Ultrastrong coupling between Andreev bound states and a high impedance lumped-element resonator

Oleg Shvetsov[1]
A. Ankit[1], V. Buccheri[1], I. Cools[1], T. Kanne[2], J. Nygård[2], A. Geresdi[1]

[1]*Quantum Device Physics Laboratory, Department of Microtechnology and Nanoscience, Chalmers University of Technology, SE 41296 Gothenburg, Sweden*

[2]*Center for Quantum Devices, Niels Bohr Institute, University of Copenhagen, DK-2100 Copenhagen, Denmark*

shvetsov@chalmers.se

Josephson junctions in Al/InAs nanowires host Andreev bound states[1] (ABSs) and can be considered as a platform for realization of gate-tunable Andreev qubits[2-4]. An acute challenge of such architecture is to improve the coupling between an ABS and a microwave resonator.
Here, we report microwave characterization of an Al/InAs nanowire weak link embedded in a superconducting loop with a lumped-element resonator patterned from a thin NbTiN film with high kinetic inductance. We demonstrate that our approach offers a compact geometry, a high resonator impedance above 12 kOhm and remarkably large coupling rates between ABSs and the resonator mode reaching the value of 1.2 GHz. This result provides a basis for exploration of strongly correlated light–matter states in cQED.

References

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[3] M. Hays et al, Phys. Rev. Lett. 121, 047001 (2018)
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Figures

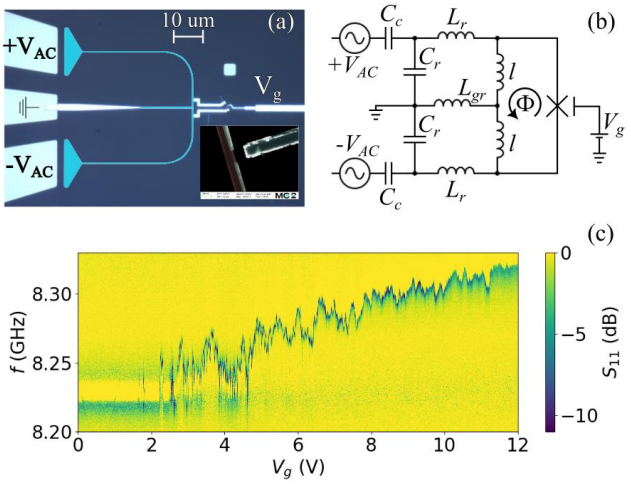
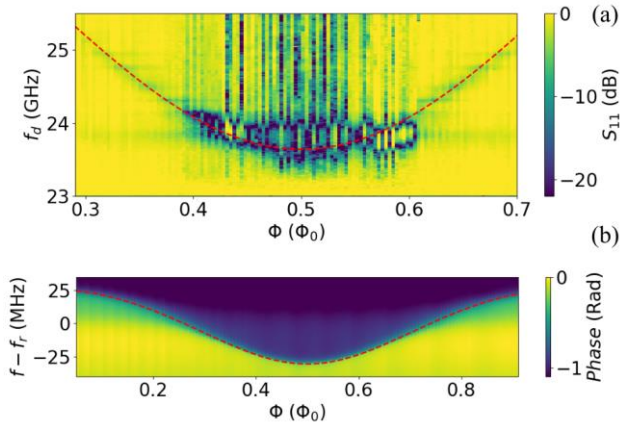


Figure 1: (a) Differentially driven lumped element resonator coupled to a nanowire weak link. Inset: SEM picture of the nanowire Josephson junction. (b) Circuit equivalent of the device. (c) Gate-tunable microwave response.



Channel	Δ (GHz)	τ	δ_{zp} (Rad)
1	13.95	0.282	0.121
2*	15.5	0.2	0.121

Figure 2: (a) Two-tone spectrum in dispersive regime. (b) Corresponding single-tone spectrum. Dashed lines show the fitted spectra. Table: parameters for a 2-channel fitting (Δ – ABS energy gap, τ – channel transmission, δ_{zp} – zero-point phase fluctuations in the weak link). *The second channel is introduced to account for all the higher energy states.