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ABSTRACTS

The radiation appears to vary by almost 25% with the rotation of Jupiter. The intensity reaches its minimum value when the magnetic pole in the northern hemisphere, at about $\lambda_{\text{III}}=200^\circ$, lies on the central meridian. This variation is consistent with the beaming of the radiation into the plane of Jupiter's magnetic equator. The results can be combined with other measurements in order to determine the spectrum of the radiation and the physical properties of the Jovian magnetosphere.

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Secular Variations in the Radio-Frequency Emission of OH. NANNIELOU H. DIETER, HAROLD WEAVER, AND DAVID R. W. WILLIAMS, University of California, Berkeley.—Observations of five sources of OH emission have been carried out over the period from mid-July to the end of October 1965, mainly at frequencies of 1667 and 1665 Mc/sec. During this period two of the sources have shown variation in intensity of some of the individual peaks within the profile.

The emission from the Orion Nebula exhibits three major peaks in the 1665 Mc/sec line. Two have remained constant and the third has increased in intensity through the period of observation by a factor of 1.5.

Another source is the southern H II region, NGC 6334, which over an angular extent of approximately 30' has four optical condensations. It has been observed at both 1667 and 1665 Mc/sec and has been shown to vary in intensity at both frequencies. The variation occurs independently in each of the channels of 2 kc/sec bandwidth, with a maximum total range over the three months of a factor of 10. We have found no consistent relation between the variation at 1667 and 1665 Mc/sec. Individual channels can be either in phase at the two frequencies or out of phase, or nonvariable in one and variable in the other. In addition to the variation over a period of months individual channels have been observed to vary within a period of one day.

These variations cannot be explained solely on the basis of a variation in the plane of polarization. They suggest that the mechanism for excitation of the lines is a highly unstable one.

An Experimental Method of Determining the Polarization of Celestial x Rays. JOSEPH F. DOLAN, Smithsonian Astrophysical Observatory.—The Borrman effect (the anomalous transmission of x rays through a perfect crystal) has been experimentally investigated and found to be a feasible method of determining the polarization of celestial x rays. Using a 100 cm$^2$ effective collecting area, the exposure times necessary to determine the plane and magnitude of linear polarization in the 2-8 A region to 1% are as follows for the sources listed:

- Class 3 solar flare: 0.1 sec
- Class 2 solar flare: 1 sec
- Solar plage area: 0.5–5 hour
- Sec XR-1: 0.7 hour
- Tau XR-1: 7 hour

A New Search for Visual Aurorae on Jupiter. GEORGE A. DULK AND JOHN A. EDDY, University of Colorado and High Altitude Observatory.—The nature of decametric radio emission from Jupiter and the known properties of its magnetic field suggest that energetic electrons frequently impinge on its upper atmosphere. These events, occurring at the time of decametric emission, should ionize atmospheric constituents and cause a visible recombination emission spectrum. This Jupiter auroral emission has long been suspected but never observed. Past attempts to observe the effect in hydrogen-$\alpha$ have mostly used filter monochromators, with bandpass 15–20 A, or low-dispersion spectrographs. The best previous search (Smith, Rodman, and Sloan, Astron. J. 68, 79, 1963) could have detected a 100 kilorayleigh aurora in $H\alpha$, had one occurred in their field of view. The recent finding that Io controls much of the radio emission (Bigg, Nature 203, 1008, 1964) enables one to predict the time and place of probable aurorae on Jupiter (Dulk, Science 148, 1585, 1965) and thus increases the chance of detection. Auroral activity is likely to occur on magnetic field lines connecting Io to Jupiter, at times and places favorable for detection several times per week, with duration 3 to 5 h. The authors have reintegrated the optical search for these events using the coded spectrograph at the 84-in. telescope at the Kitt Peak National Observatory. Auroral emission expected is a narrow, weak perturbation in the reflected absorption lines, Doppler-shifted from line center by planetary rotation. With spectral resolution of 0.1 A, a 1.2 kilorayleigh aurora should be detectable in $H\alpha$, and approximately 10 kilorayleigh aurora elsewhere in the spectrum. Spectra were obtained on three favorable nights in November 1965 with negative results. We conclude that either no aurora brighter than 1.2 kilorayleigh was present or the spectrograph slit was incorrectly placed on the planet. Nearly concurrent filtergrams were obtained with a 5 A $H\alpha$ interference filter which has a 1000 kilorayleigh auroral threshold.

