Searching for B-modes in the polarization of the CMB with QUBIC

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Abstract / Cosmic Microwave Background (CMB) photons provide information on all phases of the evolution of the universe. Their linear polarization field can be decomposed into a gradient-like component (E-modes) and a curl-like component (B-modes). The former has been measured with good accuracy by several experiments, and is produced by the same density fluctuations producing the well measured anisotropy of the CMB. The latter is not produced by scalar (density) fluctuations. It is produced by gravitational lensing on the large-scale structures crossed by the photons, mainly at small scales, and by tensor fluctuations (gravitational waves), produced by the cosmic inflation process, mainly at large scales.
The B-modes signal amplitude is extremely small, and is related to the energy-scale of inflation. Detecting B-modes of the CMB at large scales represents one of the very few ways to investigate the very early universe, and physics at ultra-high energies.
The detection is challenging, requiring extreme sensitivity (*i.e.* large detector arrays and long integration time) and accuracy (*i.e.* ability to separate the cosmological signal from overwhelming polarized emission, from the instrument, our Galaxy, etc.). Inflationary B-modes have not been detected yet, despite of a vigorous world-wide experimental effort. Current measurements set an upper limit for the ratio of tensor fluctuations to scalar fluctuations $r < 0.1$.
The Q and U Bolometric Interferometer for Cosmology (QUBIC) is aimed at the measurement of CMB polarization by means of an original measurement setup: a bolometric interferometer, combining the sensitivity of cryogenic bolometers to the accurate control of the beam of interferometers. The first module of the instrument is sensitive in the λ1.3mm and λ2.0 mm windows of atmospheric transmission, with interesting in-band spectral capabilities. A cryogenic rotating HWP and a polarizer modulate incoming polarization as in a Stokes polarimeter. They are followed by an interferometer consisting of an array of feedhorns, a beam combiner, and an array of bolometers (cooled at 0.3K) detecting the interference fringes. The instrument is enclosed in a large pulse-tube cryostat, which is mounted on a azimuth/elevation/rotation mount.
The observation site is Alto Chorrillos (San Antonio de los Cobres, Salta, Argentina) at an altitude of 4800m. QUBIC is currently being assembled in a demonstrator configuration, to be operated in the lab by the end of 2017. The full instrument will be assembled in 2018. Its survey aims at a sensitivity on the tensor-to-scalar ratio $r \simeq 0.01$ in two years of integration.
For more information, see *http://qubic.in2p3.fr/QUBIC/Home.html*.

Keywords / cosmology: cosmic background radiation — cosmology: observations

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Invited report