CMB: What’s Happening Now - Temperature

- Planck temperature results: 2013 + 2014 (prelim.)
- Rich cosmological and galactic data set
- 33 papers covering: Cosmological parameters, topology of the Universe, cosmic strings, Inflation, Variation of the fundamental constants, Gravitational lensing, Properties of clusters, Cosmic Infrared Background, Zodiacal emission, Galactic CO emission, Galactic magnetic fields, Galactic synchrotron and free-free emission, Galactic dust, …
CMB: What’s Happening Now - Temperature

- Planck temperature results: 2013 + 2014 (prelim.)
  - Rich cosmological and galactic data set
  - Consistency with 6 parameter cosmological model
  - Consistency among different experiments
  - Session #220 on Tuesday (2 - 3:30 pm, 6B)
CMB: What’s Happening Now - Polarization

- The CMB is polarized with E and B modes
- E-mode: directly calculable from the T spectrum
- B-mode:
  - partly (high $\ell$) lensing
  - partly (low $\ell$) Inflation
The CMB is polarized with E and B modes

No surprises with E-mode

Detection of B-modes!
CMB: What’s Happening Now - Polarization

- The CMB is polarized with E and B modes
- No surprises with E-mode
- Detection of B-modes!

CMB Temp and Pol - Nov. 2014

Planck 2014 Preliminary
CMB: What’s Happening Now - Polarization

- The CMB is polarized with E and B modes
- No surprises with E-mode
- Detection of B-modes!
CMB: What’s Happening Now - Polarization

- The CMB is polarized with E and B modes
- No surprises with E-mode
- Detection of B-modes!

Planck 2014 Preliminary

Planck (2013)
ACTPol (2014, ~650 hours)
SPTPol (2013/14)
BICEP2 (2014)
PBea (2014)
The CMB is polarized with E and B modes.

No surprises with E-mode.

Detection of B-modes!

Planck finds significant levels of dust in the B2 region.

Planck 2014 (prelim) limit: $r \leq 0.09$
CMB: Coming Soon

- Planck polarization results: January 2014
  - M. White Plenary (#334, Wed. 4:30 pm, 6E)
- Keck Array (ground, low ell)
- SPTPol (ground, high ell)
- ACTPol (ground, high ell)
- POLARBEAR (ground, high ell)
- EBEX (balloon, intermediate ell)
- SPIDER (balloon, low ell)
- PIPER (balloon, low ell)
- SPT3G
- Advanced ACTPol
- POLARBEAR/Simons Array

All Analyzing Available Polarization Data

Launch in 2015

Funded extensions to ~20,000 detectors
IPSIG - Active Year: B2

- White Paper (April - August)
  - Wake of B2 results
  - What are the next steps? Are we done?
    - Step 1: verification
    - Step 2: implement NWNHs plan of considering a space mission
      - Need: high sensitivity; over entire sky; multiple frequencies
    - In parallel: Facilitate participation in International missions

- Community-wide (including international) contributions + telecons + several iterations
IPSIG - Active Year: Planck Funding

- $4.7M cut to US Planck team request for FY15/16
- Wake of 2014 Senior Review
- Impact: incomplete calibration and characterization of systematic effects (with permanent effects on the legacy of Planck).
- IPSIG provided a letter with technical perspectives about the process of CMB data analysis and specifically in Planck’s case.
- NASA reviews decision, consults Planck team and members of the community - restores the most critical $3.1M
IPSIG - Active Year: CMB-S4

- Coordinating with CMB-S4
- P5 recommended project for DOE
- Using 250,000 detectors
Response to NASA’s PhysPAG Charge:
Landscape of Inflation Probe Space Projects

- **US**
  - Decadal Panel: review case for Inflation Probe mission by a mid-decade review panel.
  - BEPAC cost (~2008): $1.2B - $1.33B
  - PIXIE - submitted as Explorer class mission (2011)
    - low resolution (1.6 deg), spectrometer, LEO
  - ESA M4 (Jan. 15, 2015; ~E600M cost cap)
    - COre+Light: $720M; COre+Extended: $850M
      - medium resolution (5 arcmin), L2
    - Strong US community backing
  - JAXA - ongoing discussions
    - LiteBIRD (includes US contribution)
      - low resolution, LEO
    - Less than $500M
Response to NASA’s PhysPAG Charge: Landscape of Inflation Probe Space Projects

- Minneapolis CMB Workshop (Jan. 12 - 14)
- Satellite Session + IPSIG Discussion on Jan. 14
  - Large Mission: to be or not to be?
  - What input to provide for the Mid-Decade Review?
  - How should NASA respond to international opportunities?
Final Comments

• The response to BICEP2 demonstrated the intense interest in Inflation and CMB polarization science, both among scientists and among the general public.

• With NASA’s support, the US has been leading CMB discoveries for most of its 50 years of history.

• The US is currently leading the field of CMB Polarization in both science and focal plane technologies.

• New PhysPAG EC members: Olivier Dore, Amber Miller, Ed Wollack.
Extra Slides
To Do