Vacuum Noise Squeezing with a Kinetic Inductance Parametric Amplifier

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Squeezing electromagnetic noise allows for measurements beyond the standard quantum limit, relevant to a range of quantum applications including spectroscopy, sensing, and the search for dark matter. Squeezing can be generated using a phase-sensitive amplifier, which in the microwave domain is typically achieved with parametric amplifiers that employ dissipationless and nonlinear Josephson junctions [1]. Recently, resonant parametric amplifiers made from superconductors with kinetic inductance have shown to be a promising candidate to achieve high levels of microwave noise squeezing [2]. By exploiting a stepped-impedance filter design, the kinetic inductance amplifier is sourced with both a DC current bias and microwave pump tone, which facilitates amplification via three-wave mixing. Extending these devices to a two-port design allows the signal input to be separated from the DC bias and pump tone, minimizing insertion loss and maximizing squeezing potential. With this new generation of parametric amplifier, we have realised direct vacuum noise squeezing by linking two amplifiers together [3] in a squeezed state receiver configuration. High levels of direct noise squeezing could have applications in measurement-based quantum computation, where fault-tolerant squeezing thresholds in these schemes might be attained with further optimisation of the amplifier design and the setup [4].

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[3] K. M. Backes, et al. "A quantum enhanced search for dark matter axions", Nature 590, 238–242 (2021)

[4] N. C. Menicucci. "Fault-Tolerant Measurement-Based Quantum Computing with Continuous-Variable Cluster States", Phys. Rev. Lett. **112**, 120504 (2014)