From Cavities to Quantum Pumps: New Insights into Metal-Graphene Interfaces

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Understanding metal-graphene interfaces is crucial for realizing graphene-based nanoelectronics, yet conventional views overlook subtle phenomena emerging at nanoscale contacts.

Here, we report the unexpected formation of a localized n-doped radial cavity around high-quality, sub-micrometer metal contacts on graphene, created through a combination of metal-induced electrostatic potentials and Klein tunneling. This cavity hosts quantized energy states, evident as secondary resistance peaks in transport measurements. Under a perpendicular magnetic field, the cavity further evolves, generating a distinct set of Landau levels and an emergent secondary bulk around the contact. This dual-bulk configuration directly reveals topological edge states arising from bulk-boundary correspondence, offering unprecedented insight into fundamental graphene physics.

Additionally, we briefly introduce ongoing experiments that directly observe Laughlin's quantized charge pump mechanism in graphene, leveraging similar nanoscale contact geometries to achieve pristine, quantized edge states.

References

[1] Zhao, Y., Kapfer, M., Watanabe, K., Taniguchi, T., Zilberberg, O., & Jessen, B. S. Emergent Cavity Junction around Metal-on-Graphene Contacts. (2024).

Figures

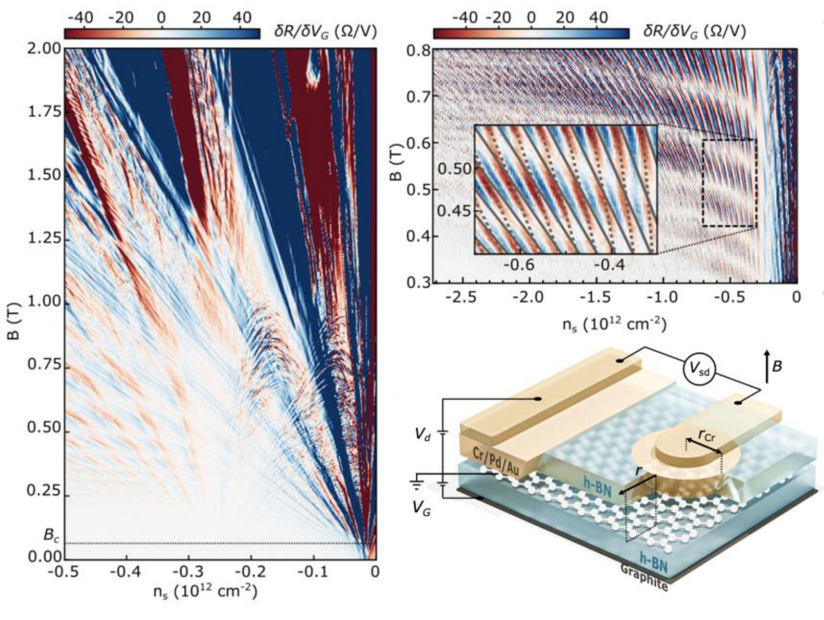

Figure 1: Small and clean top-contacts on graphene can induce unexpected cavities around the contact, which in turn enables unusual magneto-transport measurement.