Visit at Qudev group, 23. June 2017, 10:00h, D 12

Clemens Müller
Postdoctoral Research Fellow
ARC Centre for Engineered Quantum Systems, The University of Queensland, Australia

Title:
On-chip microwave circulators - Breaking time-reversal symmetry with quantum phase slips

Abstract:

We present the design of a passive, on-chip microwave circulator based on superconducting quantum phase slip (QPS) junctions. QPS junctions are dual circuit-elements that are equivalent to Josephson junctions under the exchange of voltage and current [1] and they have recently been employed to observe coherent quantum phase slips [2] and as the basic buidling block of a new type of flux qubit [3].
In our proposed QPS-junction based circulator, the three ports of the circulator are inductively connected to superconducting loops hosting trapped flux quanta. The role of a symmetry-breaking magnetic field is played by an external gate charge on a central island. The design is similar to one previously proposed using Jopsephson junctions [4], but exchanges the charge and flux degrees of freedom. The QPS circulator therefore is much less sensitive to environmental perturbations, since fluctuations in background magnetic flux are many orders of magnitude suppressed as compared to charge fluctuations.
We derive the properties of a QPS based circulator design from a Lagrangian description of the circuit and use the model to calculate the circulator efficiency of the system and study the effect of detrimental influences such as charge and magnetic flux noise and imperfections in device fabrication. We find that our design offers high isolation even when taking into account realistic fabrication imperfections and experimental conditions and find a circulator bandwidth in excess of 100 MHz for realistic device parameters.

[1] Mooij and Nazarov, Nature Physics 2, 169–172 (2006).
[2] Astafiev, Ioffe, Kafanov, Pashkin, Arutyunov, Shahar, Cohen, and Tsai, Nature 484, 355– 358 (2012).
[3] Peltonen, Astafiev, Korneeva, Voronov, Korneev, Charaev, Semenov, Golt'sman, Ioffe, Klapwijk, and Tsai, Physical Review B 88, 220506 (2013).
[4] Koch, Houck, Le Hur, and Girvin, Physical Review A 82, 043811 (2010)