

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



*Center for Astrophysical Research
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Office of Polar Programs

National Science Foundation



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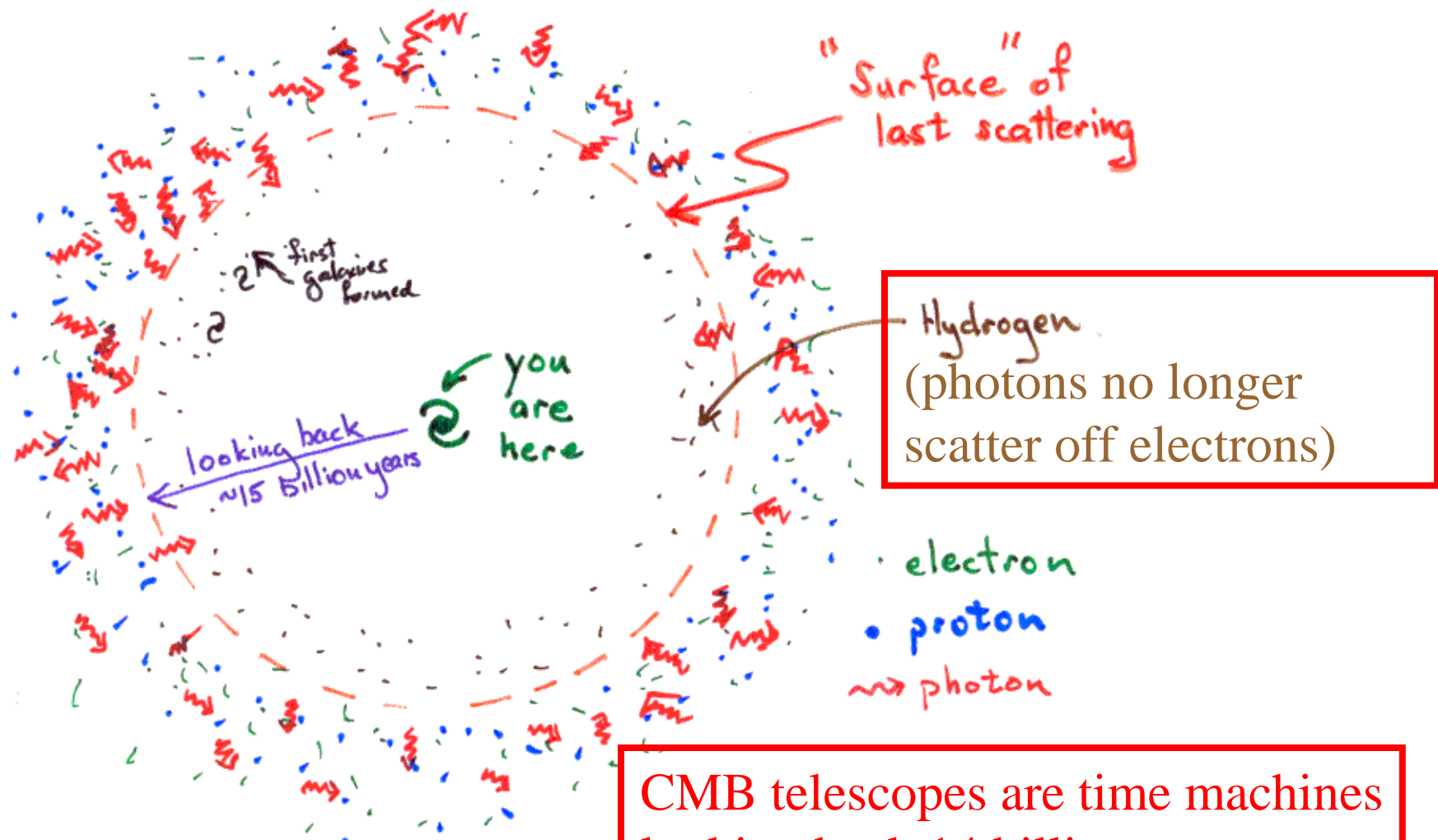
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N. W. Halverson

W. L. Holzapfel

Universe expanded, cooled

=> electrons & protons form Hydrogen, release the Cosmic Microwave Background radiation



CMB telescopes are time machines looking back 14 billions years

The Cosmic Microwave Background

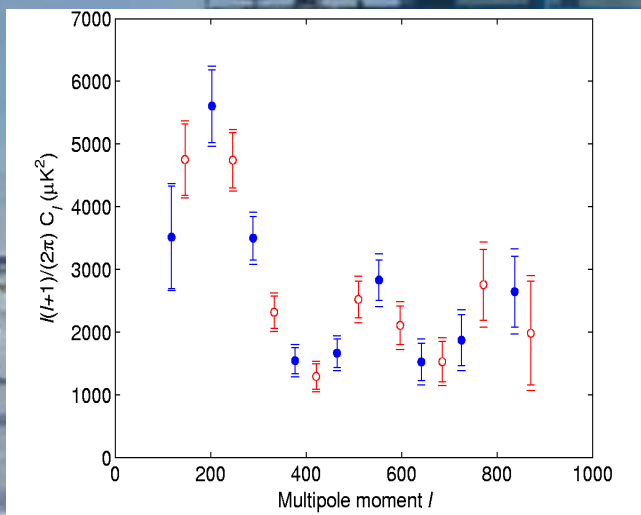
Direct view of the universe ~14 billion years ago
(400,000 years after big bang)

