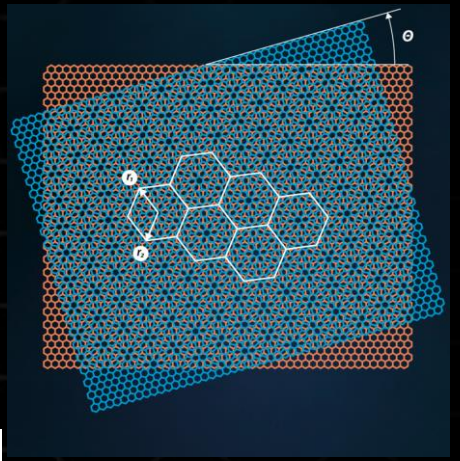
Group 9

Twisted Double Bilayer Graphene



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Article

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Superconductivity in twisted double bilayer graphene stabilized by WSe_2

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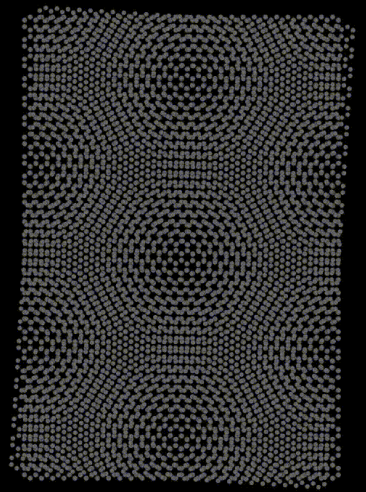
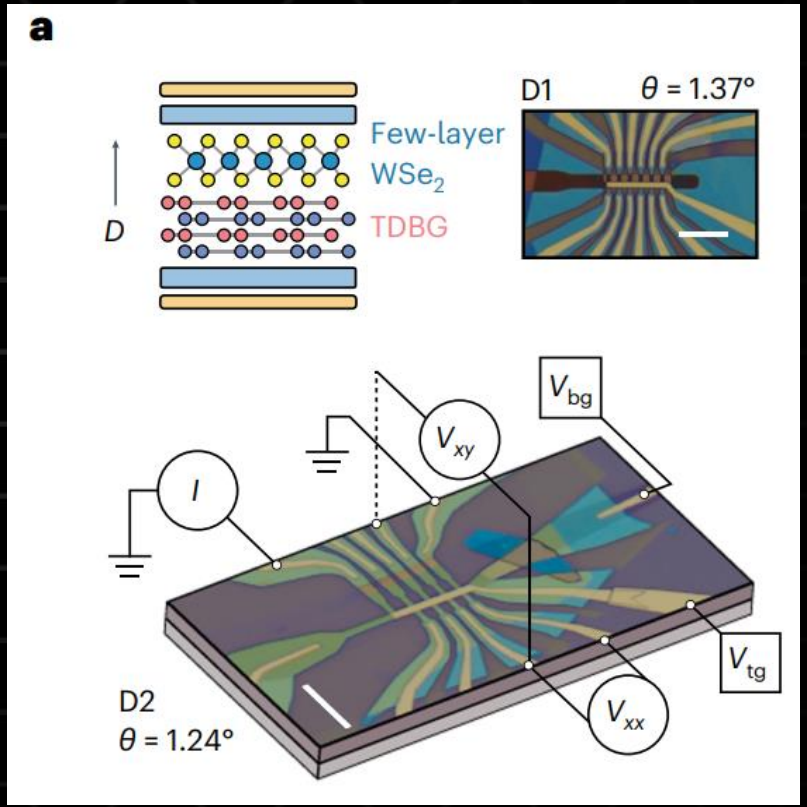
Outline

- Summary of the article
- Comparison of article’s results with previous works
- Critical analysis by the team
- Summary of conclusions by the author’s and the team
- Citation evaluation and field evolution



