Contribution ID: **87** Type: **Oral Presentation**

Status of SuperSpec, the On-Chip Spectrometer

Sunday, 9 December 2018 17:30 (30 minutes)

SuperSpec is a new technology for millimeter and submillimeter spectroscopy. It is an on-chip spectrometer being developed for multi-object, moderate resolution (R = ~300), large bandwidth survey spectroscopy of high-redshift galaxies for the 1 mm atmospheric window. SuperSpec targets the CO ladder in the redshift range of z = 0 to 4, the [CII] 158 um line from z = 5 to 9, and the [NII] 205 um line from z = 3.5-7. All together these lines offer complete redshift coverage from z = 0 to 9. SuperSpec employs a novel architecture in which detectors are coupled to a series of resonant filters along a single microwave feedline instead of using dispersive optics. This construction allows for the creation of a full spectrometer occupying only 20 cm squared of silicon, a reduction in size of several orders of magnitude when compared to standard grating spectrometers. This small profile enables the production of future multi-object spectroscopic instruments required as the millimeter-wave spectroscopy field matures.

SuperSpec uses a lens-coupled antenna to deliver astrophysical radiation to a microstrip transmission line. The radiation then propagates down this transmission line where upon proximity coupled half wavelength microstrip resonators pick off specific frequencies of radiation. Careful tuning of the proximity of the resonators to the feedline dials in the desired resolving power of the SuperSpec filterbank by tuning the coupling quality factor. The half wavelength resonators are then in turn coupled to the inductive meander of superconducting kinetic inductance detectors (KIDs), which serve as the power detectors for the SuperSpec filterbank. Each SuperSpec filter bank contains hundreds of titanium nitride TiN KIDs and the natural multiplexibility of these detectors allow for readout of the large numbers of required detectors. The unique coupling scheme employed by SuperSpec allows for the creation of incredibly low volume (2.6 cubic microns), high responsivity, TiN KIDs. Since responsivity is proportional to the inverse of quasiparticle-occupied volume, this allows SuperSpec to reach the low NEPs required by moderate resolution spectroscopy to be photon limited from the best ground-based observing sites.

We will present the latest results from SuperSpec devices. In particular, detector NEPs, measured filter bank efficiency (including transmission line losses), and spectral profiles. In addition, we will present our developments toward a SuperSpec on-sky demonstration instrument for deployment on the Large Millimeter Telescope.

Summary

SuperSpec is a new technology for millimeter and submillimeter spectroscopy. It is an on-chip spectrometer being developed for multi-object, moderate resolution (R = ~300), large bandwidth survey spectroscopy of high-redshift galaxies for the 1 mm atmospheric window. We will present the latest results from SuperSpec devices. In particular, detector NEPs, measured filter bank efficiency (including transmission line losses), and spectral profiles. In addition, we will present our developments toward a SuperSpec on-sky demonstration instrument for deployment on the Large Millimeter Telescope.

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Session Classification: Parallel Session: Superconducting Detectors

Track Classification: Superconducting Detectors