definitely extended by Mills, Slee, and Hill also have indices near the center of the distribution.

If sources have a constant index with respect to frequency and if either the present observations or those at 960 Mc by Harris and Roberts are substantially correct, then the Third Cambridge flux densities are consistently low or the Mills-Slee-Hill flux densities are consistently high. This applies even to sources whose angular sizes, measured by Moffet at 960 Mc suggest that an error due to angular size was not made in the observations at 159 Mc. The research program at Harvard is sponsored by the National Science Foundation.

A Low-Background Image Tube for Direct Electronography. W. A. HILTNER and W. F. NIKLAS, *Yerkes Observatory, University of Chicago, and the Rauland Corporation.*—The use of image tubes for direct electronography at Yerkes Observatory has been frustrated because of intense background resulting from field emission. However, during the past six months, a decrease in background of 10^7 has been achieved. This large factor has resulted in a tube that has a background 3×10^2 less than the sky background at the focus of the $f/20$ 40-inch refractor. Furthermore, no ion spot has been detected. The lifetime of the photocathode appears to be unlimited. No change in sensitivity was detected over a period of one month even though the tube was cycled (emulsions inserted and removed) over 200 times. The resolution is 40 line pairs per mm.

The Distribution of Stars in Dwarf Elliptical Galaxies. PAUL W. HODGE, *Mount Wilson and Palomar Observatories.*—Star counts and photoelectric and photographic surface photometry have been used to determine the luminosity and stellar distributions across the faces of some local-group dwarf elliptical galaxies. Of the extreme dwarfs, the Fornax galaxy is the most favorable object for study because of its richness and size. The distribution of projected density with radius is, for Fornax, decidedly unlike the distribution of luminosity with radius for giant elliptical galaxies. It approximately follows Hubble's interpolation formula out to a distance of only $1 a$ (Hubble's notation for the characteristic radius), beyond which the density falls off much more rapidly, reaching a rather definite zero value at a distance along the major axis of approximately 56 minutes of arc, which is 3.3 kpc at the assumed distance of 190 kpc. This is in reasonable agreement with the predicted value of the gravitationally limited radius imposed on the Fornax dwarf by the mass of the Galaxy.

Similar results are obtained for the other dwarf elliptical galaxies, Sculptor, Leo II, NGC 147, and NGC 185.

Diffuse Reflection by a Semi-Infinite Atmosphere. HENRY G. HORAK and S. CHANDRASEKHAR, *University of Kansas and University of Chicago.*—The solution has been obtained for the problem of diffuse reflection by a semi-infinite atmosphere which scatters light in accordance with the phase function

$$p(\cos\theta) = \omega_0 + \omega_1 P_1(\cos\theta) + \omega_2 P_2(\cos\theta),$$

where ω_0 , ω_1 , ω_2 are constants and P_1 , P_2 are Legendre polynomials. The albedo, ω_0 , can be less than or equal to unity. The solution was obtained by the principle-of-invariance method.

A Modification of von Zeipel's Method for a Choice of Canonical Variables Especially Suitable for Orbits with Small Eccentricities, GEN-ICHIRO HORI, *Yale University Observatory.*—A set of canonical variables, in which a pair of the conjugate variables is $[2(L-G)]^{1/2}(\cos l, \sin l)$, is adopted in order to avoid the divisor e when the odd powers of e are contained in the Hamiltonian. A modification of von Zeipel's method is discussed so as to be applicable, yet preserve its main advantages. The theory is applied to the second "operation" of Delaunay's lunar theory.

Departures from Thermodynamic Equilibrium in Chromospheric MgI, CaI, and OI. LEWIS L. HOUSE and R. GRANT ATHAY, *High Altitude Observatory, Boulder, Colorado.*—Line intensities from the chromospheric flash spectrum observed at the 1952 total eclipse clearly indicate marked departures from LTE in MgI and OI. The same is suggested for CaI, but not unambiguously. The following remarks relate only to MgI.

The stronger triplets $\lambda 5184$ and $\lambda 3838$ are influenced by self-absorption for heights below about 2500 km. The forbidden line $\lambda 4571$ is observed, and is shown to be free from self-absorption. Its intensity leads directly to the opacities in the $\lambda 5184$ and $\lambda 3838$ triplets. At 500 km the radial opacities at line center are $\tau_{5184} \approx 3$ and $\tau_{3838} \approx 7$, establishing that the centers of these lines in the Fraunhofer spectrum are chromospheric in origin.

The singlet line $\lambda 5528$ is observed to fall off much more rapidly with height than the triplets even in the absence of self-absorption. The singlet to triplet ratios give unambiguous evidence of departures from LTE. At 1000 km, the intensity of $\lambda 4571$ is enhanced relative to $\lambda 5528$ by factors of 20 to 200 for assumed values of T_e of 6000° and $10\,000^\circ$, respectively.