- *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)

*1st and 2nd peaks clearly detected and
3rd 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

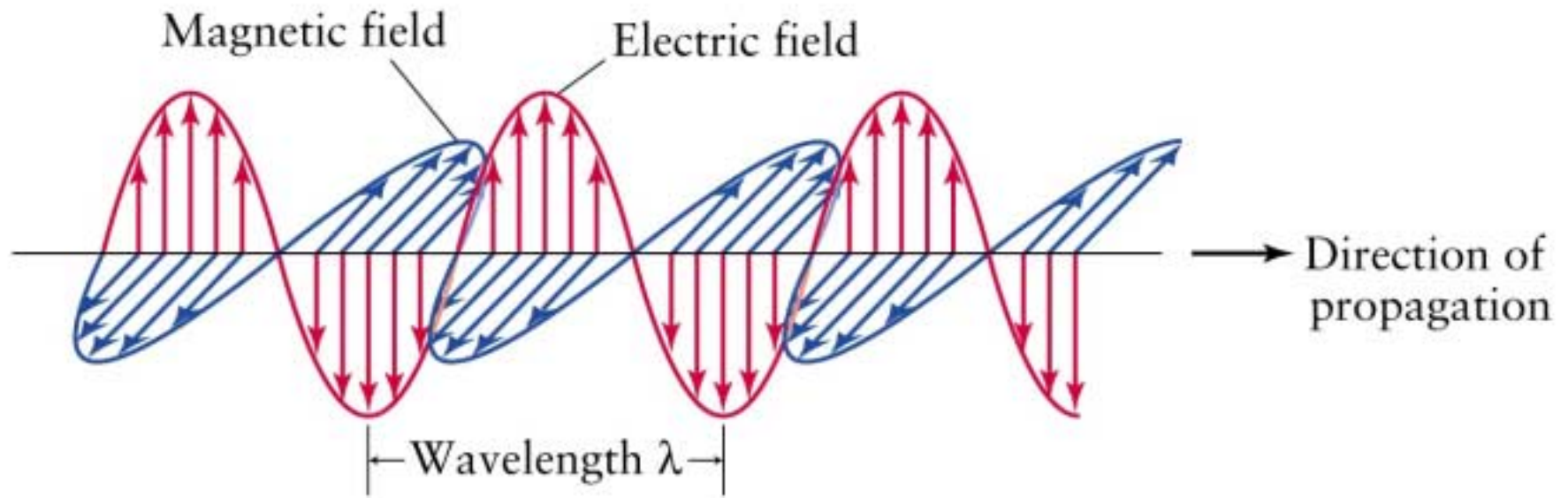
→ if it's not there at the predicted level, we're back to the drawing board.

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!)

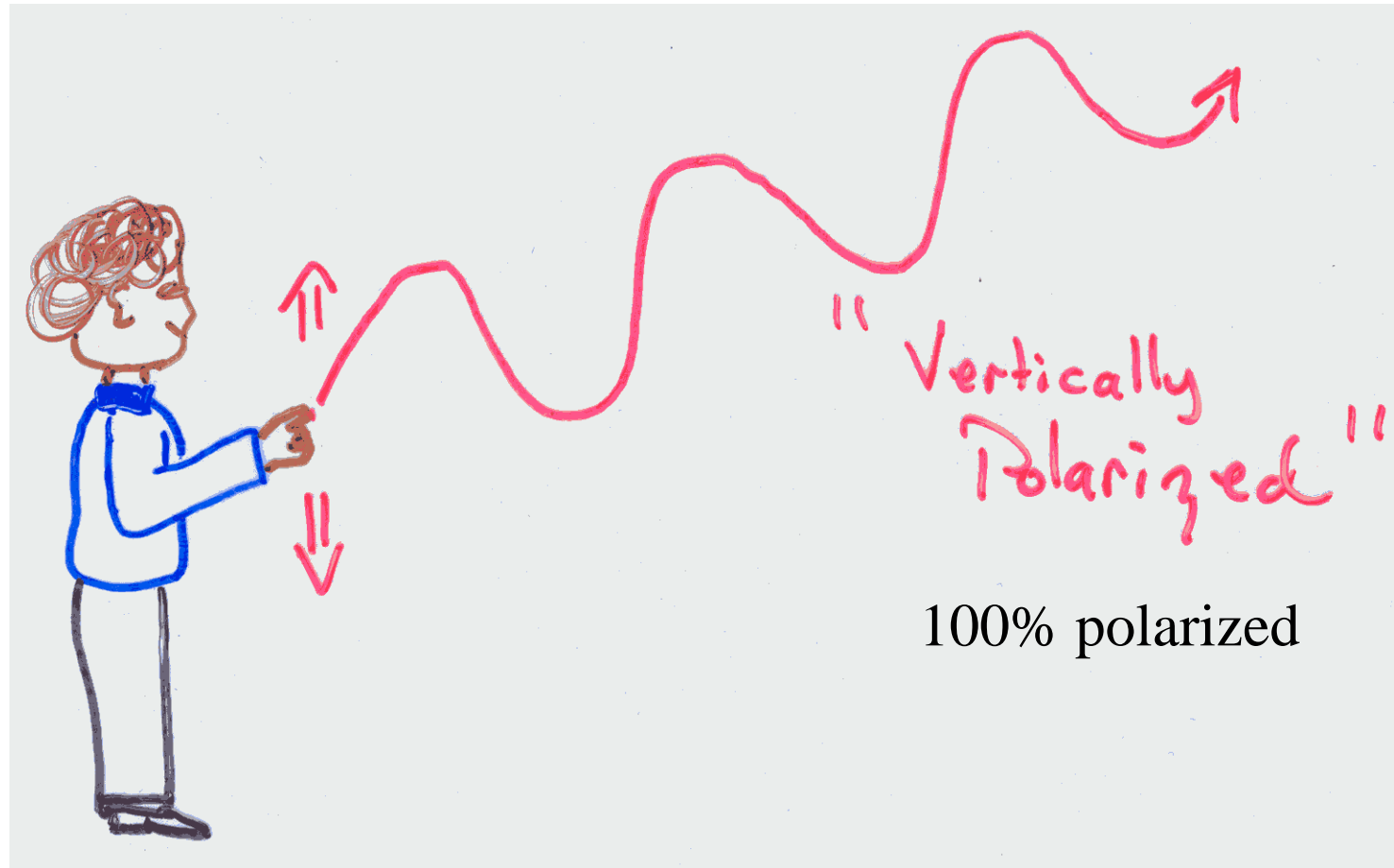
Remember this from high school?

