Characterization System with Cryogenically-Cooled Loads for next-generation CMB Polarimeters

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***Abstract*—**

Polarimeters used in the cosmic microwave background (CMB) experiments are required to be well characterized to measure faint CMB polarization patterns with low systematic errors. Reproduction of the observing condition, especially sky temperature, is important for characterization of the polarimeters, since characteristics of the polarimeters are depend on the load temperature.

We developed a characterization system with cryogenically-cooled loads for CMB polarimeters. The loads generate unpolarized radiation of (~10 K and ~30 K). The system reproduces the sky temperature at observation sites e.g., the Atacama desert in Chile (~10 K). The radiation from the loads reflects on a metal mirror in a cryostat, yielding a partially polarized radiation (~100 mK), going into a feed horn of the polarimeter. Rotation of the mirror varies the incident angle of polarization and causes a periodical variation of the load temperature. Therefore, the system enables us to simultaneously measure receiver temperature using the Y-factor scheme, polarization responsivity, and leakage from unpolarized to polarized radiation.

Using the above system, we successfully characterized the prototype polarimeter developed for an upgrade Q/U Imaging ExperimentT (QUIET), which aims to search for the 'curl-like' polarization patterns induced by primordial gravitational waves at the level of r=0.01, where r is the intensity of the primordial gravitational waves. The simultaneous characterization enables us to finalize the polarimeter parameter, e.g., bias voltages, in the laboratory. Thus far we have directly measured a polarimeter sensitivity of 400uKs$^{1/2}$ under the reproduced observing condition.

The principle of our system is not limited by frequency bands or detector types. The scheme of our system is very promising for various types of state-of-the-art detectors for mm and sub-mm experiments.