Spatial control of Andreev bound states using superconducting phase texture

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We study planar Josephson junctions fabricated on InAs/Al heterostructure stacks, see Fig. 1 for a device micrograph. The Josephson junction is connected to a superconducting loop and is probed by tunnelling spectroscopy on both ends. When a perpendicular magnetic field is applied to the device, local and non-local differential conductance spectroscopy indicates phase-asymmetric local Andreev bound states which opposite asymmetry on both ends, see Fig. 1b and c. We interpret these results as signatures of Andreev bound states localized at a local superconducting phase difference of π, whose position and localization length is tuned by superconducting phase texture imposed by the magnetic flux through the loop and junction area, respectively. These features are captured by numerical simulations. Fig. 2 illustrates the magnetic field-controlled Andreev bound state movement from the calculated local density of states of the lowest-energy Andreev bound state.

Figures

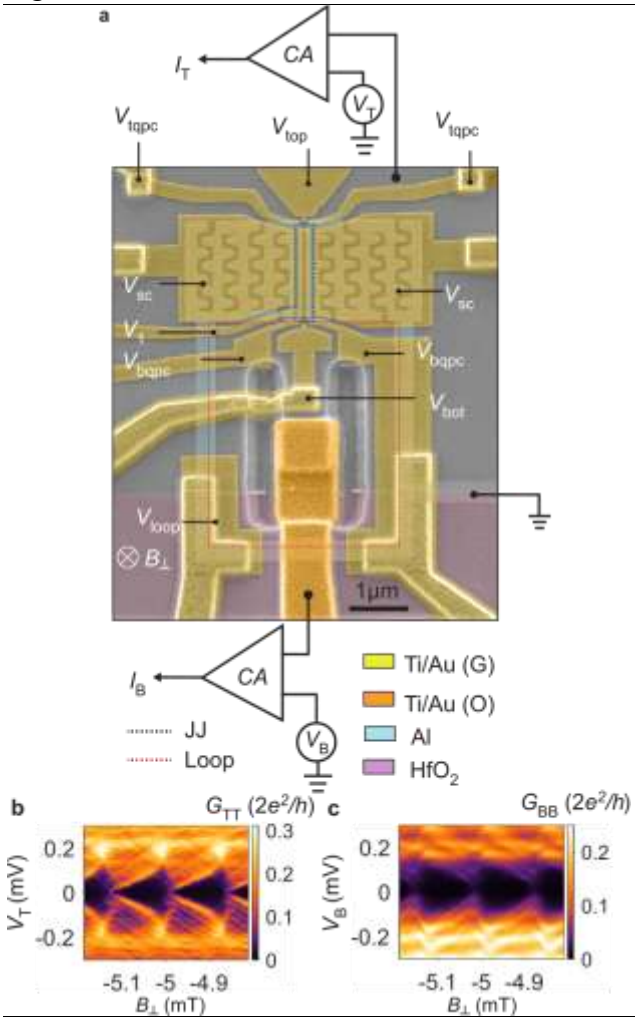

Figure 1: (a) False-colored scanning electron micrograph of a planar Josephson junction device measured in a three-terminal configuration. (b), (c) Local differential conductance spectroscopy at the top and bottom end of the Josephson junction, respectively.

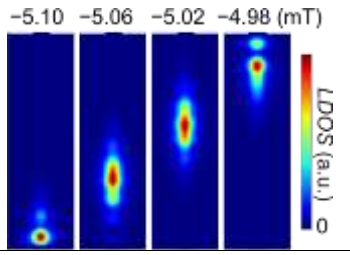

Figure 2: Calculated local density of states of the lowest-energy Andreev bound state in the junction for different values of the perpendicular magnetic field.