Light is a wave – just like waves on string

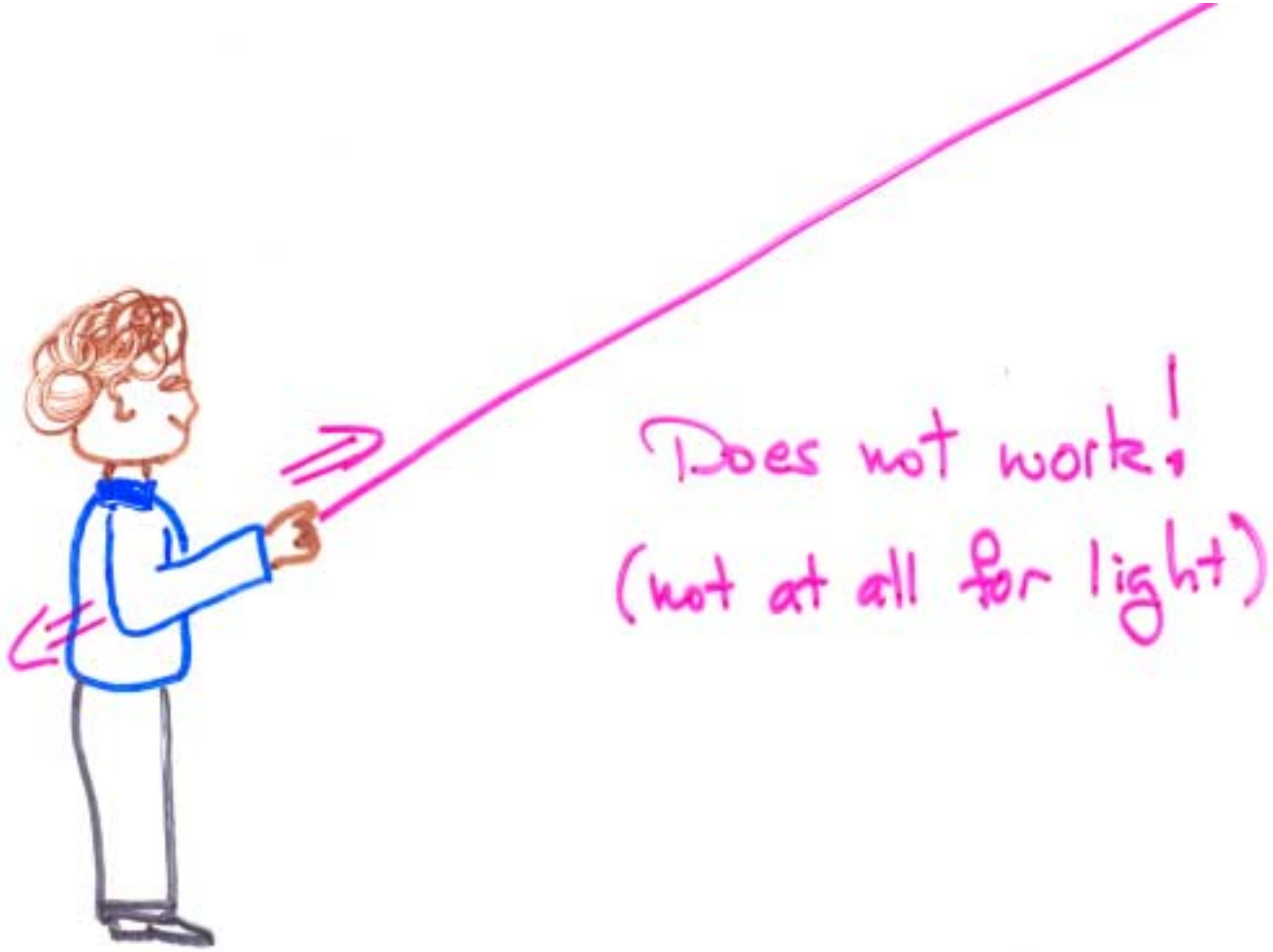


Polarization is a measure of

- how well the light waves are lined up
(random \rightarrow no polarization)
- and in what direction







Does not work!
(not at all for light)

