means of the $H\alpha$ and $[NII]$ emission lines. The rotation curve for the bar and points outside is shown. A preliminary estimate of the mass of the bar is given, and some ideas concerning the structure of barred spirals are discussed.

Heat Transfer Coefficient for Meteors Shielded by an Air Cap. ALLAN F. COOK, *Harvard College Observatory*.—The equation of heat conduction is solved for the following model: The presentation area of the meteoroid is a flat circular surface normal to the direction of flight. Only rotational and translational degrees of freedom are activated within the air cap. Vibrational and electronic degrees of freedom are assumed to require much longer times for activation than the average duration of the transit of an air molecule through the air cap. The boundary conditions are the surface temperature at the meteoroid and at the front of the air cap, those obtaining immediately behind a shock wave traveling at the velocity of the meteoroid. Isobaric conditions are assumed within the air cap. The equation of continuity is also employed. The results indicate heat transfer coefficients ranging from $\frac{1}{3}$ at a velocity of 12 km/sec⁻¹ to 1/20 at a velocity of 72 km/sec⁻¹ provided the meteoroid is larger than a mean free path of a high velocity air molecule in the air. These values are increased by about 40% for a turbulent boundary layer.

Narrow Band Photoelectric Photometry for G and K Giants. D. L. CRAWFORD, *Kitt Peak National Observatory*.—Narrow band photoelectric photometry has been done on a number of G and K giant stars. The three filters used measured the break in the spectrum at the G band and at a CN band. The range in each parameter is about 0.300 mag. and the mean error of one observation is ± 0.007 . A good correlation with spectral type, luminosity, age or space velocity, and line strength is shown. In addition, *UBV* colors are available for a few of these stars and these colors strengthen the correlation. Peculiar CN stars stand out clearly.

The Structure of Sunspot Penumbrae. ROBERT E. DANIELSON, *Princeton University Observatory*.—Many sunspot photographs having a resolution of about $\frac{1}{3}$ second of arc were obtained last summer during Project Stratoscope. These photographs show the penumbra resolved into a complex array of predominantly radial filaments. Most of these filaments have an apparent width of about 300 km

(which is the diffraction width of the 12-inch telescope) and a length of 5000 to 10 000 km (the width of an average penumbra). Thus it is possible that the filaments have an actual width smaller than 300 km.

The filaments are, for the most part, brighter than the umbra, but not as bright as the granulation. Many of the filaments are recognizable after 10 minutes even though noticeable changes can occur in a few minutes. A few filaments have been traced for 40 minutes. Thus their lifetime is definitely longer than the lifetime of the granulation.

The filaments cannot be explained as hot material flowing up at the inner edge of the penumbra in tubes of 300 km diameter (or less) and flowing across the penumbra along magnetic lines of force. The reason is that the time for cooling by radiation of a 300-km filament is of the order of 1 minute while the time for material to flow across the penumbra (Evershed effect) is of the order of 100 minutes. Because of this short cooling time, the only macroscopic flow which is capable of explaining the filaments is convective rolls with the axis of the roll along the magnetic field. It is thought that most of the penumbral filaments can be explained in this fashion. Some filaments, however, are seen to cross other filaments while some are observed in places where they cannot be convective rolls. These filaments must therefore lie above the surface of the sunspot and are therefore structures in the chromosphere above the sunspot.

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A Report on Experiments with the Image Orthicon As a Light Receiver. JOHN H. DEWITT, JR., *Dyer Observatory, Vanderbilt University*.—Work was begun in May, 1956 on the "Mars" project which was designed to explore the possibility of using the television image orthicon tube, then available, as a light receiver at the output of a telescope for the indirect photography of planetary images. A system was developed using an electronic image stabilizing device which overcame some of the deleterious effects of atmospheric instability.

When the General Electric Z-5294 orthicon utilizing a magnesium oxide target became available in the fall of 1958 it was apparent that its superior storage characteristics would permit photography of very faint objects and possibly show a large improvement over the sensitivity of the photographic plate. Subsequent trials at the output of the 24-inch Cassegrain telescope indicated that eleventh magnitude could be reached in 1/30th sec and fifteenth magnitude in 8 sec or less. Equipment now being designed and constructed to explore further possi-

bilities of the image orthicon in photography of star fields, nebulae and spectra will be described.

