ISOTROPY OF COSMIC BACKGROUND RADIATION AT 10 690 MHz*

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The proposal of Dicke, Peebles, Roll, and Wilkinson[1] that the universe is filled with blackbody radiation left over from a fireball at 10^{10} °K that constituted the universe some 10^{10} years ago is supported by the detection of such background radiation over a wavelength range from 1.5 to 21 cm.[2-6] The measured brightness temperatures are around 3°K with quoted absolute errors of about 20%. One property of the radiation that it is important to investigate is isotropy. Roll and Wilkinson[5] have already reported an upper limit of ±10% to any anisotropy; the only other work of which we are aware is by Penzias and Wilson[4] and Partridge and Wilkinson.[7] The present investigation differs in that it aims at discovery of, or setting an upper limit to the strength of, features of small angular size.

Our radiometer operates at a frequency of 10 690 MHz with a bandwidth of 100 MHz; the antenna is a 60-ft paraboloid pointed at the zenith. Reception of thermal radiation from the ground is reduced by the use of an oversize feed horn at the focus, and thermal radiation from the earth's atmosphere is compensated by a zenith reference horn which is switched against the feed horn by means of a ferrite circulator. The reference antenna beam is about 80° wide; the beam of the 60-ft paraboloid is about 12 min of arc wide. The system noise temperature is about 600°K.

Figure 1 shows observations made at declination 37.4°N over a right ascension interval of 4 h centered at $01^h\,30^m$. The integrating time was 290 sec, giving an angular resolution of 1°; this interval was chosen as a compromise between high angular resolution and low fluctuation level. The observations were made on 11 days and were combined by addition, no corrections of any kind being made to the raw data. The temperature calibration was made by injecting a known 1°K step into one arm from a gas-discharge tube. The standard deviation of the temperature is 0.005°K. There are indications that some of the variability in Fig. 1 was caused by changes in the atmosphere, and some is due to the receiver. However, if we attribute the fluctuations entirely to the cosmic background, the present observation sets an upper limit to the rms departure from the mean 3°K radiation (over the range of right ascension from $23^h\,30^m$ to $3^h\,30^m$ and to an angular resolution of 1°) of ±0.17%. On increasing the integration time to 1740 sec, corresponding to a resolution of 6°, we observed a value of 0.12%. We conclude that the background radiation, if it exists, is structureless, in the region observed, to less than $\frac{1}{5}$ of 1% on an angular scale of the order of 1°.

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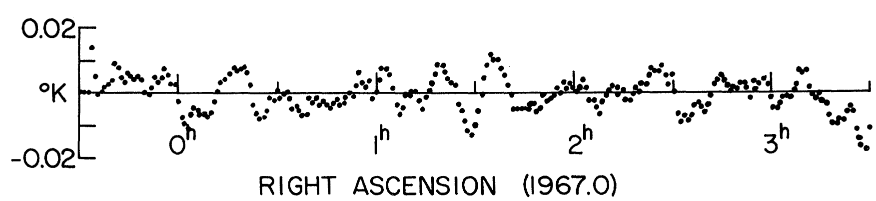

FIG. 1. Observed temperature averaged over 290 sec minus the mean for the whole observing period.