QI 26: Superconducting Electronics: Qubits II (joint session TT/QI)

Time: Thursday 15:00–16:15 Location: H 2053

QI 26.1 Thu 15:00 H 2053

Frequency-conversion loss in three-wave-mixing traveling-wave parametric amplifiers — •Christoph Kissling, Victor Gaydamachenko, Marat Khabipov, Alexander B. Zorin, and Lukas Grünhaupt — Physikalisch-Technische Bundesanstalt, Bundesallee 100, 38116 Braunschweig, Germany

Traveling-Wave Parametric Amplifiers (TWPAs) enable near-quantum-limited amplification of weak microwave signals with several GHz bandwidths and saturation powers above -100 dBm. One aspect of current research is the reduction of microwave loss in TWPAs, which is seen as one reason why the added noise of TWPAs stays repeatedly above the quantum limit. Typically, most of the microwave loss is attributed to lossy dielectric layers. However, in this talk we address another loss mechanism which can occur in three-wave-mixing TWPAs. We discuss how frequency-conversion of a probe tone by the presence of noise in the kHz to MHz range can dominate the insertion loss. This potentially-overlooked nonlinear loss mechanism appears like linear loss and can therefore lead to false conclusions in the characterization and optimization of TWPAs.

QI 26.2 Thu 15:15 H 2053

Generating on-chip ac radiation for high impedance electronics — •David Scheer and Fabian Hassler — Institute for Quantum Information, RWTH Aachen University, 52056 Aachen, Germany

Superconducting circuits with high impedances have promising applications in qubit design and quantum metrology. It is however difficult to supply external ac signals to a high impedance environment due to impedance mismatching and parasitic capacitances. The ac Josephson effect can provide a solution to this problem since it generates oscillating currents from an external dc bias. Here we present the use of Josephson junctions as an on chip radiation source as a way to avoid external driving of high impedance circuits.

QI 26.3 Thu 15:30 H 2053

High-impedance resonators based on granular aluminum — •Mahya Khorramshahi, Martin Spiecker, Patrick Paluch, Ritika Dhundhwal, Nicolas Zapata, Ioan M. Pop, and Thomas Reisinger — Karlsruhe Institute of Technology, Karlsruhe, Germany

High-impedance resonators in superconducting quantum circuits are important in the advancement of quantum computing technologies. In particular, impedances surpassing the resistance quantum can be realized, enabling the development of protected qubits and strong coupling to small-dipole-moment systems with exciting prospects for interfacing to spin qubits or donor spins. Utilizing granular aluminum (GrAl), we have developed compact resonators operating in the few GHz regime and characteristic impedances as high as 80 kOhm. We characterized the resonators, with GrAl resistivity increasingly close to the superconducting to insulating transition, and report on single photon quality factors, non-linearity, and noise-spectral density.

QI 26.4 Thu 15:45 H 2053

Longitudinal coupling between a molecular spin ensemble and a superconducting resonator — •Simon Günzler[1,2], Dennis Rieger[2], Thomas Koch[2], Kiril Borisov[2], Patrick Winkel[2], Grigore Timco[3], Richard E.P. Winpenny[3], Ioan M. Pop[1,2], and Wolfgang Wernsdorfer[1,2] — [1]IQMT, Karlsruhe Institute of Technology, Germany — [2]PHI, Karlsruhe Institute of Technology, Germany — [3]PSI and School of Chemistry, The University of Manchester, UK

Hybrid quantum architectures coupling electronic spin ensembles to superconducting circuits have advanced remarkably in the past decade. So far, however, they rely on transverse coupling schemes, tuning the spin transition in close proximity to the circuit's frequency. Here, we demonstrate longitudinal coupling between spins in a microcrystal of Cr_7Ni and the kinetic inductance of a granular aluminum superconducting microwave resonator. Remarkably, this enables the measurement of the crystal's magnetization independent of the detuning between the spin and resonator mode. Separate resonators fabricated from niobium on the same chip allow us to excite and measure the relaxation of the spins more than 2 GHz detuned from the readout resonator.

QI 26.5 Thu 16:00 H 2053

Fermionic quantum computation with Cooper pair splitters — Kostas Vilkelis[1,2], •Antonio Manesco[2], Juan Daniel Torres Luna[1,2], Sebastian Miles[1,2], Michael Wimmer[1,2], and Anton Akhmerov[2] — [1]Qutech, Delft University of Technology, Delft 2600 GA, The Netherlands — [2]Kavli Institute of Nanoscience, Delft University of Technology, Delft 2600 GA, The Netherlands

We propose a practical implementation of a universal quantum computer that uses local fermionic modes (LFM) rather than qubits. Our design consists of quantum dots tunnel coupled by a hybrid superconducting island together with a tunable capacitive coupling between the dots. We show that coherent control of Cooper pair splitting, elastic cotunneling, and Coulomb interactions allows us to implement the universal set of quantum gates defined by Bravyi and Kitaev. Finally, we discuss possible limitations of the device and list necessary experimental efforts to overcome them.