1D Andreev bound states along quantum Hall edges

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A supercurrent flow in a superconductor-normal metal-superconductor junction is made possible via resonances of normal charge carriers (electrons and holes): Andreev bound states, transmitting Cooper pairs in the superconductors. Engineering superconductivity in the quantum Hall regime is a promising route to create novel electronic states [1,2], but, in this regime different carriers move on opposite device sides which necessitates a tedious coupling between distant edges to achieve small supercurrents [3-5].
Here we present a new geometry where quantum Hall edge states are carried along narrow domain walls (DWs) at the centre of the device allowing localised Andreev bound states insensitive to the magnetic field [6]. At magnetic fields as high as 8T, we observe Josephson coupling with relatively large critical currents. We find superconducting interferences between domain walls and Fabry-Pérot oscillations in individual DWs, effects attributed unambiguously to a 1D nature.
Such localised Andreev states may host non-trivial excitations and could be a platform for new devices and applications, such as SQUID magnetometers, Andreev qubits, CQUIDs of fluxon devices [7].

References

[1] I. Khaymovich et al. *EPL (Europhysics Letters)*. **91**, 17005 (2010).
[2] O. Gamayun et al. *Physical Review B*. **96**, 241104 (2017).
[3] J. Eroms et al. *Physical Review Letters*. **95**, 107001 (2005).
[4] F. Amet et al. *Science*. **352**, 966–969 (2016).
[5] A. Seredinski et al. *Science advances*. **5**, eaaw8693 (2019).
[6] J. Barrier et al. submitted.
[7] A. Ustinov, *Physica D: Nonlinear Phenomena*. **123**, 315-329 (1998)