The QUIET Polarimeter Array

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QUIET (the QU Imaging ExperimenT) will soon begin measurements of the CMB polarization anisotropy with arrays of sensitive pseudo-correlation polarimeters operating at 40 and 90 GHz. Large arrays are made possible by a design that packs the entire polarimeter, from amplification through detection, into a small module (just over 1 inch square for a 90 GHz detector) with the ability to simultaneously measure both components of linear polarization, Stokes parameters Q and U.

For Phase 1 of the experiment, QUIET will operate with 91 modules at 90 GHz and 19 modules at 40 GHz at the Chajnantor Observatory, located in Chile's Atacama desert. In the first ten months of observing, QUIET will achieve a sensitivity of 400 nK per square degree over four 400 square degree patches, with the goal of detecting the B-mode polarization signature of gravity waves. Phase 2 of the experiment will make use of the 7 meter Crawford Hill telescope and also expand the arrays to 397 modules at 90 GHz and 91 modules at 40 GHz, allowing QUIET to make precision measurements of the B-mode spectrum across a large range of angular scales.

The key component of the QUIET modules are MMIC HEMT amplifiers, which operate at 20K inside a custom built cryostat. Input RF signals are amplified, modulated at 4 kHz, filtered, correlated, and detected, all within the QUIET module. The detector array is supported by additional electronics which bias the low noise amplifiers and control the modulation. The post-detection signal chain includes a high speed ADC which performs digital demodulation of the data signals.

It is necessary to tune roughly 20 bias values (voltages and currents) to get good performance from a module. In order to feasibly optimize arrays of 100 or more detectors, we have developed procedures which use a variety of thermal loads, both polarized and unpolarized, that can simultaneously characterize the performance of the entire array. Eventually this will lead to fully automated detector optimization.

The QUIET collaboration includes members at MPI-Bonn, Caltech, Columbia, JPL, KICP (University of Chicago), KIPAC (Stanford), University of Manchester, University of Miami, University of Oslo, Oxford, and Princeton.