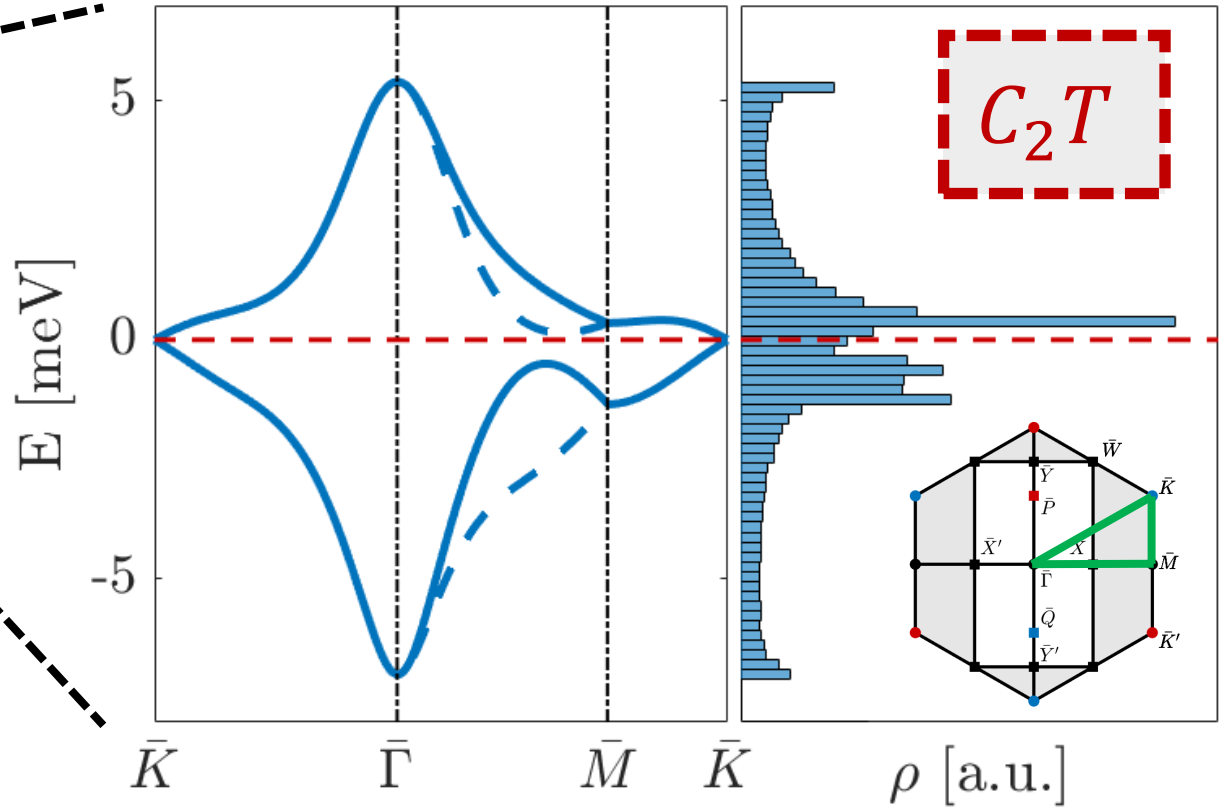
II. MODELIZATION: Continuum and lattice models



