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Observation of conducting edge states in graphene at zero magnetic field MONICA ALLEN, Harvard University, ION FULGA, Weizmann Institute of Science, OLES SHTANKO, Massachusetts Institute of Technology, KENJI WATANABI, TAKASHI TANIGUCHI, Environment and Energy Materials Division, National Institute for Materials Science, Japan, PABLO JARILLO-HERRERO, Massachusetts Institute of Technology, ANTON AKHMEROV, Delft University of Technology, LEONID LEVITOV, Massachusetts Institute of Technology, AMIR YACOBY, Harvard University — The electronic nature of edge states confined to the boundaries of a graphene crystal remains an outstanding question. Proposals range from Anderson localization to chiral zero-energy edge modes, but a full microscopic picture of edge transport remains elusive. We directly image current transmission in real space by coupling superconducting electrodes to a graphene crystal and measuring quantum interference as a function of applied magnetic flux. To obtain a more quantitative picture, we employ Fourier techniques to extract the real space current distribution with nanoscale precision. We observe robust confinement of current to the edges of the crystal approaching the Dirac point and show that relative edge and bulk contributions are tunable via electrostatic gating. A strong candidate consistent with our data is the proposal of chiral edge modes that arise from sublattice symmetry breaking at the edge, sustained in all crystallographic edge orientations except atomically perfect armchair. Our techniques also open the door to fast spatial imaging of current distributions along more complicated networks of domains in larger crystals.

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