COSMIC MICROWAVE BACKGROUND POLARIZATION: STATUS AND EXPERIMENTAL PROSPECTS

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CMB: Past and Present...
CMB Physics: Temperature & Polarization

- CMB blackbody radiation is anisotropic and polarized...
- Temperature anisotropy $\rightarrow$ polarization via scattering
- Powerful constraints on physics of the early Universe
CMB Status: Temperature & Polarization

- Planck – full sky maps with 4’ resolution available…
- Rich cosmological and galactic data sets…
- Consistency with 6 parameter cosmological model…
- Consistency among numerous experiments…
CMB Status: Temperature & Polarization

~ November 2014
L. Page

$\ell(\ell+1)C_{\ell}^{XX}/2\pi$ vs Multipole $\ell$
CMB Status: Temperature & Polarization

Planck (2015)
ACTPol (2014, ~650 hours)
SPTPol (2013/14)
BICEP2/Keck (2015)
PBear (2014)
CMB Status: Temperature & Polarization

• Temperature power spectra characterized over ~ four decades by a variety of experiments…

• No surprises with $E$-mode power spectra…

• Indirect detections of $B$-mode via lensing…

• Joint BICEP2/Keck/Planck analysis limit on scalar to tensor ratio, $r<0.12$, at 95% confidence. Marginalizing over dust and $r$, lensing $B$-modes are detected at $7\sigma$ significance. Dust a significant foreground at 150GHz…

CMB Coming Soon...

Analyzing available Polarization Data:
- Planck (space, intermediate ell)
- BICEP2/Keck (ground, low ell)
- SPTPol (ground, high ell)
- ACTPol (ground, high ell)
- POLARBEAR (ground, high ell)
- EBEX (balloon, intermediate ell)
- ABS (ground, low ell)

Launch/Deploy in 2015
- SPIDER (balloon, low ell)
- PIPER (balloon, low ell)

Funded extension ~20,000 detectors
- SPT3G
- Advanced ACTPol
- POLARBER/Simons Array
CMB Community Meeting and Inputs

- Response to NASA’s PhysPAG Charge – Provide input Inflation Probe and relation to other flag ship missions…

- Minneapolis CMB Workshop held January 12-14, 2015
  - IPSIG Satellite Discussion – Large Mission: to be or not to be?
  - What input to provide for the Mid-Decade Review process?
  - How should NASA respond to international opportunities?
  - Relation to CMB-S4 recommended as DOE project also discussed.

- Community Town Hall Telecon held March 4, 2015
Inflation Probe Mission Landscape

United States: NASA
- Case for Inflation Probe mission case to be reviewed by a Mid-Decadal Panel
- BEPAC cost (~2008): ~$1.2B - $1.33B
- PIXIE - submitted as Explorer class mission (2011)
  - Low Resolution (1.6 deg), LEO, FTS Spectrometer

Europe: ESA M4 (~E600M cost cap)
- COre+Light: $720M; COre+Extended: $850M
  - medium resolution (5 arcmin), L2
  - Strong Community Backing
  - …not selected to go forward…

Japan: JAXA – ongoing discussions
- LiteBIRD (includes US contribution)
  - Low Angular Resolution, LEO
  - Less than $500M
Inflation Probe Science Interest Group:

• Goal is to develop a US community response which articulates a consensus for an Inflation Probe mission priorities. Inputs from all members of the community are welcomed.

• Inflation Probe SIG website and mailing list:
  http://pcos.gsfc.nasa.gov/sigs/ipsig.php

• Physics of the Cosmos Program Analysis Group (PhysPAG) Inflation Probe Science Interest Group (IPSIG) Community Representatives: Amber Miller & Ed Wollack
Backup...
CMB Polarization Stage-IV

- CMB-S4 recommended for DOE project
- Large scale instruments using ~250,000 detectors

...proposed experimental configuration will achieve $\sigma(m_\nu) = 16$ meV and $\sigma(N_{\text{eff}}) = 0.020$. Present lower bound derived from atmospheric and solar neutrino oscillation data is ~58 meV...