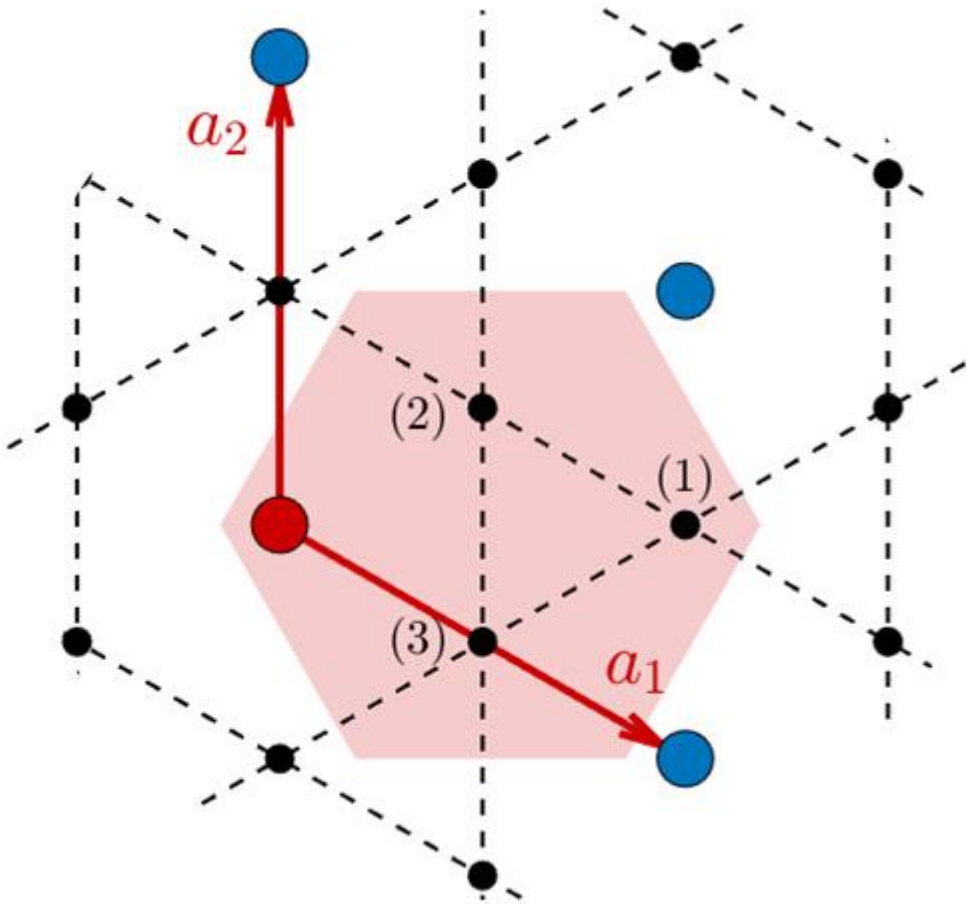
EMERGENT SYMMETRIES

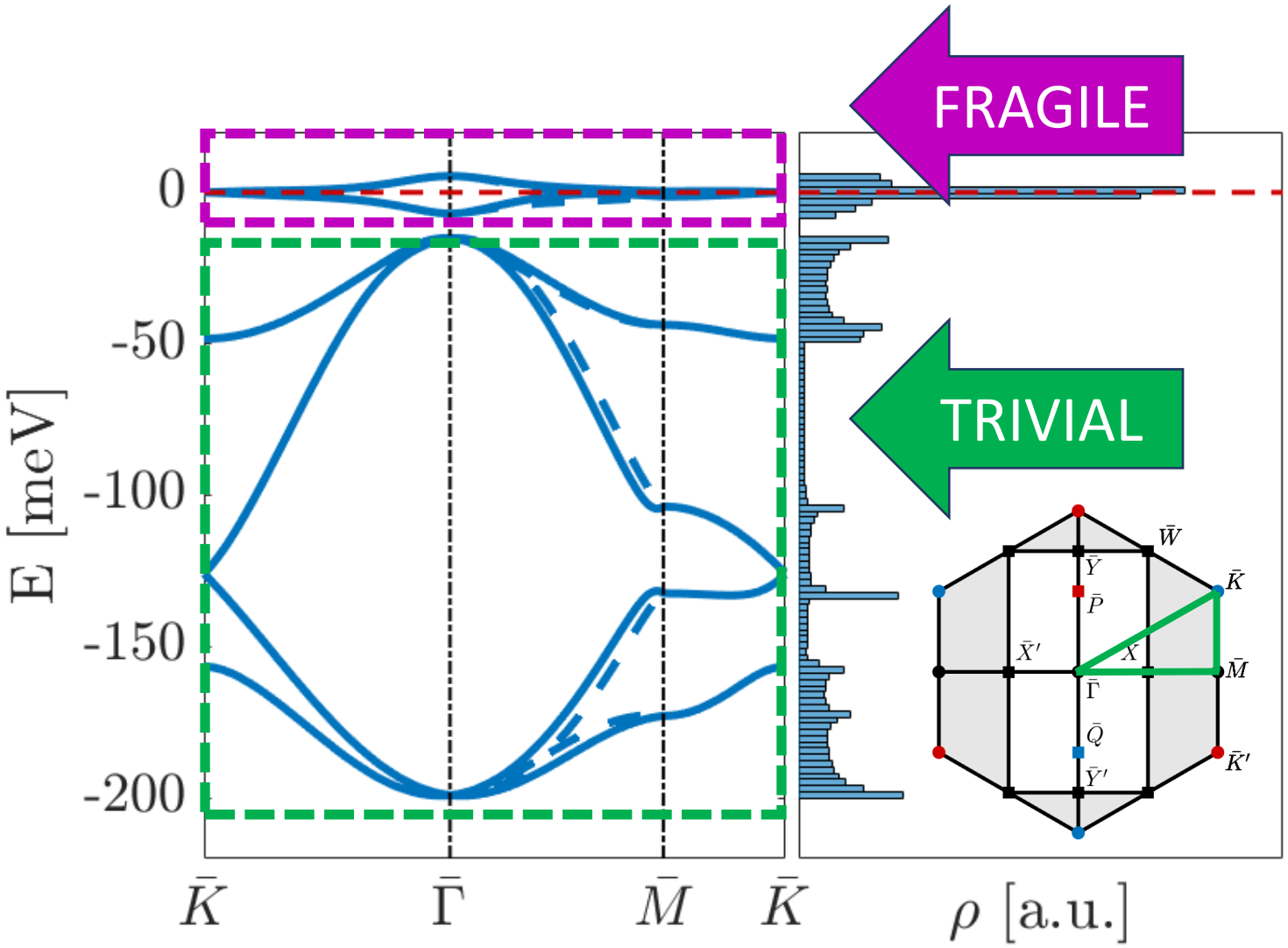
- $C_2T + U_v(1)$: spinless flat bands
- $\bar{K}, \bar{K}'$ have the same helicity



