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INDUCED SUPERCONDUCTIVITY IN THE FRACTIONAL QUANTUM HALL EDGE IN GRAPHENE HETEROSTRUCTURES

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Topological superconductors represent a phase of matter whose properties cannot be smoothly changed from one phase to another, a robustness which renders them suitable for quantum computing. The past decade has witnessed substantial progress towards a qubit based on Majorana modes, non-Abelian excitations whose exchange—braiding—produces topologically protected logic operations. However, because braiding Majoranas cannot provide a universal quantum gate set, Majorana qubits are computationally limited. This drawback can be overcome by parafermions, a novel set of non-Abelian modes whose array supports universal topological quantum computation. The primary route to synthesize parafermions involves inducing superconductivity in the fractional quantum Hall (fqH) edge. In this presentation we use high-quality van der Waals devices, coupled to narrow superconducting NbN, in which superconductivity and robust fqH coexist. We find crossed Andreev reflection (CAR) across the superconductor separating two counterpropagating fqH edges which demonstrates their superconducting pairing. The CAR probability of the integer edges is insensitive to magnetic field, temperature, or filling, providing evidence for spin-orbit coupling which enables the pairing of the otherwise spin-polarized edges. FqH edges, however, may show a higher CAR probability varying with temperature, an observation contrasting with that in integer edges. Control experiments show that CAR vanishes at high temperature and excitation as expected from the finite superconducting and fqH energy gaps. These results demonstrate all the required ingredients for parafermions, laying the groundwork for their experimental research in condensed matter.