The work is being carried out under a National Science Foundation Grant.

The Occultation of the Crab Nebula by the Solar Corona in June 1959. WILLIAM C. ERICKSON, *Convair Scientific Research Laboratory, San Diego 11, California*.—During June 1959, observations were made of the occultation of the Crab nebula by the solar corona at the Clark Lake radio astronomy station. The observing frequency was 26.3 Mc/sec (11.4 m wavelength). These observations extend the work of other observers to this lower frequency. Effects due to the scattering of radio waves in the solar corona have been found to a distance of 25 solar radii. These results are in agreement with those of other observers when scaled to their frequencies; however, they extend the observations to larger distances from the sun than those over which effects have previously been observed.

A Model for the Decimeter Radiation by Jupiter. GEORGE B. FIELD, *Princeton University Observatory*.—The model is based on emission at the cyclotron frequency by electrons trapped in Jupiter's magnetic field. The decimeter waves originate close to the magnetic poles, where the field strength must exceed 1200 gauss. The theoretical spectrum is proportional to λ^3 and agrees satisfactorily with the observed one. The polarization should be almost completely linear, with the magnetic vector parallel to Jupiter's magnetic axis. The required electron densities are of the order of 10^{-2} cm^{-3} if the electron energies are about 40 kev, as for the outer radiation belt of the Earth. The solar wind appears capable of supplying many times the radio-frequency energy.

The source and observable effects of such a strong magnetic field are considered. It is shown that the field can be primordial, being frozen in the metallic-hydrogen core of the planet, provided that the interior temperature does not exceed 800°K . The polarization of 20 Mc bursts can be explained provided their source is between 30° and 40° latitude. Both Zeeman effects and aurorae should be observable on Jupiter.

Meteoric Dust Particles and the Anomalous Polarization of Jupiter. GEORGE B. FIELD AND JOHN E. GAUSTAD, *Princeton University Observatory*.—It is suggested that the polarization in the polar regions of Jupiter is due to meteoric dust suspended in the atmosphere. The dust is accreted gravitationally

from the interplanetary medium, and, because of its electric charge acquired from the free electrons in space, is funnelled by Jupiter's magnetic field toward the poles. The rate of accretion, the required magnetic field, and the mechanism of polarization are discussed quantitatively.

The Protection of Frequencies for Radio Astronomy. J. W. FINDLAY, *National Radio Astronomy Observatory, Green Bank, West Virginia*.—The Administrative Radio Conference of the International Telecommunications Union completed its work at Geneva just before Christmas 1959. The final acts of the Conference, which will be incorporated in the new radio regulations, will come into force in May, 1961. These radio regulations will contain considerable material of importance to radio astronomers. The amount of frequency protection for radio astronomers contained in the acts of the Conference will be described.

In addition to the clearance of the hydrogen line (1400–1427 Mc), bands of frequency were designated by the Conference and given various degrees of protection at points throughout the radio spectrum from 2.5 Mc to 31.5 kMc. The value of this protection to radio astronomers will be discussed and suggestions made for further work by radio astronomers to improve the protection for the science in the future.

The Flux Density of Radiation from Cassiopeia A at 1400 Mc. J. W. FINDLAY AND H. HVATUM, *National Radio Astronomy Observatory, Green Bank, West Virginia*.—As a part of the program of source calibration at the National Radio Astronomy Observatory experiments have been started to measure the flux density from the Cas A source. One major experimental difficulty in such measurements is to determine exactly the effective collecting area of the antenna that is used. To minimize this difficulty a horn antenna of about 10 square meters collecting area has been built. This horn is large enough to give an antenna temperature from the Cas A source of about 8°K . The gain of such a horn can be calculated from its linear dimensions to a high accuracy. The horn is fixed in position at an elevation angle of 30° and is used as a transit instrument. It is 120-ft in length and is made of sheet aluminum with all joints internally welded to ensure high electrical conductivity. The design of the antenna and of the associated receiving equipment will be briefly described, and first measurements of the flux density from the Cas A source at frequencies near 1400 Mc will be reported.