R. Bistritzer and A. H. MacDonald, PNAS **108**, 12233 (2011)

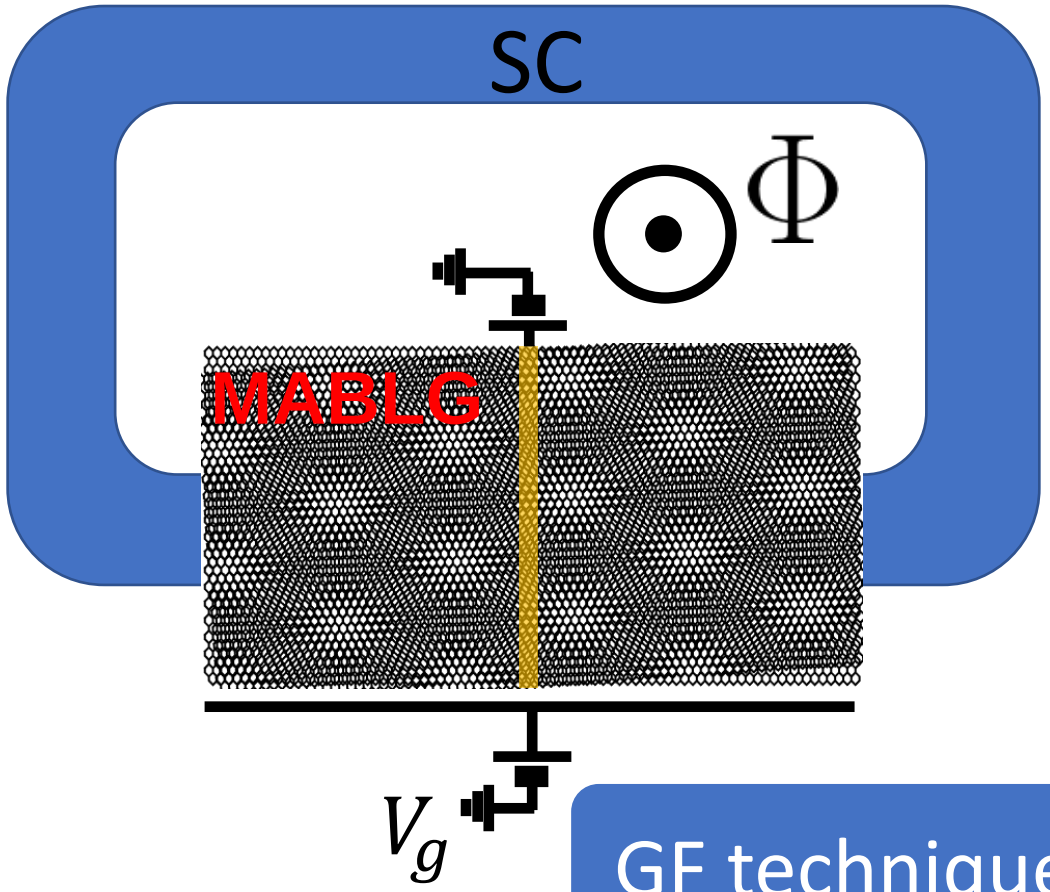
II. MODELIZATION: lattice 6B1V model

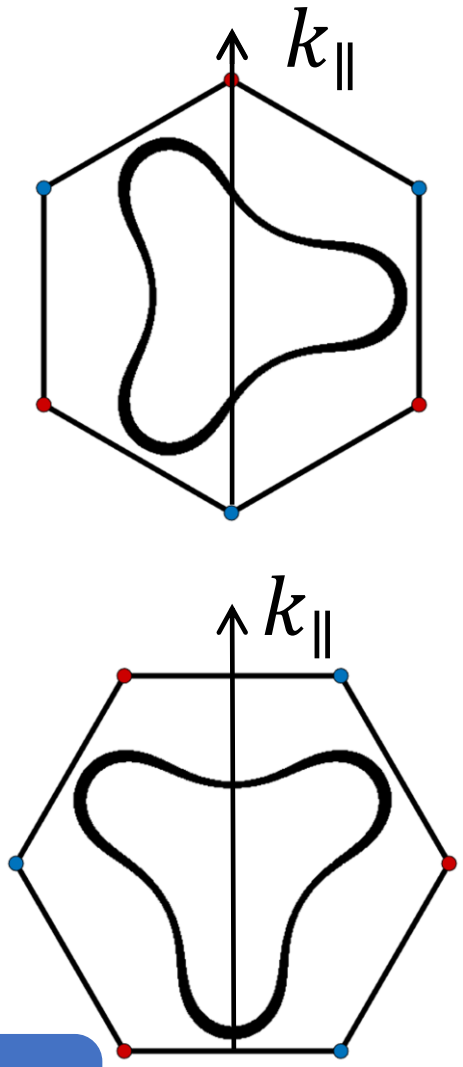


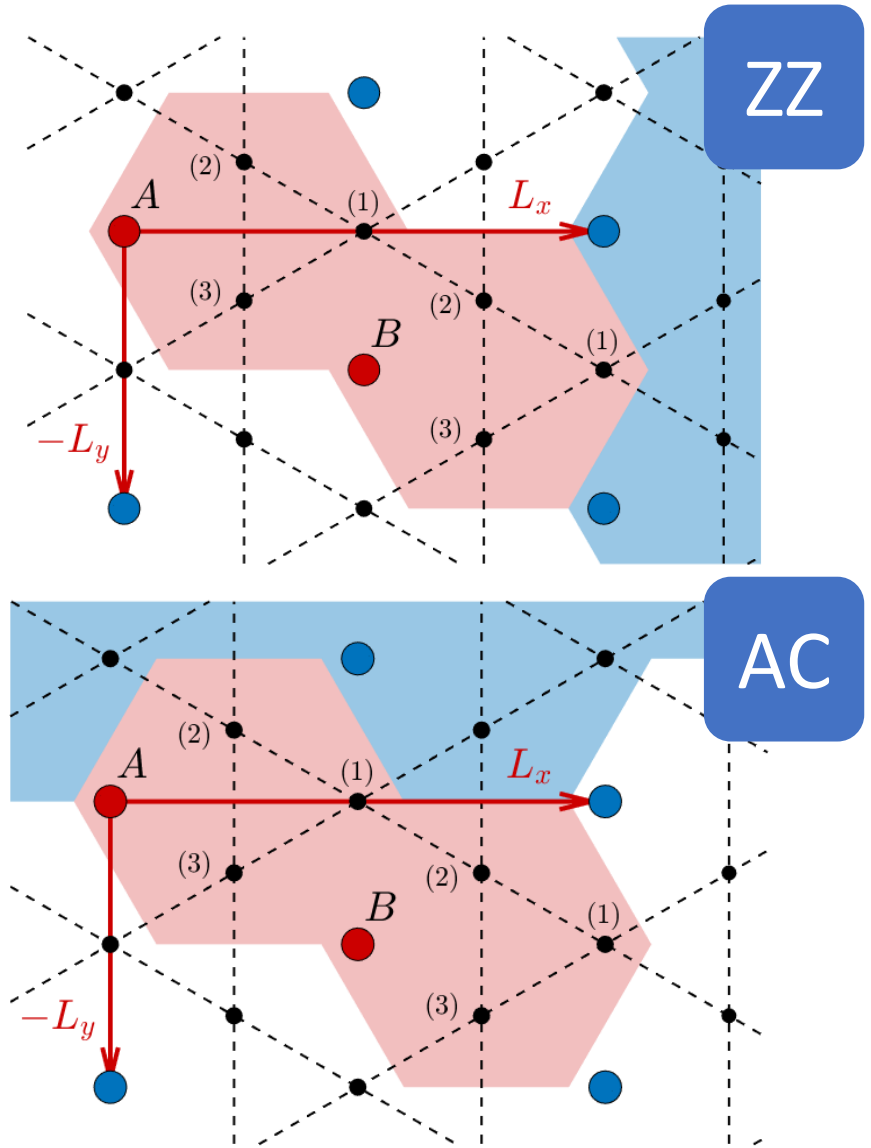


Hoi Chun Po, et al., PRB **99**, 195455 (2019)

