Contribution ID: **123** Type: **Poster**

Complex beam maps and a fourier optics analysis of a wide field MKID camera

Tuesday 23 July 2019 18:45 (15 minutes)

For astronomical instruments, accurate knowledge of the optical pointing and coupling are essential to cross-check or characterize the alignment and performance of (sub-)systems prior to integration and deployment. The standard technique for this purpose with phase-sensitive heterodyne spectrometer instruments is the complex beam pattern, which describes both the amplitude and phase response of an optical system. The phase response gives the optical path difference and hence describes the curvature of the (spherical) optical wavefront. Previously with direct (phase-insensitive) total power detector systems the beam patterns were typically measured with incoherent thermal sources. The resultant amplitude-only maps could then only be interpreted by a comparison to simulation in the plane of measurement. To extract precisely the pointing and focus position would then require multiple scans along the direction of the beam propagation. In comparison, from a single complex beam pattern map the beam pointing and focus position can be directly determined by fitting the complex beam parameters. The complex beam pattern can additionally be further analyzed, for example by using angular plane wave spectrum Fourier optics or by directly importing into physical optics software. Here we show how the measured complex patterns can be analyzed with Fourier optics and integrated into a telescope model to calculate the on sky beam pattern and telescope aperture efficiency prior to deployment at a telescope. As a test case we present measurements and analysis on complex beam maps from a wide camera at 350GHz, using an array of 880 array of lens-antenna coupled Microwave Kinetic Inductance Detectors.

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

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

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Session Classification: Poster session

Track Classification: Detector readout, signal processing, and related technologies