Wide-band Superconducting Parametric Amplifiers for Millimeter-Wave Instruments

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Recently, superconducting parametric amplifiers have been developed that are able to provide gain over a very wide instantaneous bandwidth, extending up to an octave at microwave frequencies. These amplifiers overcome the limited bandwidth of previous implementations of paramps that relied on nonlinear components embedded in resonant circuits while maintaining extremely low noise behavior that is limited only by quantum mechanical constraints. The new designs are based on a traveling wave architecture where the nonlinearity of the circuit is distributed along the length of a non-resonant transmission line structure. An example of this sort of device makes use of the nonlinear kinetic inductance of a thin film superconducting transmission line [1].

Kinetic inductance traveling wave parametric amplifiers may be interesting for millimeter-wave instruments either as very low noise front-end amplifiers or as microwave band IF amplifiers. The use of a paramp front end amplifier could allow for an improvement in system noise temperature beyond what has been achieved with transistor amplifiers or SIS mixers. We have observed gain at around 90 GHz in a waveguide-coupled paramp, demonstrating the potential of these devices at millimeter wavelengths.

We will also discuss results on microwave band paramps and their possible use as IF amplifiers in heterodyne receiver systems. These paramps dissipate only a few microwatts of power, compared to a few mW transistor LNA amplifiers, making them interesting for arrays. The added noise is measured to be close to the quantum limit over about an octave bandwidth.

References

[1] Ho Eom, B., Day, P., LeDuc, H. *et al.* A wideband, low-noise superconducting amplifier with high dynamic range. *Nature Phys* **8,** 623–627 (2012) doi:10.1038/nphys2356

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