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Fabrication of artificial graphene in a GaAs heterostructure[1]
DIEGO SCARABELLI, SHENG WANG, YULIYA KUZNETSOVA, Columbia University, LOREN PFEIFFER, KEN WEST, Princeton University, GEOFF GARDNER, MICHAEL MANFRA, Purdue University, VITTORIO PELLEGRINI, Italian Institute of Technology, ARON PINCZUK, SHALOM WIND, Columbia University — Engineered honeycomb lattices, known as artificial graphene, constitute a platform for the exploration of graphene-like phenomena in a highly controllable and tunable manner, offering insight into a broader parameter range inaccessible to natural graphene. The electronic states of a 2D electron gas whose density is modulated by a potential with honeycomb topology have been predicted to generate massless Dirac fermions (MDFs) with tunable Fermi velocity. In this work we present the fabrication of artificial graphene in an ultrahigh quality GaAs/AlGaAs quantum well, with lattice period as small as 40nm, the smallest reported so far for this type of system. The combination of high precision electron-beam lithography, used to define an etch mask with honeycomb geometry on the surface of the sample, and precise anisotropic reactive ion etching allows to create artificial graphene with excellent uniformity and long range order. Different methodologies for preparation of the mask are compared and their limits are discussed. Thanks to the achievement of such high-resolution artificial graphene we expected to be able to observe, for the first time, MDFs in an engineered semiconductor and the possibility of access to novel topological phases.

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