DIRECT JOSEPHSON JUNCTIONS





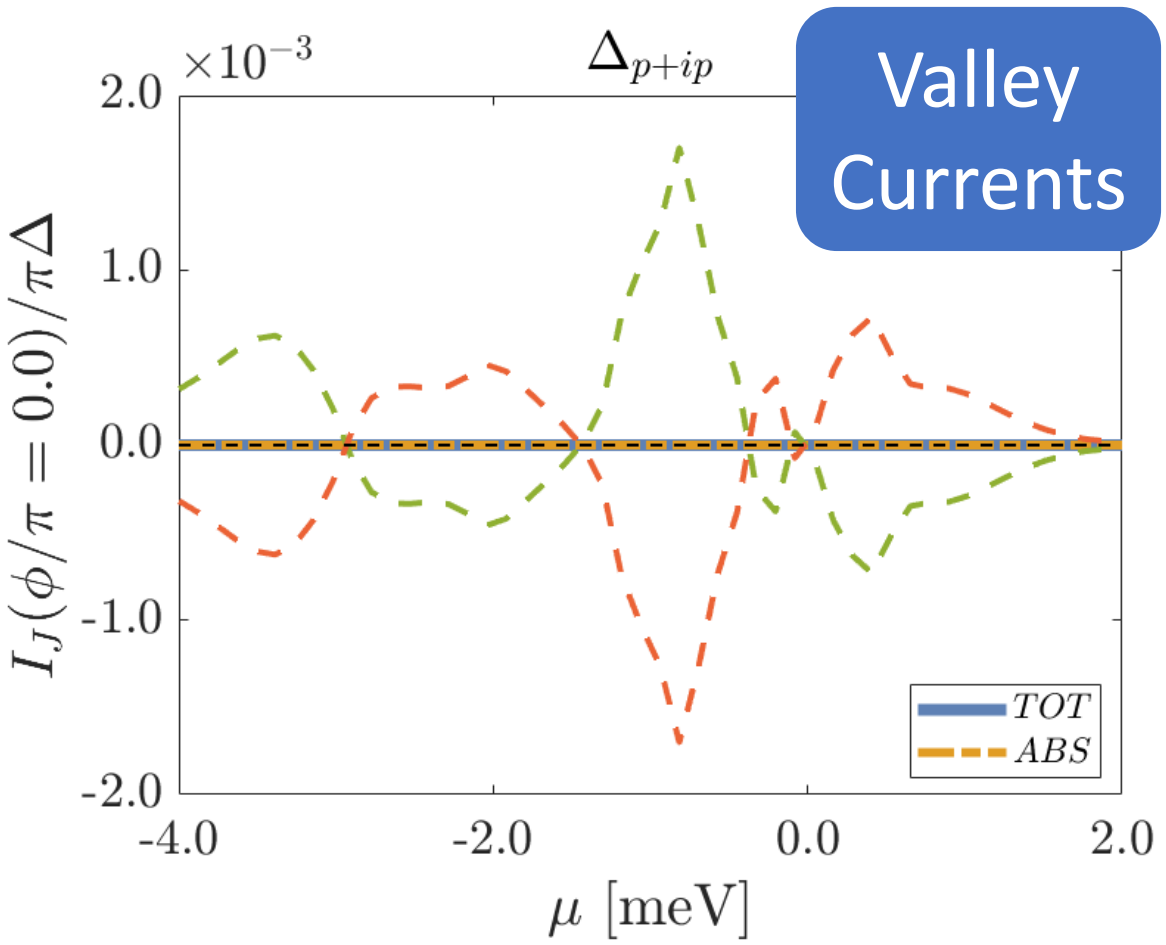


GF techniques

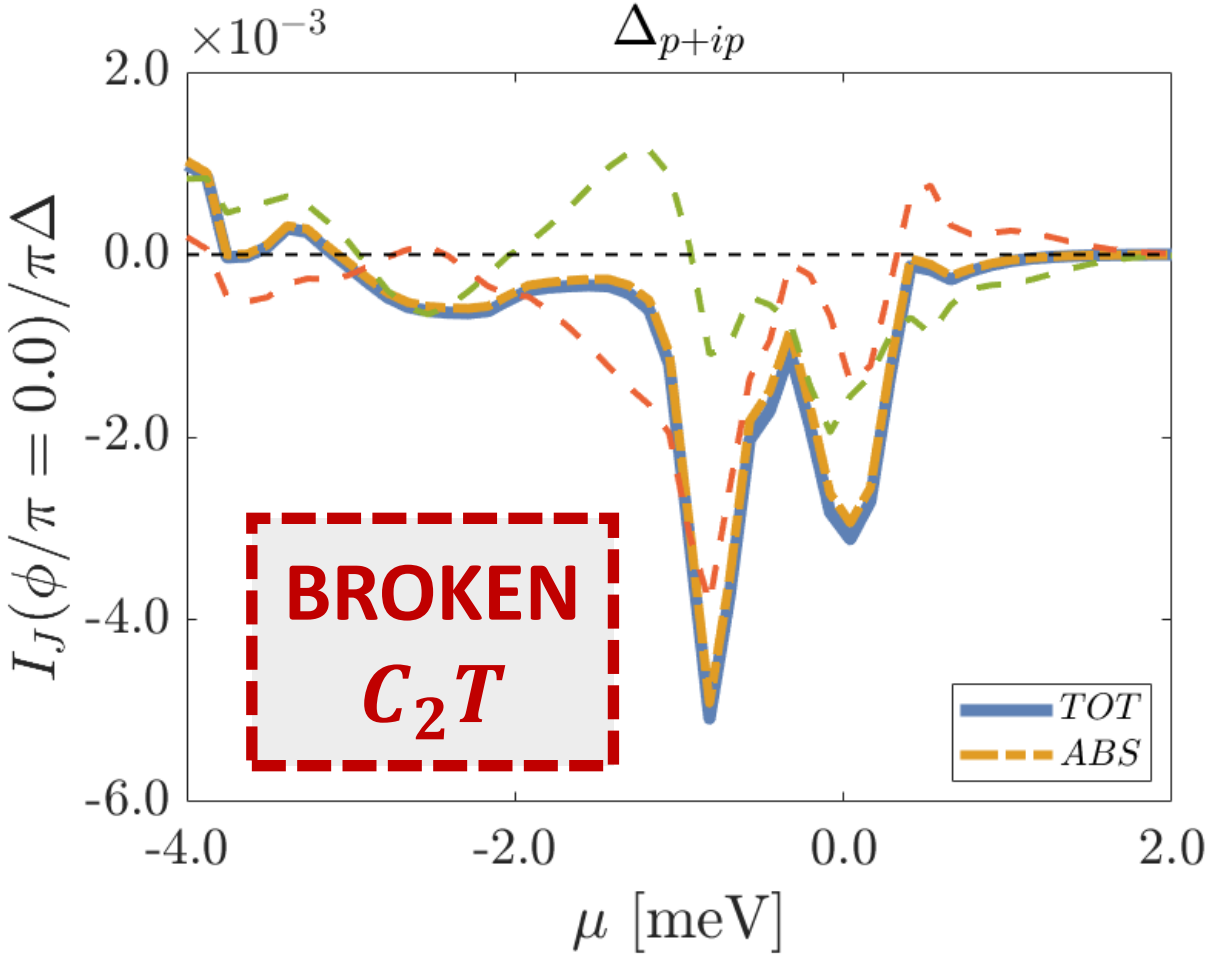