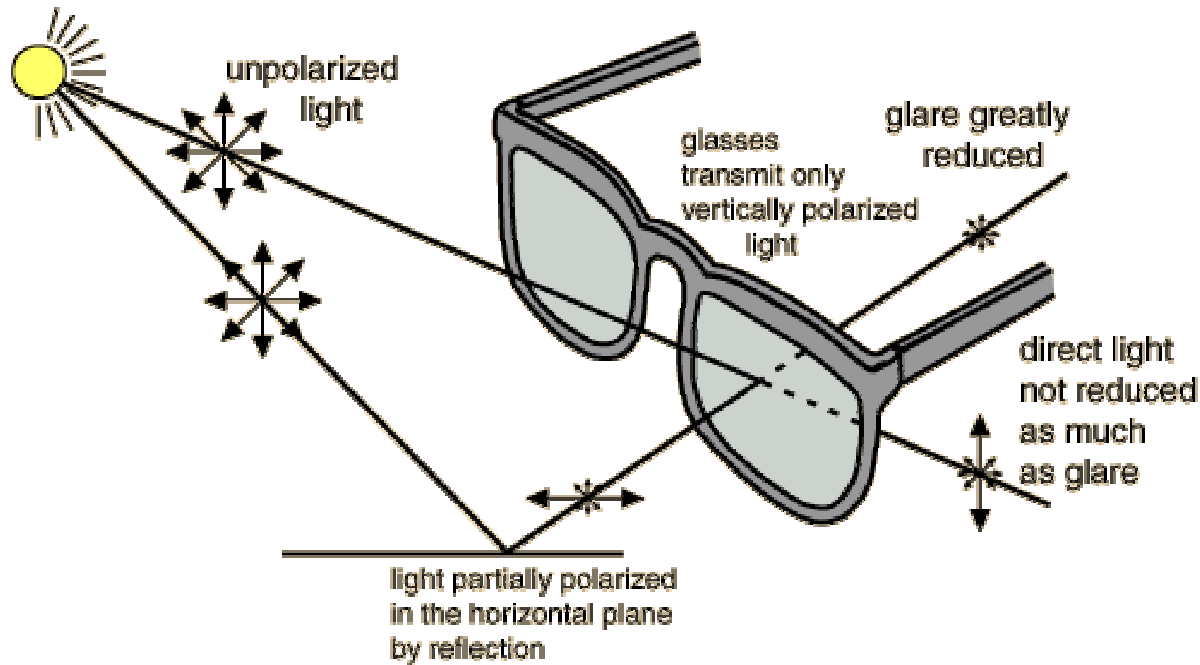
SCATTERING CAUSES POLARIZATION



So.., SCATTERING CAUSES POLARIZATION



We need very sensitive Microwave Polarizers



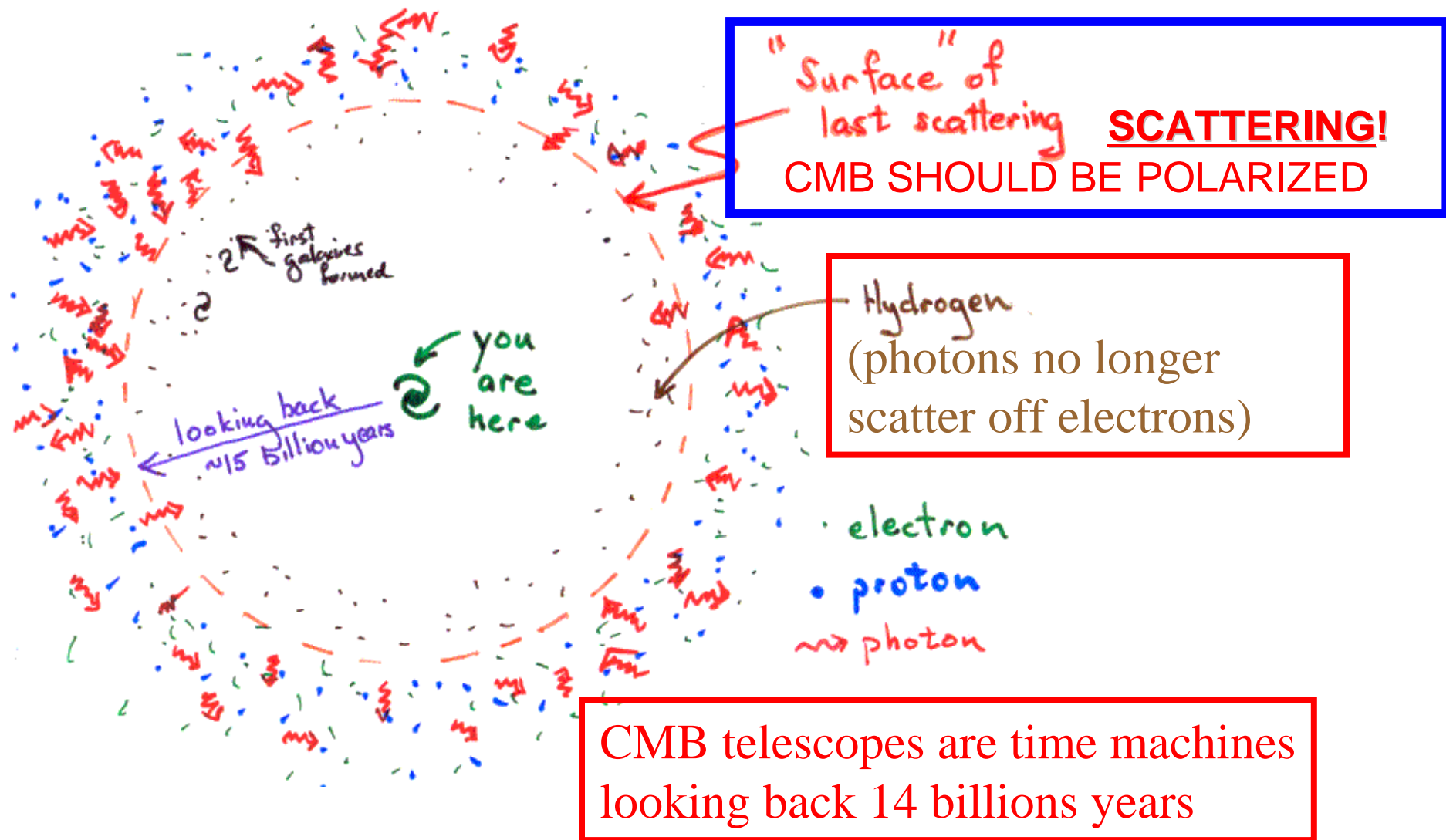
Stolen from: <http://230nsc1.phy-astr.gsu.edu/hbase/phyopt/imgpho/sunglass.gif>