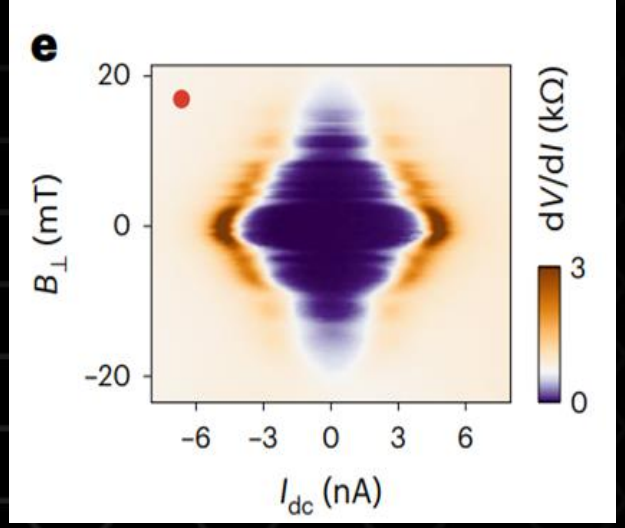
Summary of the article

- Twisted double bilayer graphene (TDBG) bounded by WSe_2 layer exhibits superconductivity
- Electrical gates, V_{tg} and V_{bg}, control carrier density (n) and displacement field (D)
- Superconductivity appears in isospin-unpolarised phases, near transitions to a polarized phases.

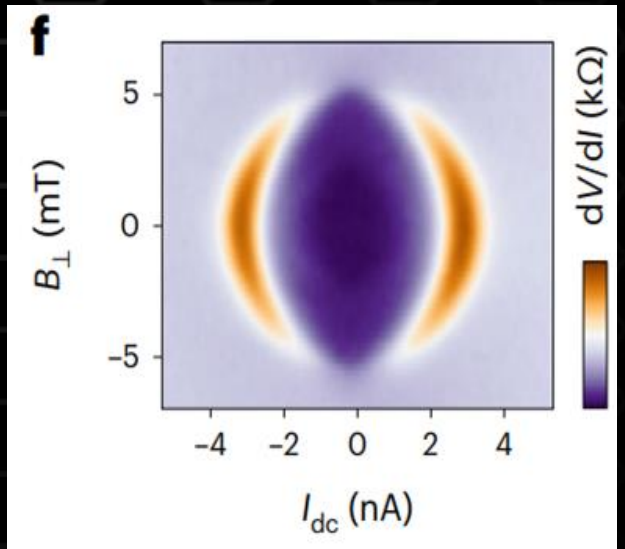


Results Comparison

- TDBG bounded by WSe_2 exhibits superconductivity over a different parameter range than twisted bilayer graphene (TBG).
- D2 Lacks the Fraunhofer oscillations, which is characteristic to many other low-T_c graphene superconductors.
- D2 behavior not well explained by current symmetry breaking TDBG theory, or Joule heating.



