One-dimensional proximity superconductivity in the quantum Hall regime

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Extensive efforts have been undertaken to combine superconductivity and the quantum Hall effect so that Cooper-pair transport between superconducting electrodes in Josephson junctions is mediated by one-dimensional (1D) edge states [1-4]. This interest has been motivated by prospects of finding new physics, including topologically-protected quasiparticles, but also extends into metrology and device applications. So far it has proven challenging to achieve detectable supercurrents through quantum Hall conductors [2-4]. Here we show that domain walls in minimally twisted bilayer graphene support exceptionally robust proximity superconductivity in the quantum Hall regime, allowing Josephson junctions operational in fields close to the upper critical field of superconducting electrodes. The critical current is found to be non-oscillatory, practically unchanging over the entire range of quantizing fields, with its value being limited by the quantum conductance of ballistic strictly-1D electronic channels residing within the domain walls [5]. The described system is unique in its ability to support Andreev bound states in high fields and offers many interesting directions for further exploration.

References:
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