INTERFEROMETRIC IMAGING OF THE MICROWAVE BACKGROUND RADIATION

Tim Pearson, for the CBI collaboration
Caltech

The anisotropies of the cosmic microwave background radiation (CMB) provide valuable diagnostics of the condition in the early universe at about 100,000 yr after the Big Bang. The signals are very weak, a few microkelvin on scales of a few minutes of arc, and present a challenge to observers.

A number of ground-based interferometer arrays have recently been successful in measuring both the intensity and the polarization of the CMB on these scales. These include the Degree Angular Scale Interferometer (DASI, Antarctica), the Cosmic Background Imager (CBI, Chile), and the Very Small Array (Tenerife).

The CBI is a planar array of thirteen 0.9-m Cassegrain antennas on a common mount, with interferometer baselines ranging from 1 to 5 m, receiving radiation in the 26-36 GHz band. It measures linear polarization by cross-correlating the signals from antennas sensitive to orthogonal circular polarizations, and intensity by correlating antennas of the same polarization.

Images can be formed by mosaicking together observations from adjacent pointings of the telescope. Although the techniques involved are similar to those of longer baseline interferometers such as the Very Large Array, we have developed a number of techniques specialized for observations of the CMB. These include: elimination of contaminating ground radiation by projection of a common mode; elimination of foreground point sources of known position but unknown flux density by projection; and specialized techniques for polarization calibration. Gridding the data in the u,v plane provides an efficient way both to make images and to estimate the angular power spectrum of the fluctuations, which is the primary point of contact with theoretical models of the early universe.

The pattern of polarization on the sky can be separated into a divergence-free part (B mode) and a curl-free part (E mode). This is important because scalar (density) fluctuations generate only the E-mode, and detection of the B-mode will indicate the presence of contaminating foreground radiation or, more excitingly, tensor (gravitational wave) fluctuations from the epoch of inflation. We show how an interferometer is well suited for making this separation, and present images of the E and B modes in addition to images of the Stokes parameters I, Q and U. We also present maps of E and B in uv plane, which is equivalent to the multipole ℓ space used in CMB theory.

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1. (a)
Tim Pearson
105-24 Caltech
Pasadena, CA
91125 United States
`tjp@astro.caltech.edu`
(b) 626 395-4980
(c)
2. J - Radio Astronomy
3. (a) S-J3
4. I - Invited Paper, Program chair: S Myers
5. No special instructions