Y. Xie, *arXiv:2202.05663*

III. RESULTS:
TBG Josephson Junctions

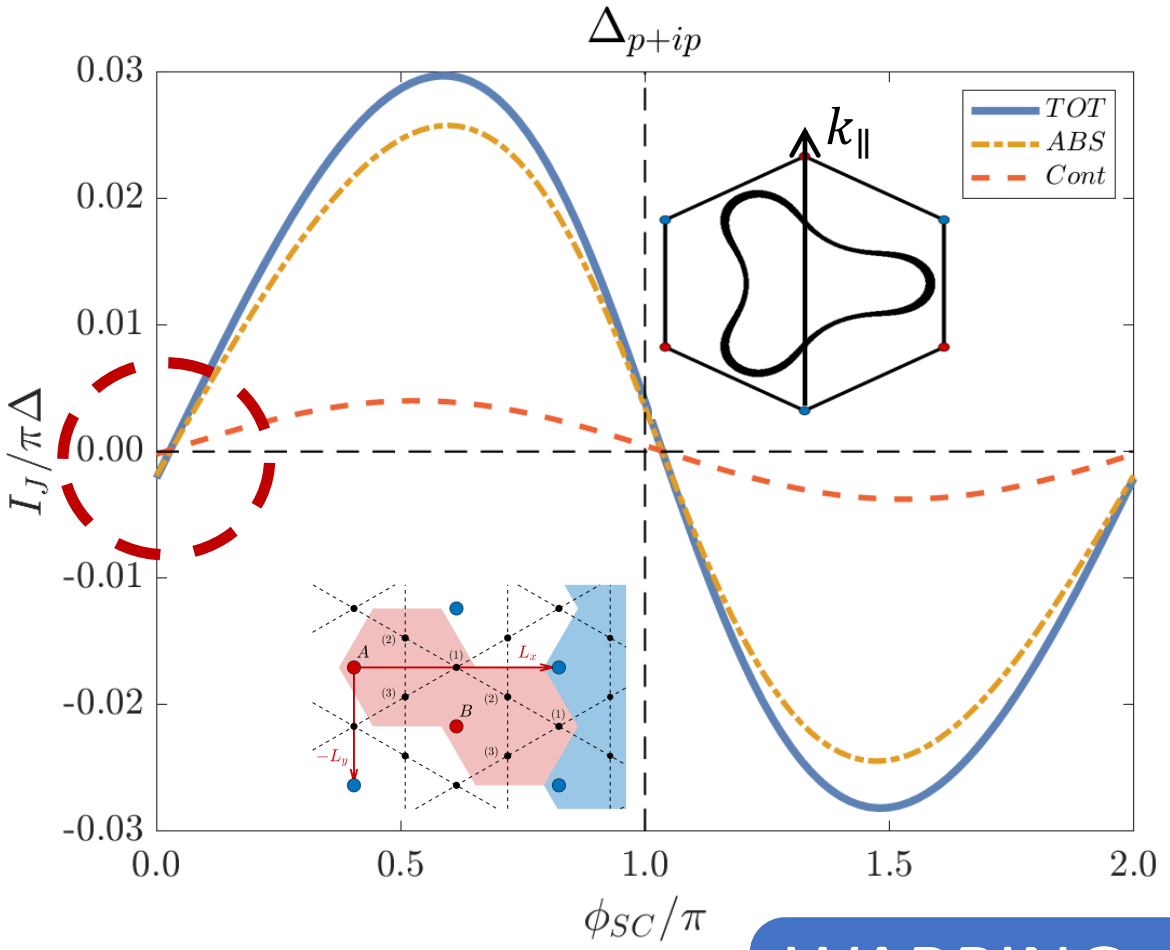
III. RESULTS: ZZ Current at zero phase-bias

