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Real Space Imaging of the Quantum Hall Effect and Valley Polarization in Graphene DAVID MILLER, KEVIN KUBISTA, MING RUAN, WALT DE HEER, PHILLIP FIRST, Georgia Institute of Technology, GREGORY RUTTER, JOSEPH STROSCIO, Center for Nanoscale Science and Technology, NIST
— When a perpendicular magnetic field is applied to a graphene sheet, the resulting eigenenergies (Landau Levels or LLs) have a nonlinear energy distribution that includes a four-fold degenerate zero-energy state (LL_0). Maps of the energy-resolved local density of states (LDOS) acquired via cryogenic scanning tunneling spectroscopy (STS) provide atomic-scale images of the LL spatial distribution. Focusing on LL_0, we use STS maps to show the distribution of "drift states" and find unexpected atomic-scale spatial variations of the LDOS above a critical field of $B_* = 4T$. We resolve an energy gap in LL_0 and show how it depends on the local A-B lattice symmetry and magnetic field. The gap is observed only within patches of at least a few magnetic lengths in size, which forces the splitting to "turn off" below the critical field. We attribute this behavior to a breaking of the local sublattice symmetry imposed by moire layer stacking.

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