

POLARIMETER ARRAYS FOR COSMIC MICROWAVE BACKGROUND MEASUREMENTS

Thomas Stevenson¹, Nga Cao¹, David Chuss², Dale Fixsen², Wen-Ting Hsieh¹, Alan Kogut², Michele Limon², S. Harvey Moseley², Nicholas Phillips², Gideon Schneider¹, Douglas Travers¹, Edward Wollack²

¹NASA, Goddard Space Flight Center, Detector Systems Branch, Code 553, Greenbelt, MD 20771, USA

²NASA, Goddard Space Flight Center, Observational Cosmology Laboratory, Code 665, Greenbelt, MD 20771, USA

We discuss general system architectures and specific work towards precision measurements of Cosmic Microwave Background (CMB) polarization. The CMB and its polarization carry fundamental information on the origin, structure, and evolution of the universe. Detecting the imprint of primordial gravitational radiation on the faint polarization of the CMB will be difficult. The two primary challenges will be achieving both the required sensitivity and precise control over systematic errors. At anisotropy levels possibly as small as a few nanokelvin, the gravity-wave signal is faint compared to the fundamental sensitivity limit imposed by photon arrival statistics, and one must make simultaneous measurements with large numbers, hundreds to thousands, of independent background-limited direct detectors. Highly integrated focal plane architectures, and multiplexing of detector outputs, will be essential. Because the detectors, optics, and even the CMB itself are brighter than the faint gravity-wave signal by six to nine orders of magnitude, even a tiny leakage of polarized light reflected or diffracted from warm objects could overwhelm the primordial signal. Advanced methods of modulating only the polarized component of the incident radiation will play an essential role in measurements of CMB polarization.

One promising general polarimeter concept that is under investigation by a number of institutions is to first use planar antennas to separate millimeter-wave radiation collected by a lens or horn into two polarization channels. Then the signals can be fed to a pair of direct detectors through a planar circuit consisting of superconducting niobium microstrip transmission lines, hybrid couplers, band-pass filters, and phase modulators to measure the Stokes parameters of the incoming radiation.

PAPPA (Primordial Anisotropy Polarization Pathfinder Array) is a project to validate such concepts for measuring CMB polarization in a balloon flight environment. PAPPA will consist of 32 independent polarimeters-on-a-chip based on superconducting microstrip circuits. For laboratory characterization of microstrip components, we have designed and fabricated test circuits with a planar antenna and RF choke on thin silicon cantilevers that act as waveguide probes. The design makes possible efficient coupling of radiation between waveguide and the planar circuits, and enables S-parameter measurements to be made to characterize and refine building blocks for a polarimeter-on-a-chip.

Abstract Submission Form

2006 National Radio Science Meeting

Abstract: stevenson4152

Date Received: September 16, 2005

1. (a)

Thomas Stevenson
NASA/GSFC
Detector Systems Branch, Code
Greenbelt, MD
20771 USA
Thomas.R.Stevenson@nas

(b) 301-286-1221

(c) 301-286-1672

2. J - Radio Astronomy

3. (a)

4. C - Contributed Paper

5. No special instructions