CCAT-Prime Direct Detection Instrumentation

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Science Needs

- Need multicolor camera to measure SZ effect over 1000 clusters and derive velocities to ~ 100 km/s
  - Could also be used as CMBR instrument
- Need spectrometer to measure [CII] line at redshifts from 7 to 9 (0.93 to 1.58 mm band) at RP ~ 600

- First set of ideas, not set in stone.
- Very interested in collaborations
One even wins a bit at mm wavelengths: 
*a few percent (~ 7% to 5%) emissivity matters!*
Camera

- $1.5 \frac{\lambda}{d}$ pixels $\Leftrightarrow$ $18'' \times (\frac{\lambda}{350})$
- 7 – 1° FoV cameras
  - 3° FoV
  - interchangeable
- 7 colors to map out SED
- TES (multi-chroic) and/or KID designs
- $N_{\text{pixels}}$ per camera is $\sim 20,000 \ (350/\lambda)^2$: total $\sim 50$ to $100,000$
EOR Instrumentation: Spectrometer on a Chip

- Essentially filter bank tapping off of a superconducting transmission line
- Each channel is a half-wave resonator that dumps power to the detector
- Can cover very large instantaneous bandwidths, so that source redshifts (and science) are obtained

Several groups working in this field including:

**Delft:** DESHIMA 320-950 GHz, 6-9 pixels, R ~ 1000 (A. Endo)

**GSFC:** Microspect, (S.H. Moseley)

**JPL:** SuperSpec 95-520 GHz, R ~ 400 to 700 (C.M. Bradford)
EOR Instrumentation: FPI

- Imaging FPI
  - Straight-forward to implement at $R \sim 500$ in front of cameras
  - BW coverage is 45% from 1 to 1.6 mm
  - $R = 0.2\% \Rightarrow n_{\text{elements}} = 225$
  - Need 225 spatial positions to tie with grating
  - However with 2 poln, and $1.5 \frac{\lambda}{d}$ (50") pixels the throughput is $4.5 \times$ larger
  - Need only $40 \times$ spatial positions to win
  - We expect $\sim 5,000$ to 10,000

- Have lots of experience and ongoing programs.

- Useful for [NII] 205 $\mu$m mapping of the galaxy nearby galaxies ($5\sigma$, 1 hr $\sim 6E^{-18}$ W/m$^2$)