

# Single-gate tracking behavior in flat-band multilayer graphene devices

Cyprian Lewandowski

Kryštof Kolář, Dacén Waters, Joshua Folk, Matthew Yankowitz, Cyprian Lewandowski

National High Magnetic Field Laboratory, Tallahassee, Florida, 32310, USA

Department of Physics, Florida State University, Tallahassee, Florida 32306, USA

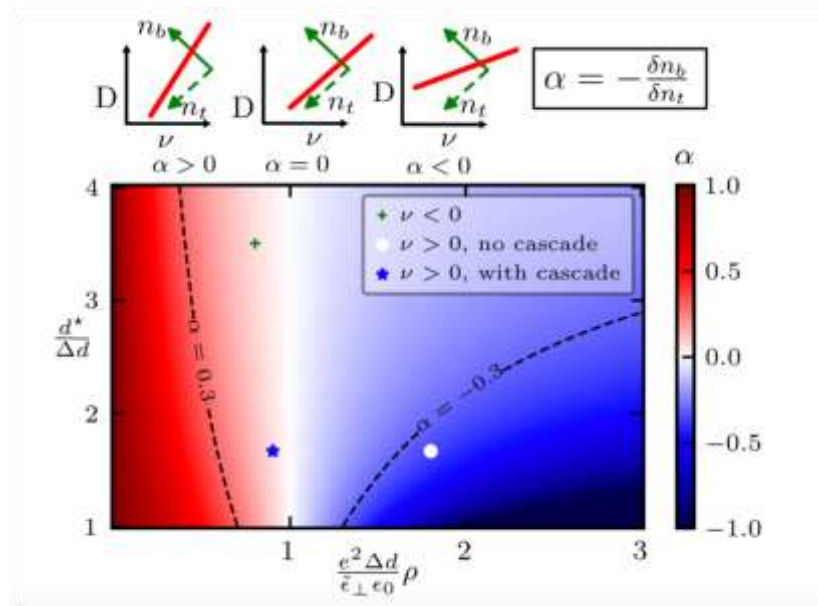
[clewandowski@magnet.fsu.edu](mailto:clewandowski@magnet.fsu.edu)

A central feature of many van der Waals (vdW) materials is the ability to precisely control their charge doping,  $n$ , and electric displacement field,  $D$ , using top and bottom gates. For devices composed of only a few layers, it is commonly assumed that  $D$  causes the layer-by-layer potential to drop linearly across the structure. Here, we show that this assumption fails for a broad class of crystalline and moiré vdW structures based on Bernal- or rhombohedral-stacked multilayer graphene. We find that the electronic properties at the Fermi level are largely dictated by special layer—polarized states arising at Bernal-stacked crystal faces, which typically coexist in the same band with layer-delocalized states. We uncover a novel mechanism by which the layer-delocalized states completely screen the layer—polarized states from the bias applied to the remote gate. This screening mechanism leads to an unusual scenario where voltages on either gate dope the band as expected, yet the band dispersion and associated electronic properties remain primarily (and sometimes exclusively) governed by the gate closer to the layer—polarized states. Our results reveal a novel electronic mechanism underlying the atypical single-gate—controlled transport characteristics observed across many flat-band graphitic structures, and provide key theoretical insights essential or accurately modelling these systems.

## References

- [1] Kryštof Kolář, Dacén Waters, Joshua Folk, Matthew Yankowitz, Cyprian Lewandowski, *Physical Review B*, 113 (2026) 075131

## Figures



**Figure 1:** Single-gate tracking mechanism in multilayer graphene systems as a function of system parameters.