D1
1.37°

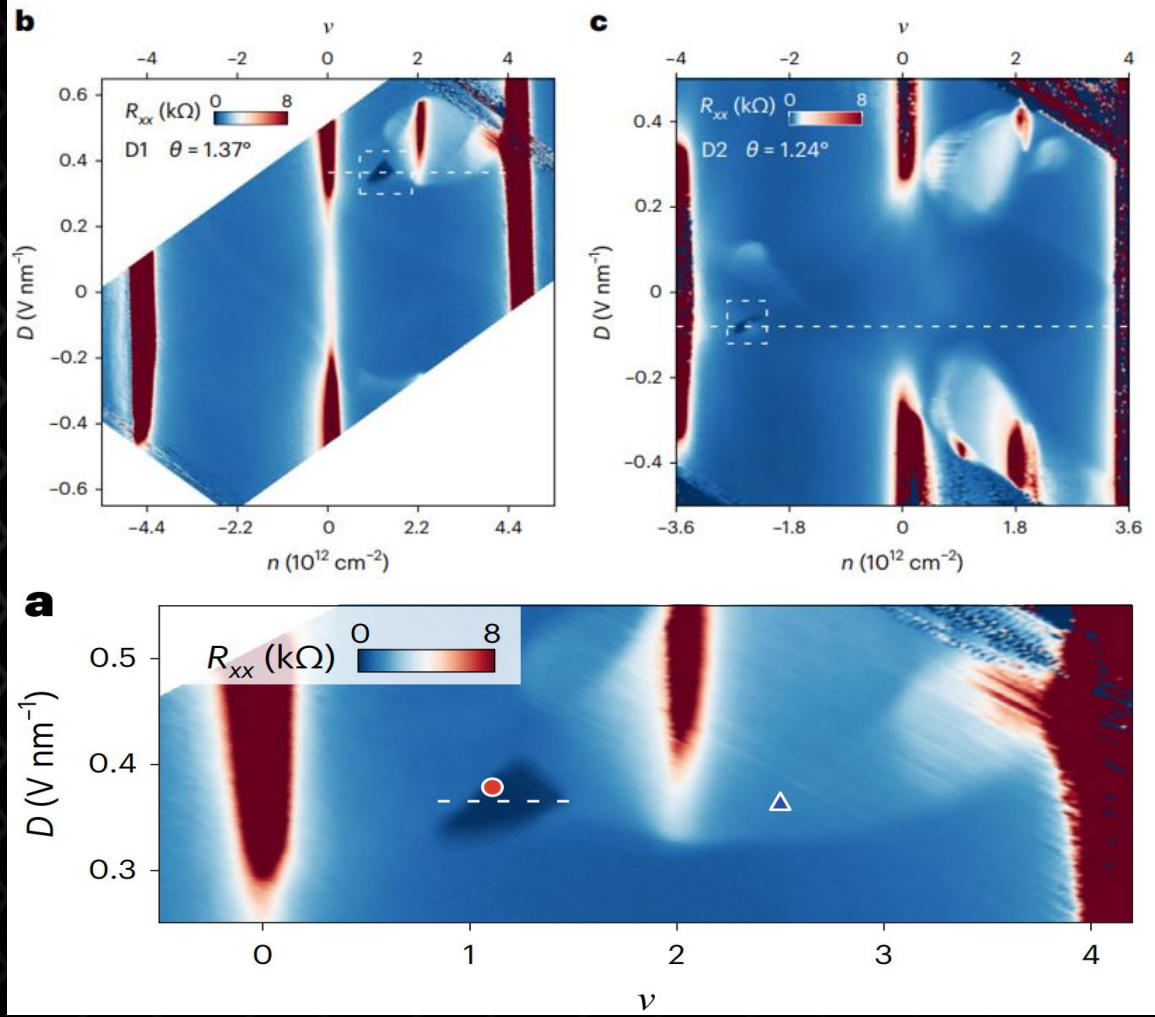


D2
1.24°

Critical Analysis

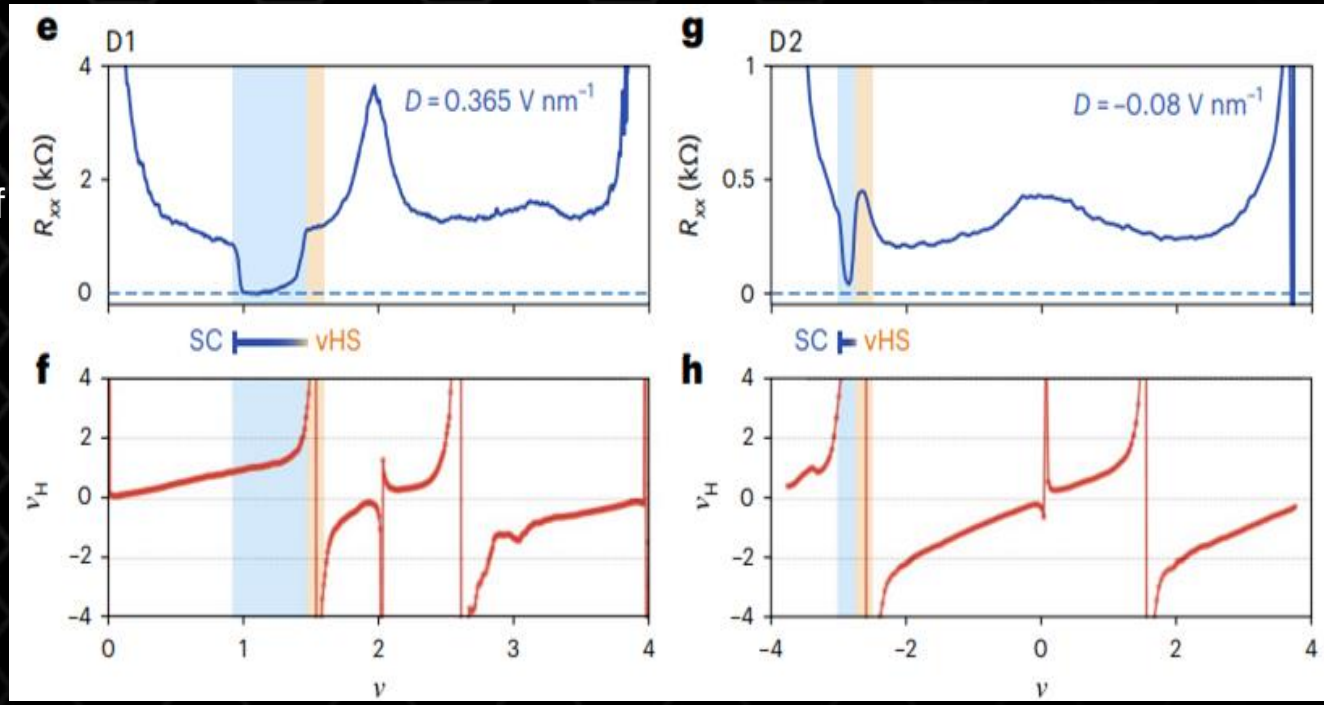
Experimental Results

- Superconductivity!
- θ=1.37°: Differential resistance lies within the range of experimental uncertainty of 0 at around T=80mK
