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Detecting topological currents in graphene superlattices
GELIANG YU, ANDREY KRETININ, School of Physics and Astronomy, University of Manchester, Oxford Road, Manchester M13 9PL, UK, JUSTIN SONG, Department of Physics, Massachusetts Institute of Technology, Cambridge, MA 02139, USA, ROMAN GORBACHEV, Centre for Mesoscience and Nanotechnology, University of Manchester, Manchester M13 9PL, UK, LEONID LEVITOV, Department of Physics, Massachusetts Institute of Technology, Cambridge, MA 02139, USA, KONSTANTIN NOVOSELOV, ANDRE GEIM, School of Physics and Astronomy, University of Manchester, Oxford Road, Manchester M13 9PL, UK — Topological materials may exhibit Hall-like currents flowing transversely to the applied electric field even in the absence of a magnetic field. In graphene superlattices, which have broken inversion symmetry, topological currents originating from graphene's two valleys are predicted to flow in opposite directions and combine to produce long-range charge neutral flow. We observed this effect as a nonlocal voltage at zero magnetic field in a narrow energy range near Dirac points at distances as large as several micrometers away from the nominal current path. Locally, topological currents are comparable in strength with the applied current, indicating large valley-Hall angles. The long-range character of topological currents and their transistor-like control by means of gate voltage can be exploited for information processing based on valley degrees of freedom.

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