Atomically Thin Current Pathways in Graphene through Kekulé-O Engineering

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We demonstrate that the current flow in graphene can be guided on atomically thin current pathways by the engineering of Kekulé-O distortions. A grain boundary in these distortions separates the system into topologically distinct regions and induces a ballistic domain-wall state. The state is independent of the orientation of the grain boundary with respect to the graphene sublattice and permits guiding the current on arbitrary paths. As the state is gapped, the current flow can be switched by electrostatic gates. Our findings are explained by a generalization of the Jackiw–Rebbi model, where the electrons behave in one region of the system as Fermions with an effective complex mass, making the device not only promising for technological applications but also a test-ground for concepts from high-energy physics. An atomic model supported by DFT calculations demonstrates that the system can be realized by decorating graphene with Ti atoms.

References

[1] Santiago Galván y García, Yonatan Betancur-Ocampo, Francisco Sánchez-Ochoa, Thomas Stegmann, Nano Lett. 24: 2322 (2024) DOI: acs.nanolett.3c04703

Figures

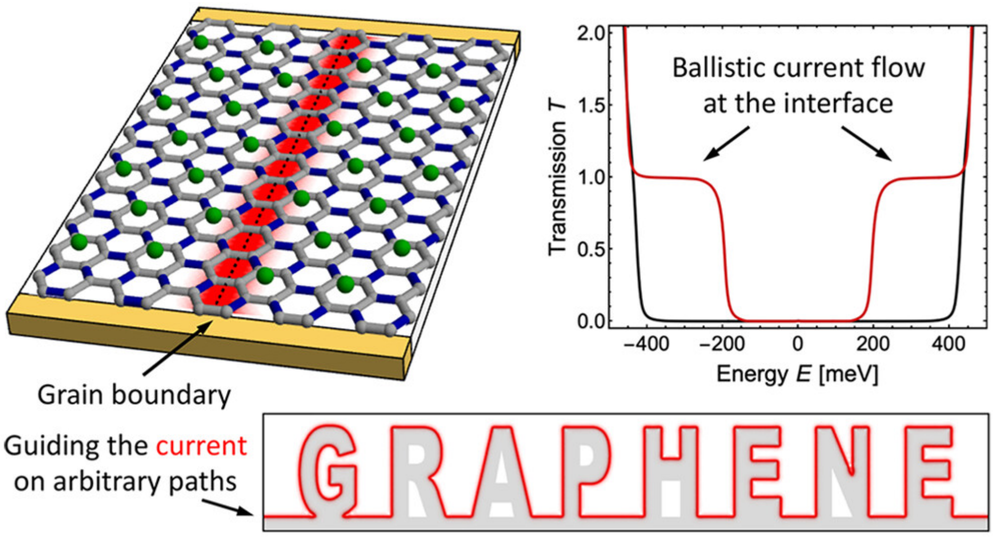

Figure 1: The engineering of a grain boundary in the Kekulé-O distortions of graphene, see the displacement of the Ti atoms (green spheres) at the black dashed line, generates a domain wall state that guides the current ballistically through the system. The current can be steered on arbitrary paths, for example forming the word "Graphene", because the domain wall state is independent of the orientation of the underlying graphene lattice.