- θ=1.24°: Superconducting below T=40mK, differential resistance on the order of 10 Ohms
  - Addressed possible alternative explanations for the low-resistance regions in D2, but claims likelihood is low



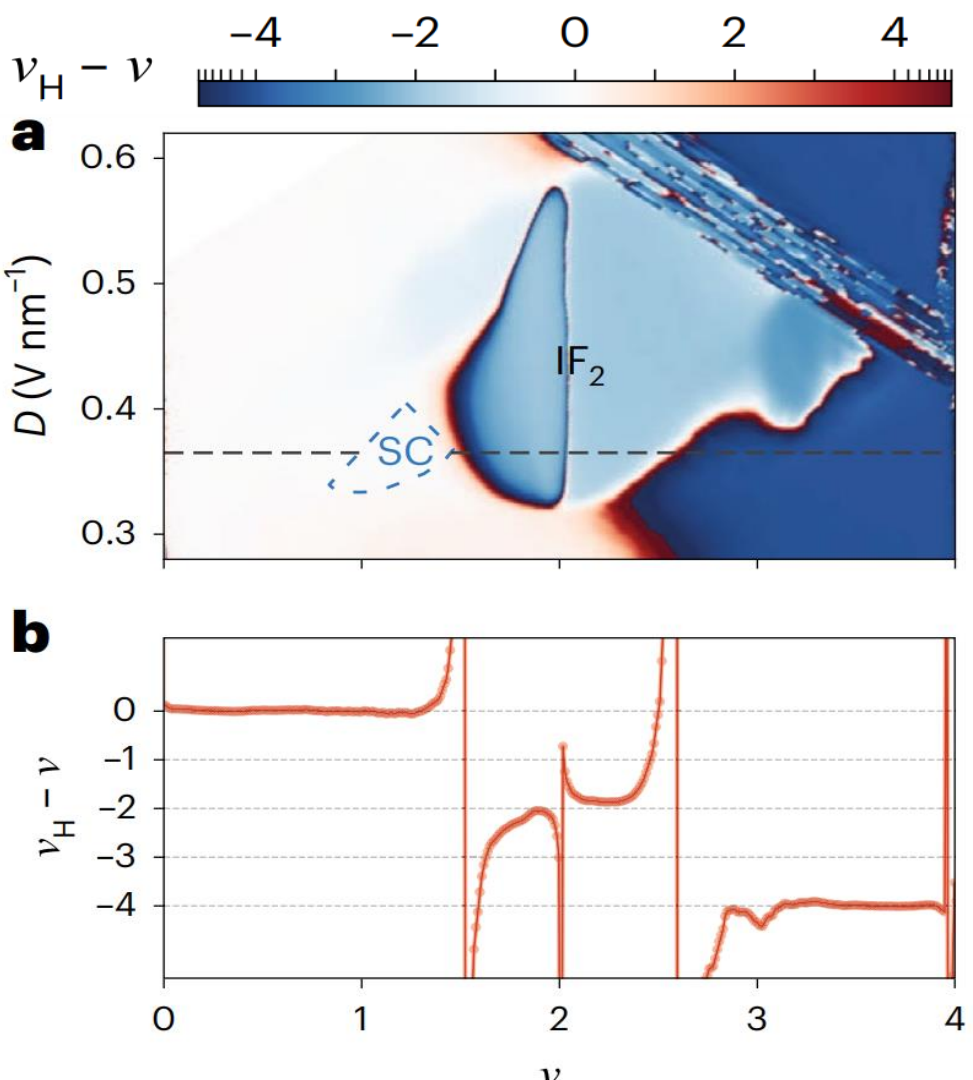
Superconductivity emerges from high density of states

