Annual Technical Report

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Annual

FROM 5/15/86 TO 5/14/87

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Not required.

S & D

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Summary

The goal of this research is to produce quantum limited SIS quasiparticle heterodyne receivers at submillimeter wavelengths. The approach is to compare the performance of waveguide and planar lithographed quasi-optical SIS mixers in W-band (1-3mm) in order to understand the factors which degrade the performance of the latter. This information will be used to optimize the planar quasi-optical mixers. Finally, these optimized designs will be scaled to submillimeter wavelengths. Systematic tests of both types of mixers have been carried out during the second grant year. Improved designs of planar quasi-optical mixers have been designed and fabricated. The construction of test apparatus for submillimeter wavelengths has begun.

Statement of Work

Tests have been carried out on a W-band waveguide mixer block which can be tuned from 2.7 - 3.7mm (80-100 GHz) with a single mechanical adjustment. This mixer has an instantaneous bandwidth of ~3GHz and uses an IF transformer with high input impedance.
When used with 2x2(um)^2 Pb-based junctions from NBS Boulder this mixer gave a DS3 gain of 8-12 dB, which is the highest ever seen in an SIS mixer. It also gave mixer noise temperatures of T_m (DSB) of 6-15K, which are the lowest yet observed at these frequencies. Preparations have been made to test Ta-based junctions from Yale in this mixer block. These should give significantly lower mixer noise.

A new quasi-optical test apparatus has been used to evaluate several types of planar lithographed mixer with bow-tie antennas. The integrated structures were fabricated at NBS Boulder using Pb-based and Nb-based junction technologies. They included mixers made with a single junction, a single junction tuned with a microstrip stub, series arrays of 5 junctions, and series arrays of 5 junctions tuned with a parallel wire inductor. In all cases the measured coupling coefficient and the bandwidth agreed well with calculations based on simple equivalent circuits models and on the nominal parameters of the structures. Measurements were made of mixer gain and noise and comparisons were made to the performance of waveguide mixers with similar types of junction. These comparisons indicate that there is a 6-7 dB loss between the cryostat window and the terminals of the bow-tie antenna. When corrected for this loss, the gains of the bow-tie mixers were comparable to the waveguide mixers, but the noises were higher by factors of 3-6. Preparations are being made for improvements in the optical system and for the use of log-periodic antennas to reduce the antenna loss. The reasons for the excess noise are being investigated.
Publications


Personnel Associated with the Effort

D. G. Créité, Visitor
A. V. Räisänen, Visitor
P. L. Richards, Professor
J. Hu, Postgraduate Research Physicist
J. Mehrs, Graduate Student Research Assistant
Interactions, Coupling Activities

Invited Talks

P. L. Richards, Progress in the Development of SIS Quasiparticle Mixers, Applied Superconductivity Conference, Baltimore, Maryland, 9/26 - 10/3/86.


Contributed Talks


Statement

There have been no inventions or patent disclosures during this grant year.
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