Abstract Submitted
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Phase-matched Josephson traveling-wave parametric amplifier for superconducting qubit readout - theory KEVIN O'BRIEN, NSF Nano-scale Science and Engineering Center (NSEC), University of California, Berkeley, CHRIS MACKLIN, IRFAN SIDDIQI, QNL, University of California, Berkeley, XIANG ZHANG, NSF Nano-scale Science and Engineering Center (NSEC), University of California, Berkeley — Josephson parametric amplifiers approach quantum-noise-limited performance and are used in experiments requiring high-fidelity detection of single-photon-level microwave signals. Current Josephson parametric amplifiers couple the Josephson junction (a nonlinear inductor) to a resonant cavity, achieving high gain at the expense of limited instantaneous bandwidth. In contrast, Josephson traveling wave parametric amplifiers (JTWPAs) avoid this gain-bandwidth trade-off by employing long propagation lengths rather than a resonant cavity. A major challenge in JTWPA design is that optimum parametric gain is only achieved when the four-wave mixing process is phase matched. We show that by adding a series of resonant elements to the transmission line, phase matching and exponential gain can be achieved. Generation of higher harmonics is automatically suppressed due to the junction plasma resonance. We present the theory and selected results, including the gain, bandwidth, and dynamic range of the amplifier. The simultaneous achievement of high gain (greater than 20 dB), large instantaneous bandwidth (greater than 2 GHz), and high dynamic range make the JTWPA a promising device for the simultaneous readout of frequency-multiplexed superconducting qubits.

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