- Superconducting in blue, van Hove singularities in orange
  - vHS where density of states diverges
- Consistent findings in θ=1.37° and θ=1.24° systems



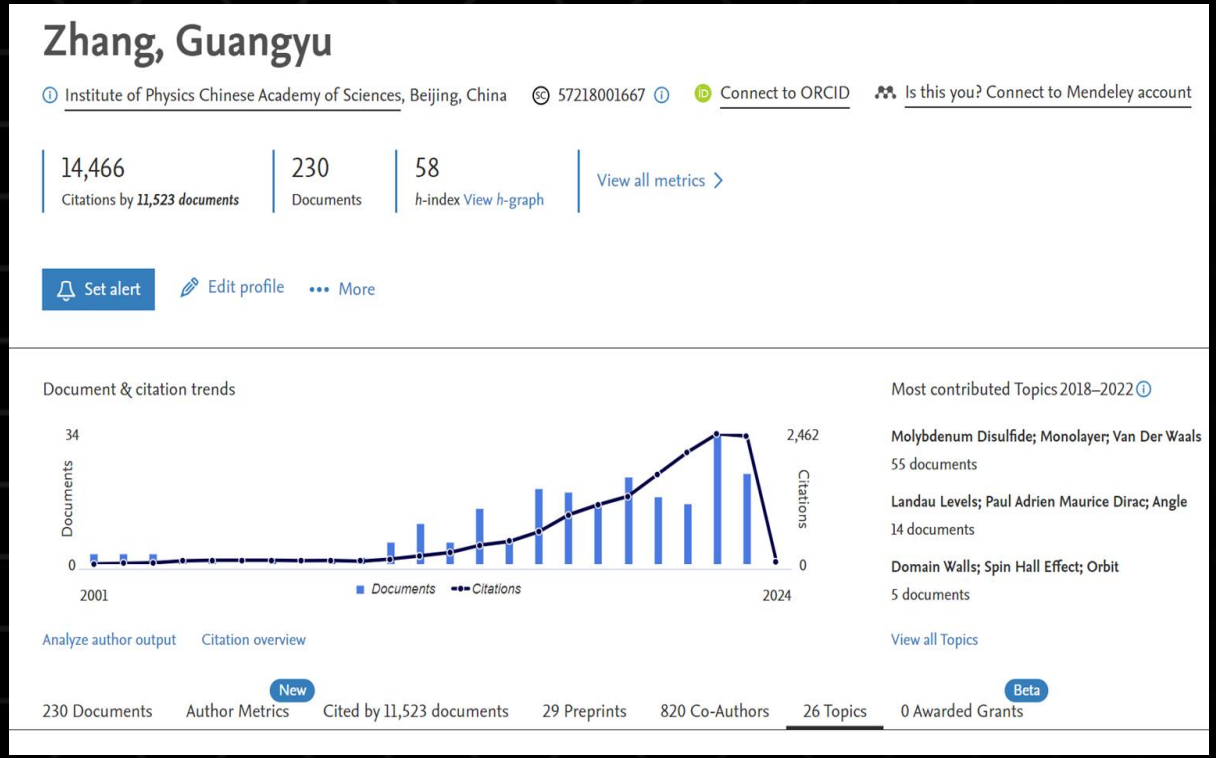
Superconductivity emerging in proximity to isospin polarized bands

- Superconductivity appears near transitions to isospin polarized phases
  - Evidence for correlation between the two properties, but no claim that they are indeed correlated
- ν_H - ν is a measure for isospin polarization



Critical Analysis

- Reproducibility
  - Paper has detailed methods section that describes sample fabrication and transport studies
  - Producing TDBG can be tricky!
- Peer Review
  - Guangyu Zhang, Institute of Physics, CAS
  - Other reviewer(s) is/are anonymous
- Conflict of Interest
  - The authors have declared no competing interests.