www.polarshades.com/polarization.htm

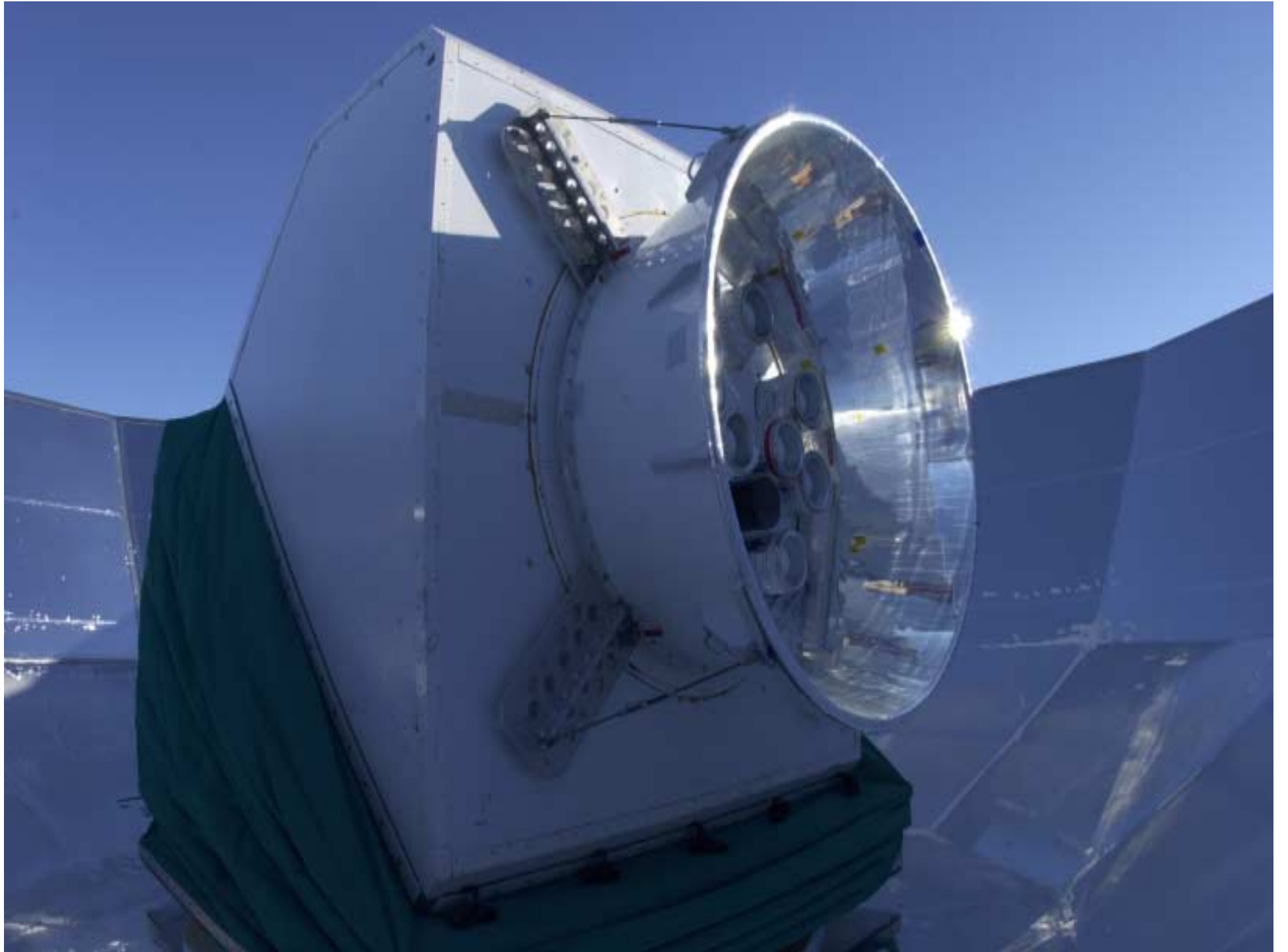
