

OBSERVATIONS OF LARGE-SCALE ANISOTROPY IN THE 3 K BACKGROUND RADIATION

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Abstract. Measurements of the background radiation were made at 8000 MHz with a beamwidth of 15 deg. Two antennas were used, arranged such that the equipment recorded the temperature difference between points five hours apart in right ascension and at declination $+32^\circ$. Data were taken only at night and at 3800 m altitude, in order to reduce systematic effects as much as possible. Two observing runs six months apart were combined; after subtracting Galactic non-thermal radiation, the remainder shows a significant dipole anisotropy, a possibly significant quadrupole anisotropy, and no detectable variations of smaller angular size: (Table I.)

TABLE I

| Angular scale θ | Temperature anisotropy | Fractional anisotropy | RA of peak value |
|--------------------------------|---|--------------------------------|--|
| dipole | $(2.28 \pm 0.92) \times 10^{-3} \text{K}$ | $(8.5 \pm 3.4) \times 10^{-4}$ | 10 ^h 58 ^m |
| quadrupole | $(1.34 \pm 0.80) \times 10^{-3} \text{K}$ | $(5.0 \pm 3.0) \times 10^{-4}$ | 5 ^h 50 ^m , 17 ^h 50 ^m |
| $10^\circ < \theta < 90^\circ$ | $\leq 2.0 \times 10^{-3} \text{K}$ | $\leq 7.5 \times 10^{-4}$ | — |

The observing technique used the Earth's rotation for scanning, so that any anisotropy in the polar direction was suppressed. The dipole and quadrupole values thus refer only to components in the equatorial plane.

The dipole anisotropy can be interpreted as due to observer motion with respect to the radiation reference frame. The value above implies a velocity component of $250 \pm 75 \text{ km s}^{-1}$ in the equatorial plane, which agrees in magnitude and direction with an estimate of solar motion in the local supercluster of galaxies. The low quadrupole anisotropy places strong limits on anisotropic expansion in some cosmological models. The upper limit to smaller scale anisotropy sets a limit of about 2% to density variations on a scale of 1000 Mpc. These data also exclude a predicted temperature fluctuation of about 0.5% due to a proposed quasar cluster near the North Galactic Pole. This work was supported by the United States Air Force Office of Scientific Research.

Discussion

Shakeshaft: What value of spectral index was assumed in extrapolating the 404 MHz data to your frequency? It may well be that the spectral index in fact varies with direction.

Conklin: The temperature spectral index was -2.8 ; the standard error quoted for the anisotropy includes a possible error of ± 0.1 in this index. Determinations of Galactic spectral index in various directions at 400 MHz and lower have not shown any significant variation in the region analyzed here.

Cohen: Can this experiment be repeated at another declination?

Conklin: It would not be difficult to repeat the experiment at another declination, but there are no plans for this. Determining the polar component of the anisotropy would be much more difficult.