effects of all environmental factors, is less than 1% per year. If a reflectivity coefficient of 0.83 is assumed, the Echo I photometric observations yield a mean radius of curvature of 47 ft with a probable error of 3 ft. Several surface anomalies were observed having local radii of curvature ranging from 39 to 66 ft.

Together with the results from laboratory hypervelocity impact tests of very small particles on aluminized Mylar, the present indications may prove of value in further defining the micrometeoroid environment at Echo I's orbital height, either with respect to the flux in the vicinity of the mass cutoff or the mass cutoff itself. The present indications should also prove of value in predicting the useful life in nearby space of exposed optical and thermal balance surfaces.

The photometric studies of Echo I are being extended at Goodyear Aerospace Corporation under NASA-Langley Research Center Contract NAS 1-3114, monitored by W. J. O'Sullivan. While final results from these additional visual and photoelectric measurements are not available at this time, the preliminary results appear to support the conclusion herein that Echo I's surface remains highly specular.

3.2-mm Observations of the Lunar Eclipse of 30 December 1963. EUGENE E. EPSTEIN AND JOSEPH M. STACEY, *Aerospace Corporation*.—Previous radio astronomical observations, at $\lambda > 3.2$ mm, during lunar eclipses have not reliably detected any temperature changes. However, no observations have been made at $\lambda \leq 3.2$ mm.

A 15-ft, 3-min of arc beamwidth antenna, operating at $\lambda = 3.2$ mm, was used from 05^h UT to 14^h UT, 30 December 1963, to observe the subterrestrial point, a mountainous region near Sinus Medii, Mare Serenitatis, Mare Imbrium, and Copernicus. The temperatures of all five regions decreased $\approx 6\%$ during the eclipse. The data show no statistically significant differences in the maximum temperature decreases or in the rates of cooling and recovery of the five regions. Cooling and recovery of each region commenced within $\approx 1^h$ of the entry into and exit from, respectively, the umbra.

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Inclined Inhomogeneities in the Solar Atmosphere. JOHN W. EVANS, *Sacramento Peak Observatory*.—Good spectrograms of undisturbed regions on the sun show a pattern of lengthwise threads representing granulation. I have measured the x positions (perpendicular to dispersion) of threads

as a function of λ distance from the center of the strong line $Fe4383.6$ from $\Delta\lambda = 0.2 \text{ \AA}$ to the continuum, and at the centers of other lines nearby. The standard deviation of a single measure corresponds to ± 20 to ± 40 km on the sun for sharp or fuzzy threads.

Inspection of many spectrograms showed that many threads are visible curved, as though the positions of the corresponding granules along the slit varied with $\Delta\lambda$. The measurements on one spectrogram covering 135 000 km on the sun showed the following thread characteristics: (a) The x displacements are symmetrical, having the same sign and magnitude on the blue and violet sides of the line. The sign of the displacement is quite random. (b) Of the 58 bright threads visible in the spectrogram, the x displacements of 39 were ≥ 160 km; of 4, ≥ 970 km; and the rms for all was 500 km. (c) The displacements are present in all Fraunhofer lines and are very strongly correlated with line strength for any single thread. (d) There is no systematic tendency for threads to become fuzzy in their curved portions.

My interpretation of this behavior is that a curved thread represents a columnar inhomogeneity which is sharply inclined to the vertical along the slit direction. At different $\Delta\lambda$'s (or at the centers of weaker lines) we see cross sections of the column at a series of different heights, and hence at different apparent x positions. Allowing a very liberal 500 km for the total height range, the statistics show that high inclinations of $\sim 45^\circ$ are the normal thing for bright inhomogeneities. This ignores the uncomfortable fact that the observed displacements occur between 5 and 20 Doppler widths from the line core, where we might expect a very small height range, and little height discrimination.

Cascade Image Intensifiers for Astronomical Spectroscopy. W. KENT FORD, JR., *Carnegie Institution of Washington*.—A cascaded image intensifier suitable for use in astronomical spectroscopy has been developed at the Electron Tube Division of RCA for the Carnegie Image Tube Committee. This tube gives a substantial gain in speed over ordinary photographic techniques, it can be used for long exposures, and it is simple and reliable in operation compared with other intensifying devices.

We now have two samples of these experimental tubes with both good cathodes and low background. The resolution at the phosphor screen, measured visually, is 40 line pairs per mm, and is uniform over the 38-mm diameter field. With our present relay or transfer lens the resolution is limited to 25 to 30 line pairs per mm on Ila-O plates. The gain in exposure time over baked Ila-O plates is