Contribution ID: **124** Type: **Oral Presentation**

Energy resolution of aluminium photon-counting MKID detectors at visible and near-infrared wavelengths

Monday, 22 July 2019 15:10 (15 minutes)

To answer the question whether there is life on exoplanets a new generation of instruments is required that will take spectra of these planets. Future instruments for visible/near-IR wavelengths therefore require noiseless, photon counting detectors, with energy resolution.
Microwave Kinetic Inductance Detectors (MKIDs) are photon-counting superconducting detectors which provide energy resolution in each pixel. The resolving power (R=E/dE) of MKIDs is theoretically limited to R~100 by Fano statistics, depending on the material. Current detectors reach R~10, thus we need to better understand the physics and improve the detector limits.
We present an energy resolution study with aluminium MKIDs, which we have previously shown to understand very well and which are the most sensitive terahertz MKIDs to date. We deliberately study a well-understood material first, before moving to higher resistivity materials, which are favourable from a photon-absorption standpoint. We have measured the resolving power of Al MKIDs, which from their THz sensitivity promise R~60 at 400 nm. We operate the MKIDs at 120 mK and illuminate them with 4 lasers between 402-1550 nm. Firstly, we find that our BK7 and fused silica windows are open to low frequency stray light (< 1 THz), which limits the measured energy resolution. After mounting the optical fiber at 100mK, we show that we reach a resolving power of 17 at 402 nm to 10 at 1550 nm from the histogram of single-photon events, with a large (factor ~4) discrepancy between the signal-to-noise and the histogram resolution. We expect that the loss of hot phonons, while down converting the photon energy to quasiparticles, is already showing up at this energy-resolution level. Al MKIDs are particularly sensitive to phonon losses because of the long pair-breaking time. We will present experiments to study the effectiveness of phonon trapping measures.

Less than 5 years of experience since completion of Ph.D

N

Student (Ph.D., M.Sc. or B.Sc.)

N

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Session Classification: Orals LM 001

Track Classification: Low Temperature Detector Development and Physics