## VI. GRAVITATION RESEARCH

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## A. PRELIMINARY RESULTS OF A MEASUREMENT OF THE ISOTROPY OF THE COSMIC BACKGROUND RADIATION <br> IN THE FAR INFRARED <br> Joint Services Electronics Program (Contract DAAB07-71-C-0300) <br> National Aeronautics and Space Administration (Grant NGR 22-009-526)

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We report preliminary results of a balloon flight, on January 28, 1974, from the scientific balloon facility of the National Center for Atmospheric Research (NCAR), in Palestine, Texas. The flight reached an altitude of 39 km and produced useful data at float altitude for $1 / 3$ hours. The instrument was described in Quarterly Progress Report No. 112 (pp. 23-26).

Figure VI-1 shows the output of the differential radiometer as a function of azimuth angle for both high-frequency ( $10-20 \mathrm{~cm}^{-1}$ ) and low-frequency ( $3-10 \mathrm{~cm}^{-1}$ ) channels. The angular sampling interval is $11.5^{\circ}$, the full beamwidth at half maximum is $20^{\circ}$ and the rotation rate is 4 rpm .

The uppermost pair of curves is an average over 30 rotations early in the flight while the moon was still in the field of view. The lunar signal is bipolar as it enters first one horn and then the other.

The middle curves are an average over 430 rotations; no corrections were applied to the data. The large sinusoidal term in the high-frequency channel is caused by the atmosphere, since the balloon gondola had a. $25^{\circ}$ wobble in zenith angle as it rotated. The wobble was caused by a sticky universal joint which has since been replaced.

The lowest curves are the same averages as the middle ones with corrections applied. The corrections are made in the following manner. Several times during the flight one horn is moved $10^{\circ}$ in zenith angle, and the change in differential radiometer output is measured and used to determine the zenith angle sensitivity. In this flight

$$
\left(\frac{\Delta \mathrm{T}_{\mathrm{RJ}}}{\Delta \theta_{\mathrm{z}}}\right)_{\mathrm{HF}}=0.029^{\circ} \mathrm{K} / \mathrm{deg}
$$



Fig. VI-1. Averaged differential radiometer output as a function of azimuth.


Fig. VI-2. Fourier amplitudes of the lowfrequency signal.

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$$
\left(\frac{\Delta \mathrm{T}_{\mathrm{RJ}}}{\Delta \theta_{\mathrm{z}}}\right)_{\mathrm{LF}}=0.007^{\circ} \mathrm{K} / \mathrm{deg}
$$

By using these coefficients and the output of an instrumented bubble level mounted on the apparatus, the signals in both channels are corrected for wobble. Finally, the lowfrequency signal is corrected for atmospheric inhomogeneity by subtracting $a$ times the high-frequency signal. The $a$ is the ratio of the atmospheric signal in the two channels; in this experiment $a$ was determined to be

$$
\frac{1}{a}=\left.\frac{\mathrm{V}(\mathrm{HF})}{\mathrm{V}(\mathrm{LF})}\right|_{\mathrm{atm}}=53.25
$$

It turned out that no other corrections were needed. One of our major worries had been that stratospheric wind shear would cause temperature gradients across the radiometer. To our surprise, the differential temperature variation of the horns and mirrors was less than $10^{-2}{ }^{\circ} \mathrm{K}$ throughout a rotation. The emissivities of both horns and mirrors were measured during the flight by heating and the result was less than $5 \times 10^{-2}$

Figure VI-2 shows results of a Fourier analysis of the low-frequency data, taken in 30 rotation blocks, at the rotation frequency and 3 harmonics. For the $\omega$ component the cosine coefficient is positive if South is hot and the sine coefficient is positive if East is hot. The data are given in millivolts of radiometer output,

$$
1 \mathrm{mV} \Longrightarrow 1.76 \times 10^{-3} \circ \mathrm{~K}_{\mathrm{RJ}}
$$

The noise in the experiment is caused entirely by the detector and is Gaussian. For a flight planned in June 1974, we have improved the detector by a factor of 3.

The velocity of the Earth in the co-moving frame determined by the expansion of the universe would be detected as an anisotropy with a period equal to the rotation period of the gondola. If $\beta$ is the velocity divided by $c$ and $\theta$ is the angle between the zenith and the velocity, the relation between the radiometer output and $\beta$ sin $\theta$ is given by

$$
\beta \sin \theta=\frac{\sqrt{2}}{2 \mathrm{~T}_{\mathrm{o}}} \frac{(\Delta \mathrm{I} / \Delta \mathrm{T})_{\mathrm{RJ}}}{(\Delta \mathrm{I} / \Delta \mathrm{T})_{\mathrm{PL}}}\left(\frac{\Delta \mathrm{~T}_{\mathrm{RJ}}}{\Delta \mathrm{~V}_{\mathrm{RJ}}}\right) \Delta \mathrm{V}(\mu)=1.5 \Delta \mathrm{~V}(\mu)
$$

The preliminary results of this flight are

$$
\begin{aligned}
& (\beta \sin \theta)_{\mathrm{E}-\mathrm{W}}=(0.92 \pm 1.12) \times 10^{-3} \\
& (\beta \sin \theta)_{\mathrm{N}-\mathrm{S}}=(0.49 \pm 1.74) \times 10^{-3}
\end{aligned}
$$

