CCAT-prime Synergies: Simons Observatory, CMB-S4, and the Atacama Cosmology Telescope

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Current CMB Survey Research

Longer wavelength complement to CCAT-prime

Temperature & Polarization Power Spectra

- Improving sensitivity of temperature & polarization
  - 1 – 10 mm
  - (30 – 300 GHz)

Goals:
- Cosmology,
- clusters, high-z galaxies, transients, galactic science, ...

Multipole number $\ell$

Atacama:
- ACT – 6m
- SA – 2.5m
- CLASS – 0.6m

South Pole:
- Keck – 0.5m
- SPT – 10m
Current & Future CMB Survey Research

Cosmic Structure

Hubble constant $H_0$

Light relics ($\nu$, DM), $N_{\text{eff}}$

Early Dark Energy

Smoking gun of inflation? $r$

Cosmic Structure

(CMB-S4 Science Book, arXiv:1610.02743)

CCAT-prime Meeting, April 9, 2020
ACT Survey Strategies

**ACTPol - Deep (Stripe 82)**
- Observations 2013-15
- 2 frequencies (90/150 GHz)
- Red patches $\sim3000$ deg$^2$
- Most papers on $\sim1/4$ survey

**Advanced ACTPol - Wide**
- Observations 2016-present
- 5 freqs (30/40/90/150/220 GHz)
- 4 new detector arrays
- 15,000 deg$^2$ survey

(De Bernardis, Stevens et al. SPIE 2016)
AdvACT data are excellent and will be public for joint analysis with CCAT.
Simons Observatory (and CCAT-prime)

CCAT-prime

Cosmic Structure Evolution
Broadband + Spectroscopy
$\lambda = 0.2 - 3.0 \text{ mm}$

CMB Polarization
Broadband
$\lambda = 1.0 - 10 \text{ mm}$
Simons Observatory
Director: Brian Keating, UCSD

Next stage of ACT + Polarbear teams

- Building a copy of CCAT-prime
  (only for 1 – 10 mm wavelengths)

- Small 0.5m aperture telescopes/cameras to constrain inflation
  \[ \sigma(r) = 0.002 – 0.003 \]

- Funded by Simons Foundation

(SO Science Forecasts, arXiv:1808.07445)

CCAT-prime Meeting, April 9, 2020
Simons Observatory

Director: Brian Keating, UCSD

Construction is underway!

Will be ideal for joint analysis with CCAT-prime after data supercedes AdvACT

The largest CMB camera yet

CCAT-prime Meeting, April 9, 2020
CMB-S4 Collaboration formed 2018
Primarily: ACT + Polarbear + BICEP/Keck + SPT

- **Science**: Inflationary Gravity Waves, Light Relics, Large Scale Structure

- **Reference design**:
  - Wavelengths: 1 – 10 mm

- *Baseline design defined this year*

- **Survey outline**:
  - ~50% sky survey for $N_{\text{eff}}$
  - ~5% sky survey for $r$
  - Roughly $4 \times 10^5$ detectors!
  - Multiple sites (Chile & South Pole)
  - Multiple high throughput telescopes

Status of Projects & Synergies

• Advanced ACTPol observing now => ~10x more data to analyze!
  – Data will be public and well-matched for early joint CCAT-prime analyses

• Simons Observatory observing starts in 2021
  – MOU in place for instrumentation. Further MOUs will be pursued as needed

• CMB-S4 passed CD-0 at DOE + small NSF funding, observing 2027?
  – CCAT-prime and SO are pathfinders (and possibly telescopes) for S4!
  – Letters of interest in collaborating exchanged between CCAT-prime and CMB-S4