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M1Po2D-04 [47]: Quantum effects in graphitic materials

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Unlike the more common local conductance spectroscopy, nonlocal conductance can differentiate between nontopological zero-energy modes localized around inhomogeneities, and true Majorana edge modes in the topological phase. In particular, negative nonlocal conductance is dominated by the crossed Andreev reflection. Fundamentally, the effect reflects the system's topology. In graphene, the Andreev reflection and the inter-band Klein tunneling couple electron-like and hole-like states through the action of either a superconducting pair potential or an electrostatic potential.
We are here probing quantum phenomena in modified graphitic samples. Four-point contact transport measurements at cryogenic to room temperatures were conducted using a Quantum Design Physical Property Measurement System. The observed negative nonlocal differential conductance Gdiff probes the Andreev reflection at the walls of the superconducting grains coupled by Josephson effect through the semiconducting matrix. In addition, Gdiff shows the butterfly shape that is characteristic to resistive random-access memory devices. In a magnetic field, the Andreev reflection counters the effect of the otherwise lowered conduction. At low temperatures, the magnetoresistance shows irreversible yet strong giant oscillations that are known to be quantum in nature. Thus, graphitic materials show potential for quantum electronics applications, including rectification and topological states.

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Primary authors: GHEORGHIU, Nadina; Mr EBBING, Charles (U. of Dayton Research Institute); HAUGAN, Timothy (U.S. Air Force Research Laboratory)

Presenter: HAUGAN, Timothy (U.S. Air Force Research Laboratory)

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