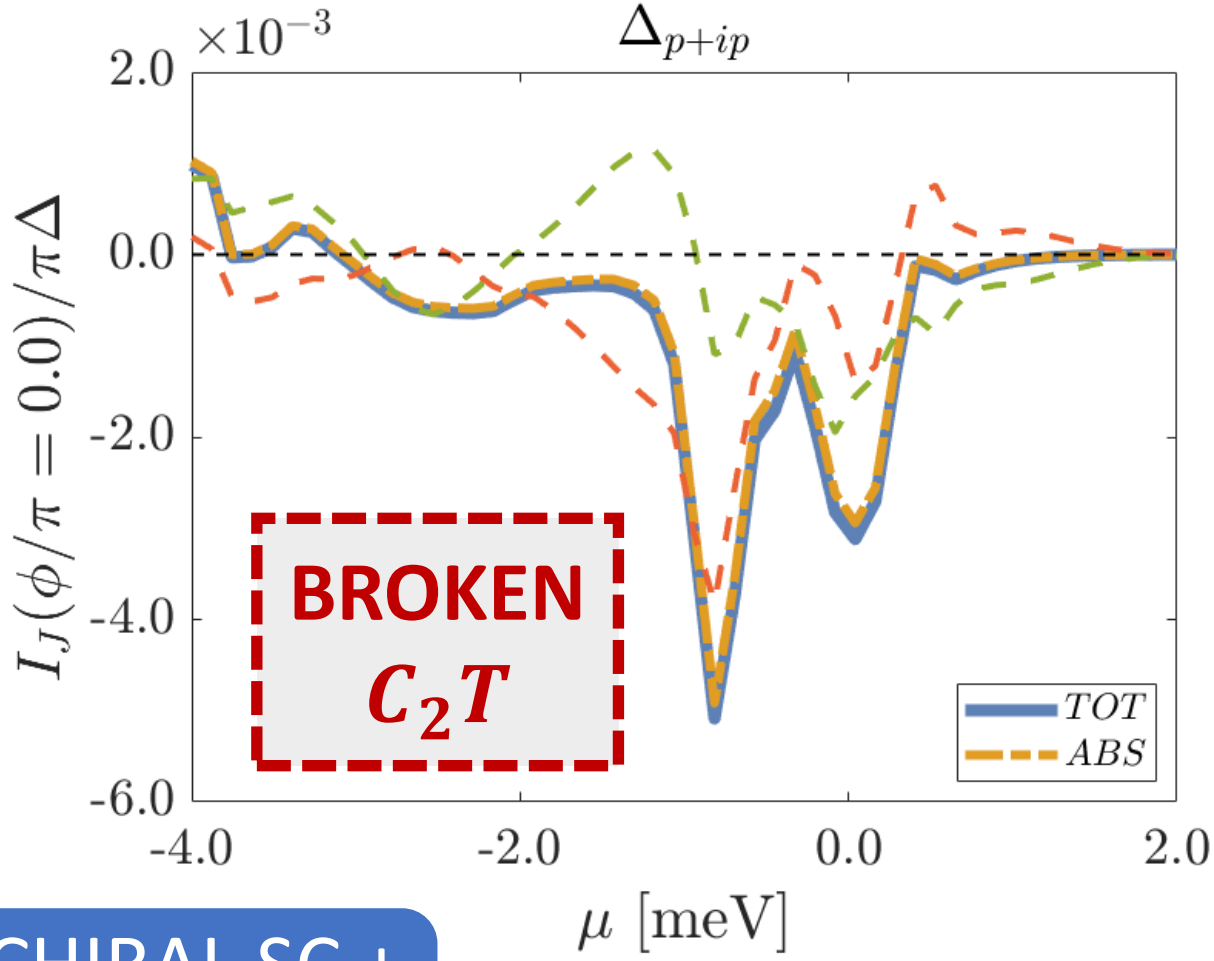


Valley Currents



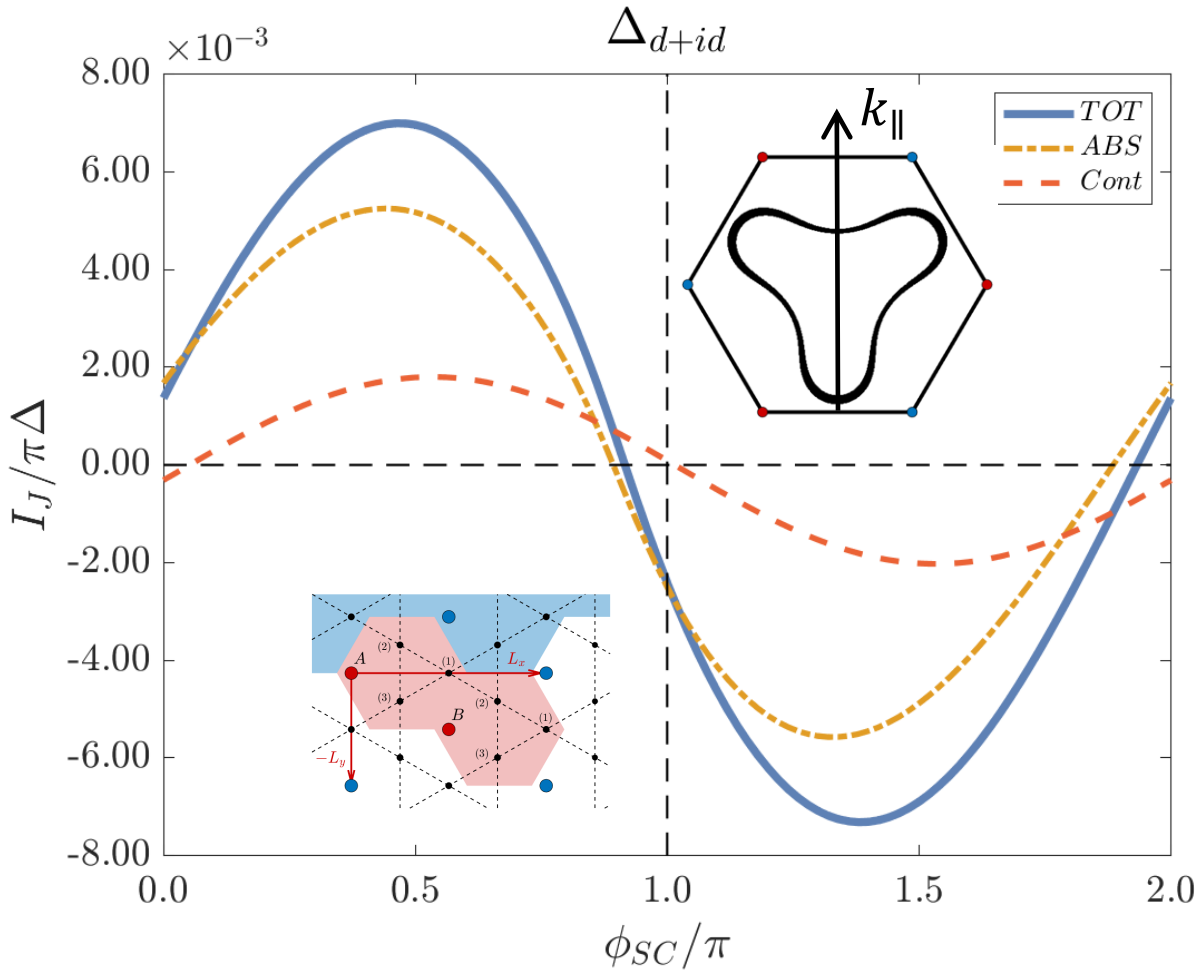
III. RESULTS: ZZ Current-phase relation

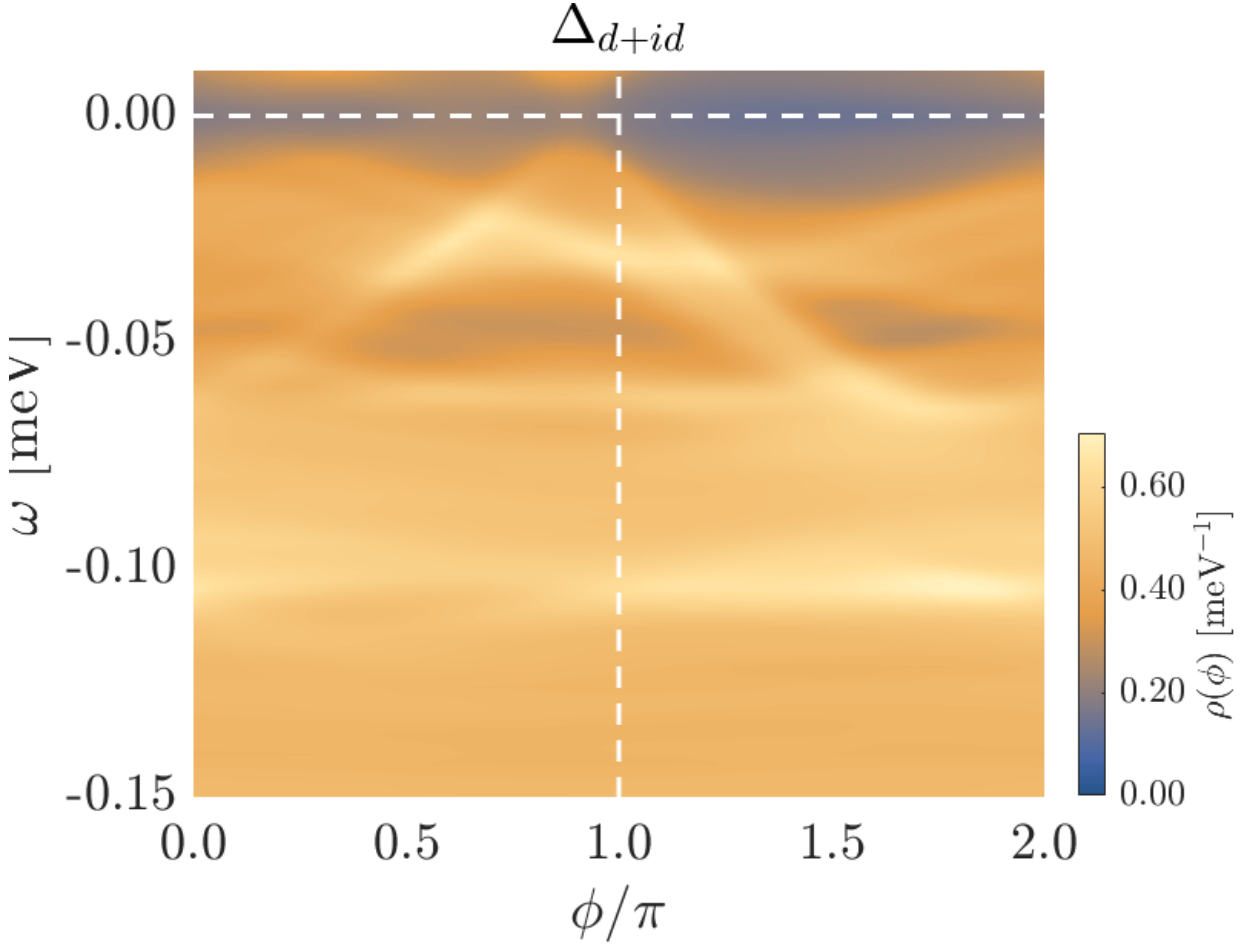




WARPING + CHIRAL SC + FRAGILE TOPOLOGY

