

Quantum Dot Formation at Gate-Defined Interfaces in Twisted Double Bilayer Graphene

E. Portolés,^{1,*,+} G. Zheng,^{1,+} F. K. de Vries,¹ J. Zhu,² P. Tomić,¹ A. H. MacDonald,² T. Ihn,¹
K. Ensslin,¹ and P. Rickhaus¹

¹ *Solid State Physics Laboratory, ETH Zuerich, CH-8093 Zuerich, Switzerland*

² *Department of Physics, University of Texas at Austin, Austin, Texas 78712, USA*

*corresponding author: eliaspo@phys.ethz.ch

+ : equal contribution

Interest in moiré crystals, sparked by the advent of magic-angle twisted bilayer graphene [1], has drawn attention to other material combinations. One of those combinations is Twisted Double Bilayer Graphene. This material brings together the strong interactions originating from the flatness of the bands and the out-of-plane electrical field (displacement field) tunability of Bernal-stacked bilayer graphene [2]. Therefore, one can electrostatically change the nature of the electronic phases. This makes of this material a suitable platform for hosting devices with an in situ tunable geometry. However, to harness such single-crystal structures, understanding of electronic transport across gate-defined interfaces is of utter importance.

Here, we electrostatically define an electronic cavity in Twisted Double Bilayer Graphene. For a particular combination of electronic regimes in the cavity and leads, we observe Coulomb blockade features in transport, an indication of strong electronic confinement. From the gate, magnetic field and source-drain voltage dependence of such features we conclude that quantum dots form at the interfaces of the cavity. We believe this quantum dot formation results from an interplay between the electric field gradient and the moiré lattice. Our results constitute a first step towards better understanding interfacial phenomena and quantum dot formation in single crystal moiré devices.

[1] Cao, Y., Fatemi, V., Fang, S. et al. Unconventional superconductivity in magic-angle graphene superlattices. *Nature* 556, 43–50 (2018).

[2] Bistritzer, R., MacDonald, A. H. Moiré bands in twisted double-layer graphene. *Proceedings of the National Academy of Sciences*, 108 (30) 12233-12237 (2011)