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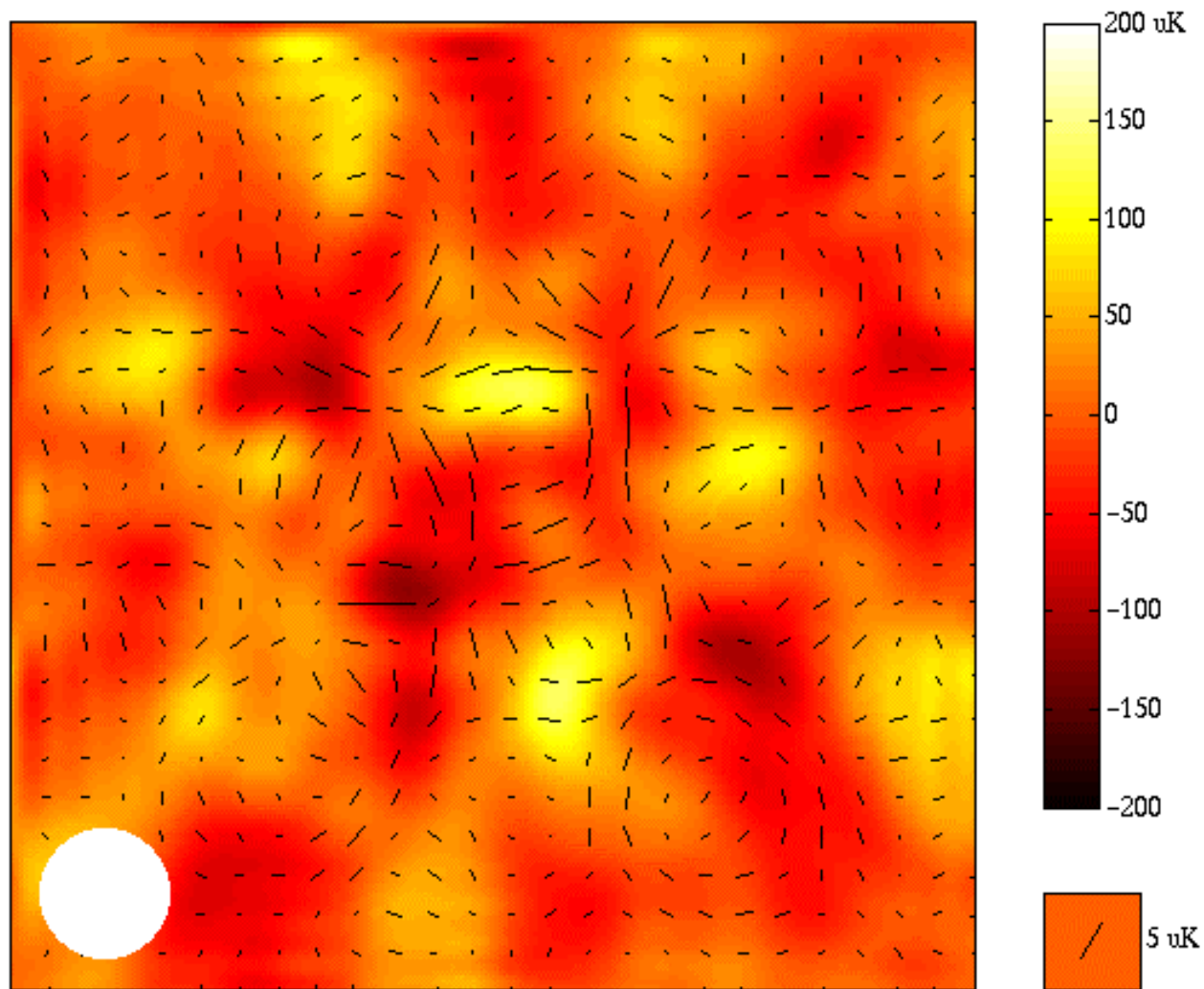