III. RESULTS: AC Current-phase relation





PRESERVED C_2T!

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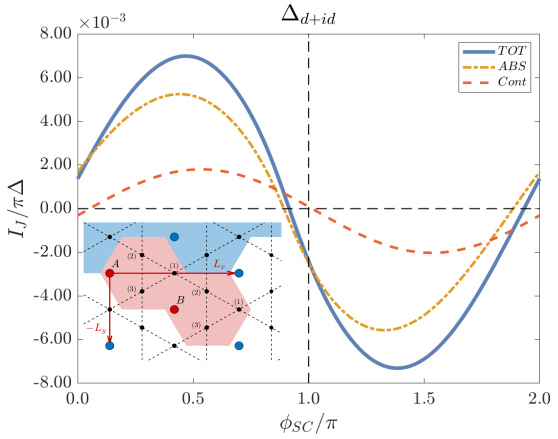
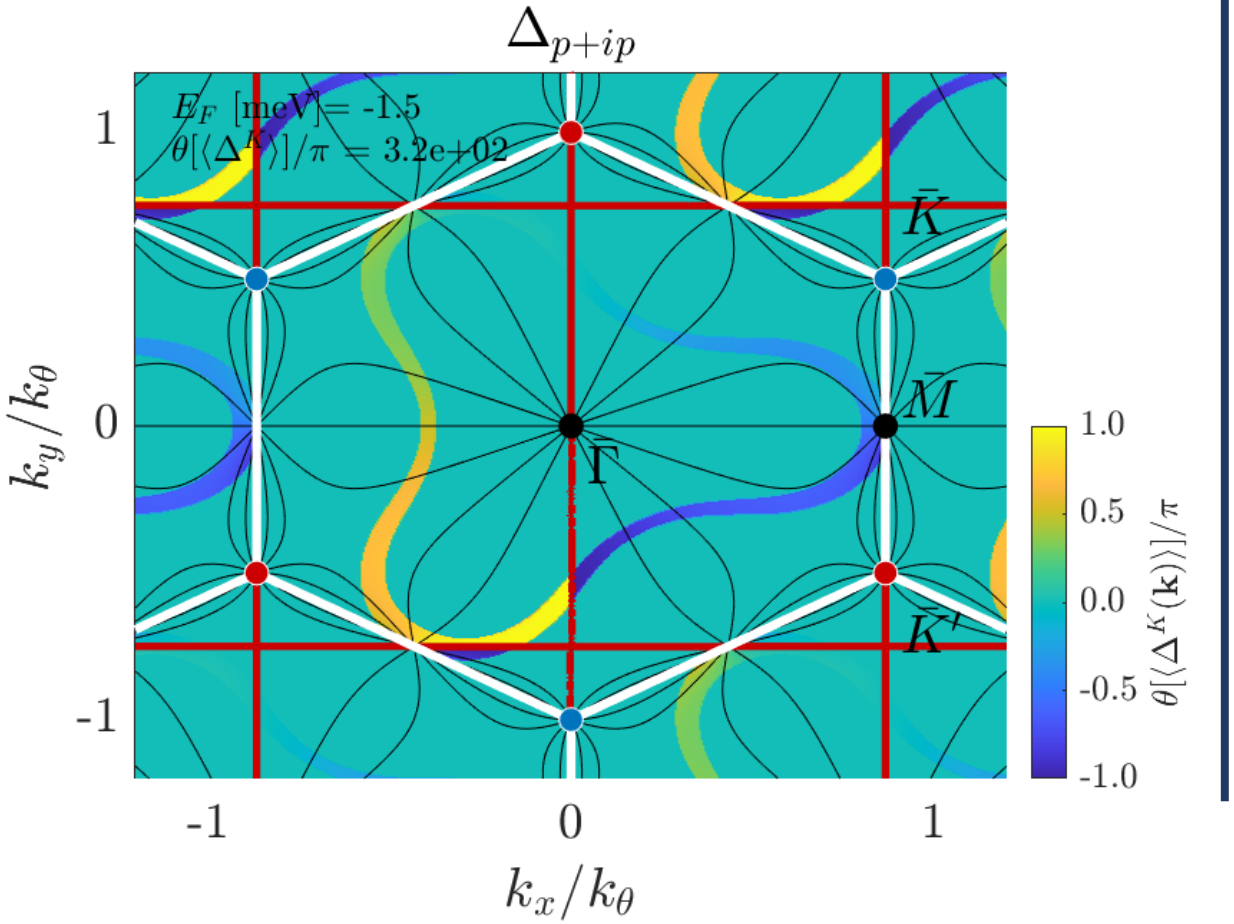
IV. CONCLUSIONS AND OUTLOOK

