EBEX: The E and B EXperiment

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The inflationary model for the evolution of the Universe predicts that gravitational waves generated in the early Universe should have left a distinct curl-like "B-mode" signature in the polarization of the cosmic microwave background radiation. Detecting this B-mode signal would provide strong confirmation of the inflationary model and directly measure the energy scale of inflation. Because the B-mode signal is so faint, galactic foregrounds are expected to comprise a significant fraction of the total sky signal measured and will need to be characterized and subtracted in order to recover the cosmological signals.

We describe the E and B EXperiment (EBEX), a balloon-borne polarimeter that is designed to detect a tensor-to-scalar ratio r of 0.1 with high confidence or set a 2σ upper limit of $r \leq 0.02$, a factor of 10 better than current limits. In addition, EBEX should be able to detect the predicted but as-yet unmeasured B-mode signal from the lensing of E-mode CMB polarization.

EBEX will use a 1.5-meter off-axis Gregorian telescope coupled to a receiver containing two 738-element focal plane detector arrays. Each array operates in three frequency bands centered at 150, 250, and 410 GHz using a common optical path. The broad frequency coverage will be used to characterize the foreground emission from galactic dust. EBEX will map a 350 square degree patch of sky with 8 arcminute beam resolution elements, giving sensitivity to angular scales of $20 \lesssim \ell \lesssim 1000$ in order to measure both the low-ℓ inflationary B-modes as well as high-ℓ lensing B-modes.

In order to measure the CMB to this unprecedented sensitivity with stringent systematic control, we are implementing several new technologies, including a continuously-rotating achromatic half wave plate (AHWP) supported by a superconducting magnetic bearing, transition edge sensor (TES) arrays, low power SQUID readout systems, and broad-band anti-reflection coatings on the lenses. Many EBEX technologies are directly applicable to a future CMB B-mode satellite mission.