DASI - our Polarimeter



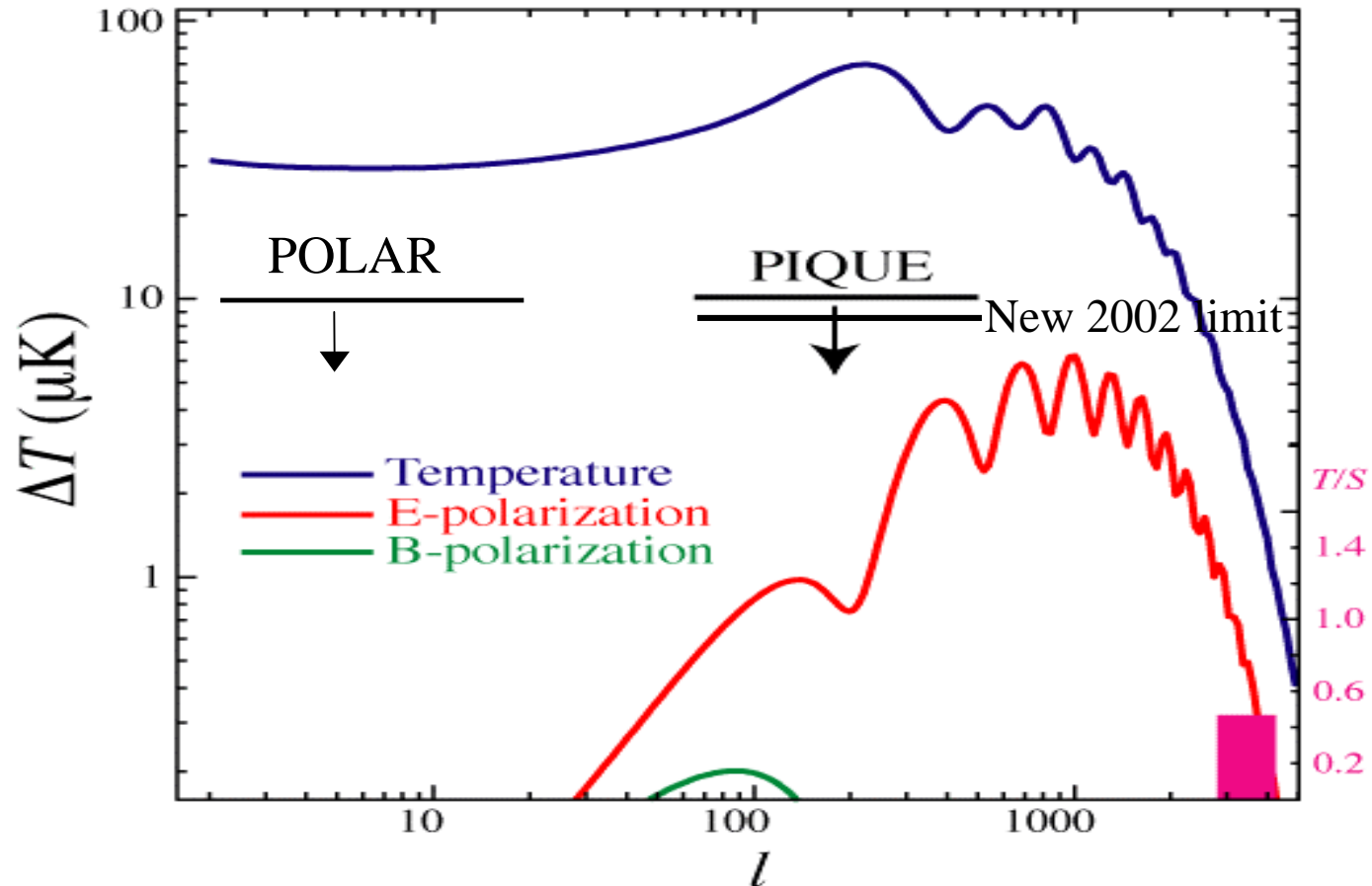


DASI Map of CMB Intensity and Polarization



Map is 5 degrees square

Previous CMB Polarization limits

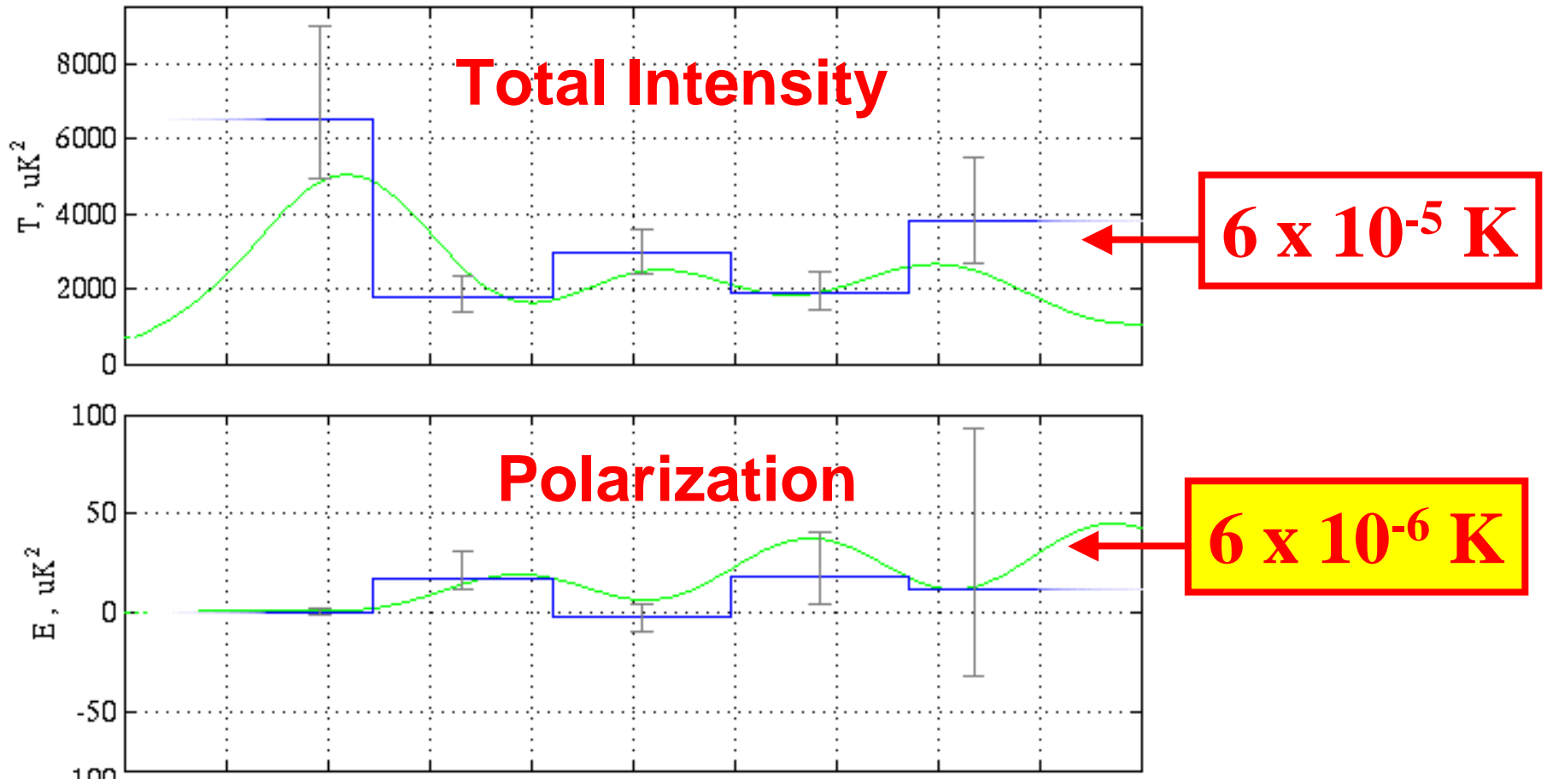


Simultaneous differencing of 2 polarization states

- using correlation receivers with HEMT amplifiers

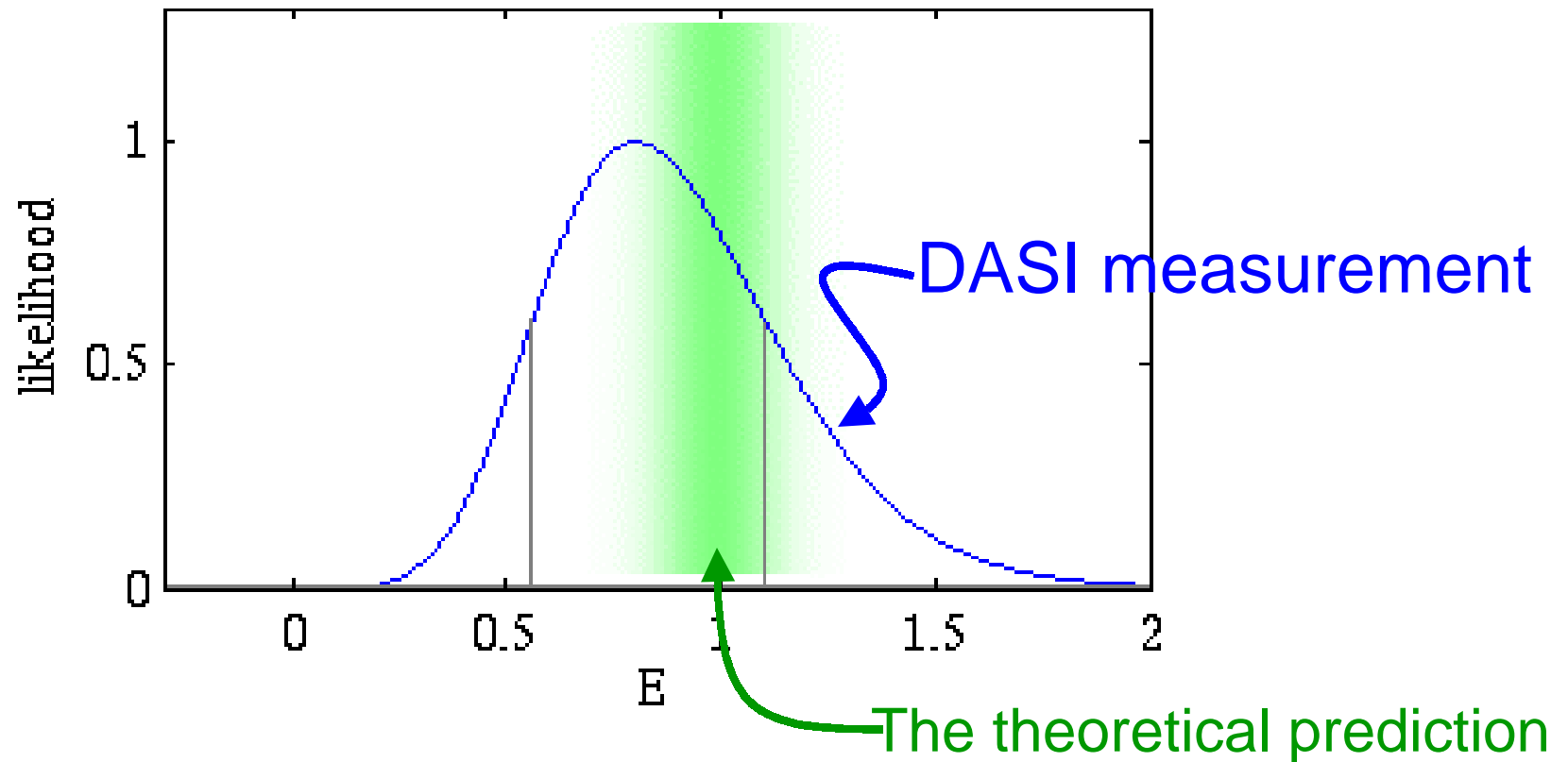
POLAR: Keating et al. astro-ph/0107013; PIQUE: Hedman et al. astro-ph/0204438

DASI DETECTION



And, it is bang on the prediction!

Seems we're stuck with this preposterous universe.



Thanks to:

- National Science Foundation and Raytheon Polar Services
- CARA
- The Caltech Cosmic Background Imager (CBI) team
- Center for Cosmological Physics