MAR13-2012-020715

Abstract for an Invited Paper
for the MAR13 Meeting of
the American Physical Society

Gate-defined Quantum Confinement in Suspended Bilayer Graphene

MONICA ALLEN, Harvard University

Quantum confined devices in carbon-based materials offer unique possibilities for applications ranging from quantum computation to sensing. In particular, nanostructured carbon is a promising candidate for spin-based quantum computation due to the ability to suppress hyperfine coupling to nuclear spins, a dominant source of spin decoherence. Yet graphene lacks an intrinsic bandgap, which poses a serious challenge for the creation of such devices. We present a novel approach to quantum confinement utilizing tunnel barriers defined by local electric fields that break sublattice symmetry in suspended bilayer graphene. This technique electrostatically confines charges via band structure control, thereby eliminating the edge and substrate disorder that hinders on-chip etched nanostructures to date. We report clean single electron tunneling through gate-defined quantum dots in two regimes: at zero magnetic field using the energy gap induced by a perpendicular electric field and at finite magnetic fields using Landau level confinement. The observed Coulomb blockade periodicity agrees with electrostatic simulations based on local top-gate geometry, a direct demonstration of local control over the band structure of graphene. This technology integrates quantum confinement with pristine device quality and access to vibrational modes, enabling wide applications from electromechanical sensors to quantum bits. More broadly, the ability to externally tailor the graphene bandgap over nanometer scales opens a new unexplored avenue for creating quantum devices.