Solutions to the statistical equilibrium equations yield populations of energy levels in good agreement with the empirical values for opacities consistent with those in the chromosphere. The departures from LTE in 3^1S and 3^3P are shown to be the same

and essentially independent of height. Typical computed values are $b_{31S} \approx 25$ at 6000° and ≈ 200 at 8000° .

The departures from LTE in the higher triplet levels are also relatively independent of height. Typical values are $b_{41S} \approx 1.4$ at 6000° and ≈ 3.3 at 8000° . For the upper level of $\lambda 5528$, 4^1d , the departure from LTE depends strongly on height thereby accounting for the steep gradient in the $\lambda 5528$ emission.

The Measurement of Microwave Radiation from the Planet Mercury. WILLIAM E. HOWARD, III, ALAN H. BARRETT, and FRED T. HADDOCK, *The Observatory of The University of Michigan, Ann Arbor, Michigan*.—Forty-nine drift curves and eight on-off measurements on Mercury were obtained during 1960–1961 near elongation with an 85-foot telescope at 3.75 cm (TWT radiometer) and 3.45 cm (maser radiometer).

The mean antenna temperature of the 49 drift curves was 0.05 ± 0.01 °K (before amplitude correction for time constant) or five times the rms noise level. The mean drift curve had a response width and a response delay in the peak which were in excellent agreement with the expected values.

During these measurements Mercury was between 19 and 28 deg from the sun. Since the undisturbed sun produces a flux density three million times that of Mercury, output variations might be caused by variations in either solar flux or side-lobe levels. Comparison of solar and Mercury records exclude deflections from solar bursts. Side-lobe variations are reduced because of the appreciable smearing of the lobe positions by the receiver bandwidth and the effect of averaging 49 drift curves at different angular distances from the sun.

If we assume that only thermal radiation is present, the subsolar point temperature T_0 , reduced to Mercury's mean solar distance, is estimated from the equivalent blackbody temperature of about 350 °K by multiplying it by (1) $(r/r_0)^{1/2}$, the reduction to mean distance, and (2) a factor which depends on both the planetocentric angle between the sun and the earth and the temperature distribution on the sunlit planetary surface. Assuming that the latter varies as $T_0 \cos^{1/2} \theta$, where θ is the angle of incidence of solar radiation on the surface and that the radiation from the dark hemisphere is negligible, then we derive $T_0 = 1050 \pm 350$ °K. This assumes that the flux density of Cygnus A is 162×10^{-26} mks units. If the sunlit surface temperature is uniform, then T_0 should be reduced by about 30%.

The subsolar point temperature of 1050 ± 350 °K is to be compared with the value of 610 °K derived by Pettit and Nicholson from vacuum thermocouple observations in the infrared.

Study of Infrared Instrumentation for Thermal Photography of the Moon. HECTOR C. INGRAO, DONALD H. MENZEL, and J. ANTHONY BURKE, *Harvard College Observatory*.—Successful thermal photography, for the primary purpose of temperature measurement, depends on the value of the signal intensity at the ground, or in a balloon or space vehicle. Computations predict the image temperature, for an image-forming system with a single thermal detector having a sequential readin and readout.

Thermal detectors and available single-quantum detectors with responses at wavelengths of approximately 5μ and longer are intercompared in terms of figures of merit.

Infrared sensitive image-forming systems are surveyed and discussed for lunar thermal photography. Lateral heat conduction in the target plate of a simultaneous readin image-forming system is analyzed to determine the size of the minimum resolvable element. On the basis of this analysis, we investigated the possible utility of new thermal detectors as target plates for image-forming systems of simultaneous readin.

The potentialities of ferroelectric materials for a target plate (thin film) of an image-forming system depend on the change in dielectric constant as a function of temperature close to the Curie point. In particular, measurement of the dielectric constants of thin films of $(\text{Sr-Ba})\text{TiO}_3$ will enable the determination of temperatures to 10^{-7} °C. This corresponds to detecting an irradiance of approximately 10^{-10} w per resolution element for a film 100μ thick.

Nonlinear phosphors, especially zinc cadmium sulfide, are considered for thermal image conversion. This phosphor fluoresces in the yellow and has a brightness change of approximately 28% deg centigrade for a given ultraviolet excitation, and phosphor temperature.

Radio Observations of Solar Active Regions at cm-dm Wavelengths. T. KAKINUMA, *Radio Astronomy Institute, Stanford University*.—Comparison has been made of the observations of the slowly varying component of solar radio emission made with high-resolution interferometers operating at wavelengths of 3.2, 7.5, 9.1, and 21 cm, and located at Nagoya, Stanford, and Sydney. The interferometers provided fan-shaped and pencil-shaped beams of about 2 to 3 minutes of arc.

The slowly varying component is radiated from hot and dense regions situated above the sunspot regions. Ten strong isolated regions observed during 1960 were selected for the present study. The area of the associated sunspot group varied from about 500 to 2000 millionths of visible hemisphere. At