POLARBEAR : A next-generation Cosmic Microwave Background polarization experiment

Michael J. Myers[1]*, Peter Ade[2], Kam Arnold[1], Julian Borrill[3], Matt Dobbs[4], Greg Engargiola[5], George Fuller[6], Nils Halverson[7], William Holzapfel[1], Andrew Jaffe[8], Brian Keating[6], Zigmund Kermish[1], Adrian T. Lee[1], Erik Leitch[9], Eric Linder[10], Nathan Miller[6], Roger O'Brient[1], Hans Paar[6], Erin Quealy[1], Paul Richards[1], Helmuth Spieler[10], Radek Stompor[11], Huan T. Tran[12], Carole Tucker[2]

Observations of the temperature anisotropies in the Cosmic Microwave Background (CMB) have greatly improved our understanding of the universe. Further insight will be gained by studying the polarization of the CMB, which has recently been detected. The observed E-mode polarization is caused by acoustic oscillations in the photon-baryon plasma, much like the temperature anisotropies. However, the B-mode polarization is caused by qualitatively different physical mechanisms. B-mode polarization anisotropies are expected due to gravity waves generated at the time of inflation. Detection of this signal can give us a powerful constraint on inflationary models. B-mode polarization can also be generated by gravitational lensing of the CMB, which effectively converts E-modes into B-modes. Both of these B-mode signals are expected to be two or more orders of magnitude fainter than the temperature anisotropies, requiring a new class of experimental sensitivity.

The POLARBEAR experiment is designed to precisely map out the CMB polarization anisotropies. The telescope has been optimized specifically for this application, with careful consideration given to polarization systematics. The 3.5m primary mirror provides 4 arcminute resolution at 150 GHz, which will allow us to do a deep search for the primordial gravity wave B-modes and to measure the gravitational lensing B-modes, which peak on smaller angular scales. Measuring the lensing signal is paramount, both because our ability to subtract it may act as the ultimate limit to how deeply we can search for gravity wave B-modes and because it contains substantial physics in its own right. A focal plane array using over 1000 antenna-coupled TES bolometers will provide the needed sensitivity. The bolometers are read out with a frequency domain SQUID multiplexer.

I will discuss the design decisions we have made and our progress towards a staged deployment beginning in 2008. We will initially deploy in California to fully qualify the instrument, with a subsequent move to the Atacama Desert in Chile, a high quality mm-wave observing site.

[1]University of California, Berkeley, Department of Physics, Berkeley, CA, USA
[2]Cardiff University, School of Physics and Astronomy, Wales, UK
[3]Lawrence Berkeley National Laboratory, Computational Research Division, Berkeley, CA, USA
[4]McGill University, Department of Physics, Montreal, Quebec, Canada
[5]University of California, Berkeley, Department of Astronomy, Berkeley, CA, USA
[6]University of California, San Diego, Department of Physics, San Diego, CA, USA
[7]University of Colorado, Boulder, Department of Physics, Boulder, CO, USA
[8]Imperial College, Astrophysics Group, London, England
[9]Jet Propulsion Laboratory, Pasadena, CA, USA
[10]Lawrence Berkeley National Laboratory, Physics Division, Berkeley, CA, USA
[11]Laboratoire Astroparticule & Cosmologie, Paris, France
[12]Space Sciences Laboratory, University of California, Berkeley, CA, USA