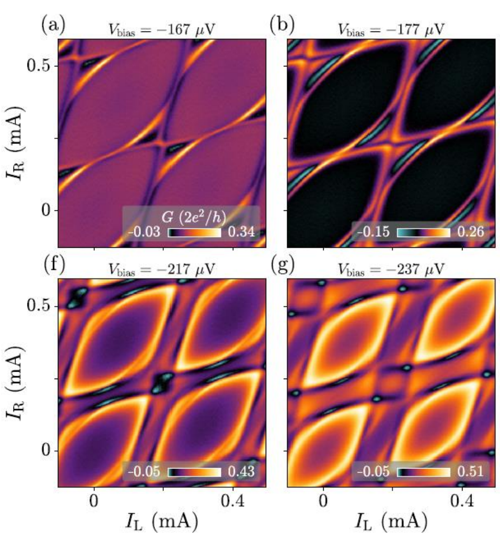
Physikalisches Kolloquium

Universität Konstanz

Dr. Fabrizio Nichele
IBM Research Europe - Zürich

Di 24.10.23
15:15 Uhr
P 603
im Anschluss Getränke und Snacks



Host:
Prof. Belzig

Organisation:
Prof. Bechinger

Linear Multiterminal Josephson junctions in hybrid materials

In a normal conductor interfacing two or more superconductors, charge carriers at energies within the superconducting gap are confined by Andreev reflection processes occurring at the interfaces. As a result, resonant sub-gap electronic excitations known as Andreev bound states (ABSs) arise in the normal region, enabling transport of a Josephson supercurrent between the superconducting terminals. These discrete ABS levels have been the subject of intense experimental investigation in various material platforms towards the realization of qubits, topological states of matter and other interesting directions.

Up to now, experimental studies focused on Josephson junctions (JJs) with two superconducting terminals, where the ABS energies depend on a single superconducting phase difference. In the presence of N>3 terminals, the ABS band structure spanned by the N-1 independent phase differences was predicted to exhibit a plethora of phenomena, including lifting of the spin degeneracy, ground state fermion parity transitions, Weyl singularities and topological properties. Here, we report on the experimental realization of superconductor--semiconductor multi-terminal JJ and study their ABS. Owing to the independent control over two superconducting phase differences, we probe the Andreev band structure in the two-dimensional (2D) phase space and find signatures of hybridization between highly transmissive ABSs, resulting in the formation of an Andreev molecule, spin-degeneracy breaking, with level splitting in excess of 9 GHz, and zero-energy crossings associated to ground state fermion parity transitions, in agreement with theoretical predictions. Our experiments highlight the potential of multiterminal hybrid devices for engineering quantum states.