Main Conclusions

Authors Conclusions:

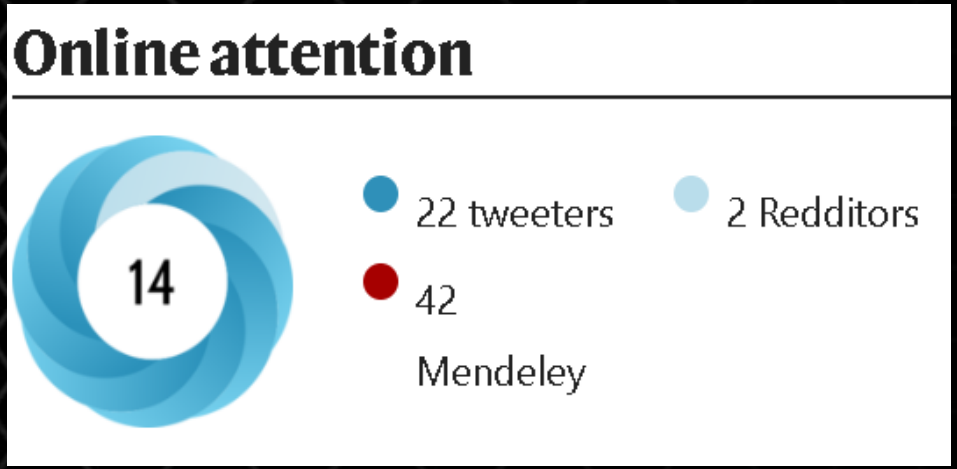
- Superconductivity and density of states
  - Correlated for TDBG!
- Stability from few-layer WSe_2
  - D>0 in the conduction band (v>0)
  - D<0 in the valence band (v<0)
- Transitions to isospin polarized phases
  - Potentially correlated to superconductivity

Group Conclusions:

- Isospin polarization correlation has merit
  - Should be investigated further
- More questions than answers…
  - Isospin polarization transitions
  - WSe_2-invoked stability
  - Twist angle

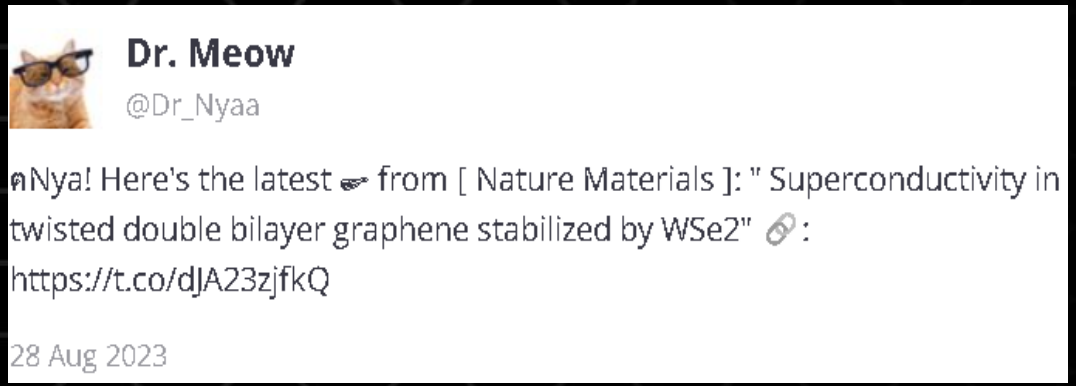
Citation Evaluation

- Published **August 28th, 2023**
  - Very recent publication!
- Cited just 6 times
- Accessed 6665 times
- Altmetric Score:
  - 87th percentile (41,000/ 338,481)
    - Similar age (all journals)
  - 56th percentile (34/ 75)
    - Similar age (*Nature Materials*)



Evolution of the Field

- Long-term evolution
  - Too soon to tell
- Short term evolution
  - Few new publications on TDBG
  - Some review, others add new information
    - Topological Josephson Junctions, edge states, etc.



Questions?