Hybridisation of Andreev bound states in a hybrid four terminal Josephson junction

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Abstract

Multi terminal Josephson junctions are emergent platform where Andreev bound states (ABSs) are predicted to exhibit non-trivial topological phases [1-6]. Particularly, in four terminal devices, the ABSs should hybridise forming Weyl nodes in their energy spectrum when the phase differences between the four terminals are tuned within a finite region of parameter space. Therefore, independent phase control is essential to experimentally investigate the properties of such devices. Here, we fabricate a four terminal device (Fig.1(a,b)) in an hybrid Al/InAs QW heterostructure, where the three phase differences are independently controlled via flux biasing. Using tunnelling spectroscopy, we explore how the ABS energy spectrum evolves across the entire three-dimensional phase space identifying different phase-regions where the hybridisation between two and three ABSs occurs as shown in Fig2(a,b). Our results pave the way for future investigations on new topological ABS in multiterminal devices.

References

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Figures

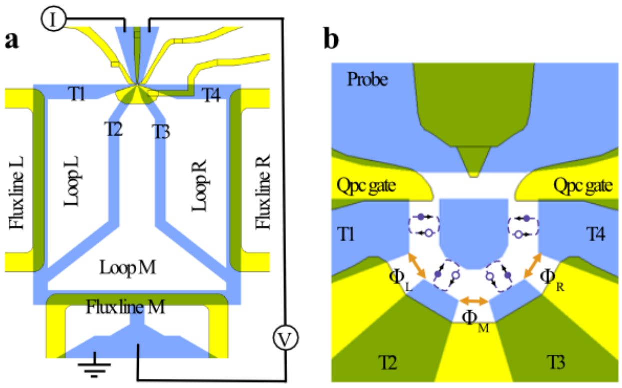

Figure 1: (a) Schematics of our four terminal device where the three phase differences (ϕ_L, ϕ_M, ϕ_R) in (b) are tuned via flux biasing. Tunnelling spectroscopy is performed on the superconductive island at the center of the scattering area (b).

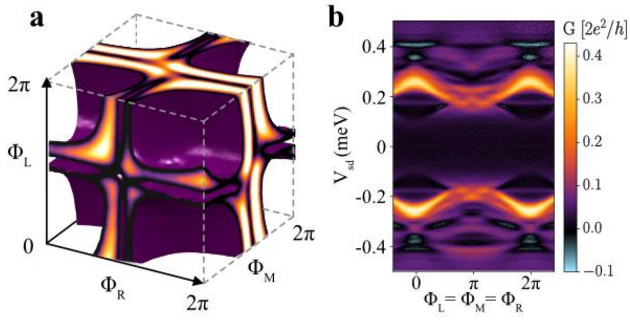

Figure 2: (a) Conductance isosurface measured at Vsd = -0.25 meV showing characteristic signatures of hybridisation between two ABSs along the cube's faces. (b) Energy spectrum of a tri-ABS molecule when the three phases are simultaneously tuned to (π, π, π).