- We explore the effects of fragile topology and SC in TBG Josephson Junctions
- We described different conditions to obtain **ϕ_0-Josephson Junctions** in SC-TBG
- We connect this phenomenology to the combined effects of **fragile topology + chiral superconductivity + Fermi surface structure**
- Still working to obtain a simpler analytical picture of the observed effects

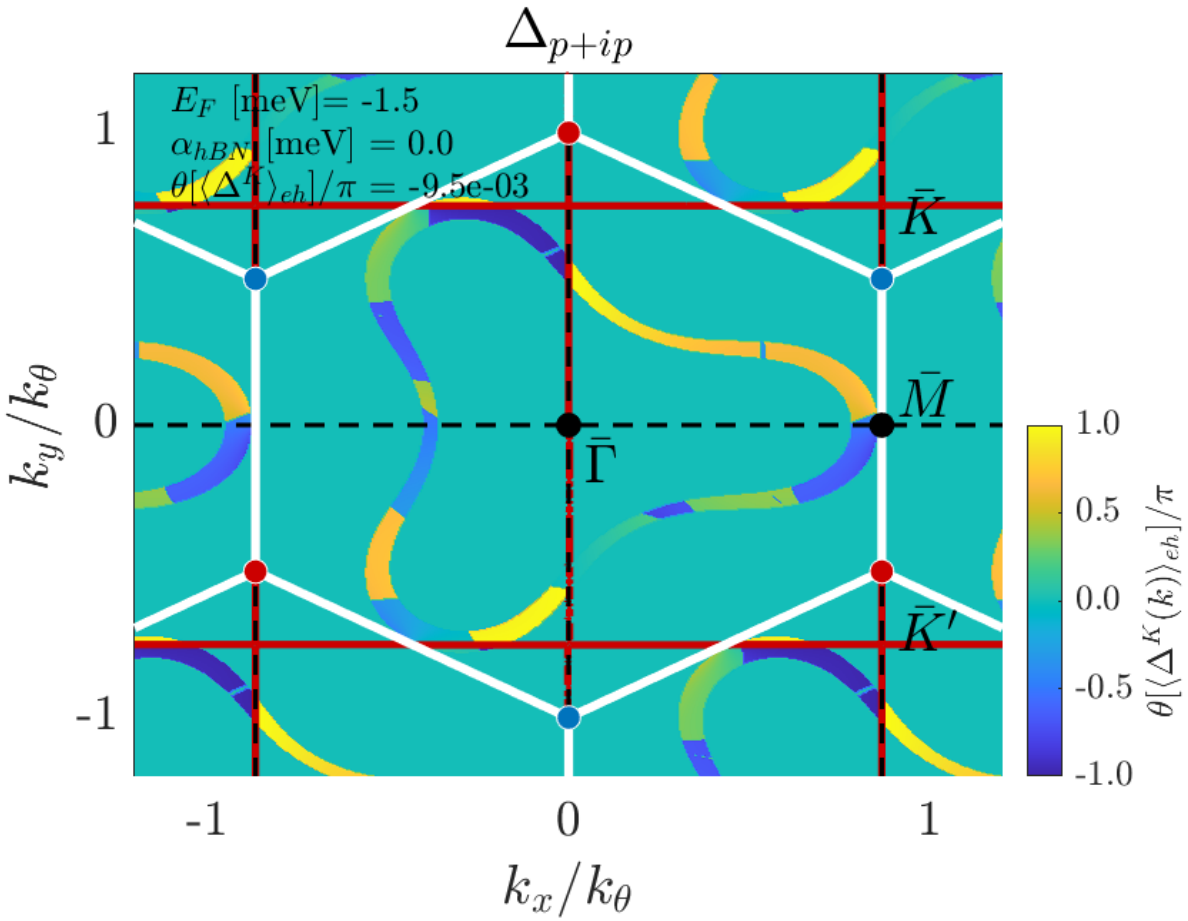


Questions?

CHIRAL SC PHASE DISTIRBUTION



FRAGILE EFFECTIVE PAIRING PHASE



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