2531cs1111

Quantum amplification using superconducting nanowires

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ProjectID	2531cs1111
Project title	Quantum amplification using superconducting nanowires
EPSRC theme	Quantum Technologies
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Standard or collaborative project	Standard project
Restrictions for candidates applying	Only Home fees candidates can apply

Project summary

Amplifiers are a key component in any solid-state quantum technology. Parametric amplifiers are established as the technology of choice for low-noise amplification of quantum devices at milliKelvin temperatures. Both the lumped-element Josephson parametric amplifier (JPA) and the distributed-element Josephson travelling-wave parametric amplifier (J-TWPA) represent the current state-of-the-art. In particular the J-TWPA enables scaling to the 100-qubit level (for quantum simulation and other near-term applications) and beyond (for fault-tolerant quantum computation) since its high bandwidth allows many signals to be multiplexed on a single channel.

The building-block of both the JPA and the J-TWPA is the Josephson junction (JJ). The JJ is a device whose current depends on the sine of magnetic flux, giving it the non-linearity which is required for amplification – in this case a non-linear inductance. The coherent quantum phase-slip nanowire (QPS-NW) is the dual of the JJ: the voltage across it depends upon the sine of the charge on it, giving it non-linear capacitance. The Warburton group at UCL has recently demonstrated both incoherent QPS effects in superconducting NbN nanowires and coherent coupling between a QPS-NW qubit and a superconducting resonator. These experimental proofs-of-principle demonstrate that applications exploiting the QPS phenomenon in superconducting nanowires are now within reach.

This project forms part of a new QuantERA-funded collaboration between Paul Warburton at UCL, Sebastian de Graaf at NPL, Nicolas Roch at Institut Neel (Grenoble) and Mikhail Feigelman (Ljubljana), with the goal of developing a prototype parametric amplifier based on superconducting nanowires. Fabrication will take place at the cleanroom in the London Centre for Nanotechnology at UCL. Measurements will be undertaken at 10 mK in an existing dilution refrigerator set-up with low-noise radio-frequency characterisation tools.

The ideal candidate will be an experimentalist with an MSc, MEng or MSci degree (or equivalent) in physics or electrical engineering or materials science.