Detection of Polarization in the Cosmic Microwave Background with the Degree Angular Scale Interferometer (DASI) at the NSF Amundsen-Scott South Pole Station
DASI Polarization Team

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Universe expanded, cooled

$\Rightarrow$ electrons & protons form Hydrogen, release the Cosmic Microwave Background radiation

CMB telescopes are time machines looking back 14 billions years
The Cosmic Microwave Background

Direct view of the universe ~14 billion years ago (400,000 years after big bang)

- Map the seeds of the magnificent structures in the universe today
- Provide stringent tests of cosmological models for the origin of the universe
- Determine the values of the cosmological parameters that describe our universe
MAPO January 2001
fully equipped modern lab at South Pole station

DASI w/ deployable ground shields

Viper/ACBAR

DASI Year 1: 92 days, 16 hours/day
32 fields, released April 2001

Aug 15, 2002 DASI polarization update:
→ 271 days of polarization data on 2 fields
Last year’s story: DASI 2001 results

Inflation tests:

*Flat universe (1.04 +/- 0.06)*

1\textsuperscript{st} and 2\textsuperscript{nd} peaks clearly detected and
3\textsuperscript{rd} peak strongly suggested

What stuff makes up the universe:

5\% Ordinary matter

30\% Dark matter

65\% Dark energy (!)

**A lot of strange stuff!**

Should you believe it ?

→ We can test the theoretical framework
   with Polarization Measurements
Why measure CMB Polarization?

Directly measures dynamics in early universe
Critical test of the underlying theoretical framework
   ➔ if it’s not there at the predicted level, we’re back to the drawing board.

Future:
• Can triple the number of CMB observables ➔ better constraints
• And, eventually, hope to measure the primordial gravity waves and directly test Inflation prediction (this is going to be hard!)
Remember this from high school?

Light is a wave – just like waves on string
Polarization is a measure of
- how well the light waves are lined up
  (random $\rightarrow$ no polarization)
- and in what direction

100% polarized
"Polarized Horizontally"
Does not work!
(not at all for light)
SCATTERING CAUSES POLARIZATION
So..., SCATTERING CAUSES POLARIZATION

Does not work! (not at all for light)
We need very sensitive Microwave Polariods

Stolen from: http://230nsc1.phy-astr.gsu.edu/hbase/phyopt/imgpho/sunglass.gif
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"Surface of last scattering" SCATTERING!
CMB SHOULD BE POLARIZED

Hydrogen
(photons no longer scatter off electrons)
DASI - our Polarimeter
DASI Map of CMB Intensity and Polarization

Map is 5 degrees square
Previous CMB Polarization limits

Simultaneous differencing of 2 polarization states
  • using correlation receivers with HEMT amplifiers

DASI DETECTION

Total Intensity

Polarization

$6 \times 10^{-5}$ K

$6 \times 10^{-6}$ K
And, it is bang on the prediction!

Seems we’re stuck with this preposterous universe.
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