SIS photon detectors for submillimeter-wave observations

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We propose to use superconducting direct detectors (SIS photon detectors) for future instruments for submillimeter-wave wide field imaging arrays. Using low leakage (less than 10pA) superconducting tunnel junctions, it is possible to realize submillimeter-wave direct detectors with noise equivalent power of less than 10^(-17)W/Hz^(0.5). We have evaluated leakage current and current noise of 4micron niobium SIS junctions with current density of 0.5-1kA/cm^2 at 0.3K. The measured leakage current is 5pA at 0.5mV and current noise is 1.5fA/Hz^(0.5) with white noise spectrum down to 5Hz. Antenna coupled SIS photon detector is designed as a distributed junction arrays, which is expected to gives good matching in wide frequency range in submillimeter-wave with low current density junctions.

Since the leakage current of the niobium junction saturates at about 0.9K, the operating temperature of the detector can be 0.9K, which greatly ease cooling and readout electronics requirements. Further advantage over bolometric detectors come from their thin film fabrication process and direct photon sensitivity. Because of the thin film fabrication process, the uniformity of the junction is good and large format array can be realized rather easily, and would be less affected by cosmic rays. Because of the direct photon sensitivity, excess noise by temperature fluctuation or electrical interference are not critical like bolometric detectors.

Submillimeter-wave imaging arrays using the SIS photon detectors have been designed and being fabricated. The arrays will be evaluated in Atacama Submillimeter Telescope Experiment.