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Development of Superconducting Cooper-pair-breaking Detectors for LiteBIRD

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***Abstract*—We present our recent development of superconducting detectors for the satellite LiteBIRD (Lite Satellite for the studies of B-mode polarization and Inflation from cosmic background Radiation Detection). LiteBIRD is aimed to make precise measurements of the B-mode polarization of cosmic microwave background and requires about 2000 detectors capable of detecting a frequency range from 50 to 250 GHz with ultra low noise. Superconducting detectors are the candidate for LiteBIRD. We have fabricated and tested two types of detectors, i.e. superconducting tunnel junction (STJ) and microwave kinetic inductance detector (MKID).**

We have designed an antenna-coupled microstrip STJ detector. The antenna is a log-periodic antenna that has a wide bandwidth. The millimeter radiation received by the antenna is transmitted to the microstrip STJ where the millimeter power create quasi-particles by breaking Cooper pairs or by using photon assisted tunneling. The quasi-particles are detected as an electric current. A test of 90 GHz light irradiation has demonstrated that our STJ detector detects the millimeter waves with photon assisted tunneling. An optimization of the fabrication procedure is being made for reducing a leak current.

We have also fabricated antenna-coupled MKIDs. For LiteBIRD, we propose to use a transmission-type MKID consisting of half wavelength resonators: it enables us to have a readout system that can track the resonant frequency change based on the phase measurements and hence provides us a larger dynamic range. A dipole antenna is attached at the middle point of the half wavelength resonators where the responsivity becomes maximal. The transmission type MKID made of Nb shows the quality factor of about 10^5 at a temperature of 0.3K. An Al MKID having the same design has successfully received 96 GHz radiation. We also have developed a new MKID readout system. The system generates multi-tones of microwaves, sends them to the MKID, and monitors the phase change of each tone. Based on the change of the phase, the system changes the microwave frequency and responds to the movement of the resonance. We present a demonstration of the performance of the system using the transmission type MKID irradiated by millimeter waves.