Measurement of the Polarization of [Fe XIII] $\lambda$10747 During the 30 May Eclipse. JOHN A. EDDY and J. McKIM MALVILLE, High Altitude Observatory.—Scans of $\lambda$10747 were obtained with a 10-in. Cassegrain from the French island Bellingshausen. The polarization of the line and the neighboring con-
tinum were measured photoelectrically using a cooled RCA 7102 tube at several locations in the corona with 1' and 5' circular apertures. Wavelengths scans were obtained by tilting a 16 A bandpass interference filter. The results are compared with theoretical estimates made on the basis of collisional and radiative excitation of the upper level of the $\lambda$10747 line.

Mercury: Anomalous Absence of a Variation with Phase in the 3.4 mm Radio Emission. EUGENE E. EPSTEIN, Aerospace Corporation.—The dark-side brightness temperature of 220±35°K which we recorded at 3.4 mm (88 GHz) during the April 1965 inferior conjunction of Mercury and the brightness temperatures recorded at longer wavelengths led us to expect a large variation with phase in the 3-mm emission of Mercury. This expectation was based on the assumption that Mercury's surface layers behave as do those of the moon. We made observations on 34 days at 3.4 mm with the 15-ft, 3 arc min beamwidth antenna of the Space Radio Systems Facility of Aerospace Corporation from 16 July through 17 October 1965; these observations cover almost a complete revolution of Mercury. We also made frequent observations of Venus and Jupiter to verify the over-all system reliability. In addition, special observations indicated that there were no detectable effects in the Mercury data due to antenna sidelobe reception of solar radiation.

The Mercury brightness temperatures were only $\approx$200°K, even when as much as 95% of the illuminated hemisphere was visible, and exhibited no significant variation with phase.

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Starlight Energy Density in the Metagalaxy. JAMES E. FELTEN (introduced by Robert J. Gould), University of California, San Diego.—The mean metagalactic energy density of thermal radiation, $\rho$, which is of interest in several astrophysical investigations but cannot at present be measured directly, is treated from a semiempirical point of view. Difficulties in experimental and theoretical determinations are discussed. Dimensionally $\rho$ may be written $\rho\approx A t_h$, where $A$ is a dimensionless factor, $t_h$ is the mean thermal emission per unit volume of space, and $t_h\approx H^{-1}$ is the Hubble time. An estimate of the factor $A$ is derived from local observations of galaxies; its value is independent of the astronomical distance scale but depends upon the assumed mean bolometric correction for galaxies. The need for more photometric data in the infrared and ultraviolet is emphasized. The factor $A$ is dependent upon the choice of cosmological model, but $A=\frac{1}{3}$ (within a factor of 2) for a wide variety of models (Whitrow and Yallop, Monthly Notices Roy. Astron. Soc. 127, 301, 1964; 130, 31, 1965). The corresponding estimate of the starlight energy density, $\rho\approx\frac{1}{2}A t_h\approx1\times10^{-2}$ eV cm$^{-3}$, is probably also correct within a factor of 2.

Radiation Temperature of Space at $\lambda$2.6 mm. GEORGE B. FIELD, G. H. HERBIG, AND JOHN HITCHCOCK, University of California, Berkeley, and Lick Observatory.—The equivalent widths of the $R(0)$ and $R(1)$ lines of interstellar CN were measured on six high-dispersion spectrograms of $\xi$ Oph obtained by Herbig, and were found to be 9.20±0.1 mÅ for the $R(0)$ and 3.37±0.1 mÅ for the $R(1)$. The corresponding excitation temperature of the rotational level $J=1$ is 3.22±0.15 K if the lines are unsaturated. A reasonable upper limit on the degree of saturation implies a lower limit of 2.75 K for the excitation temperature.

It is shown that the only reasonable mechanism for the observed excitation is absorption of pure rotational quanta at $\lambda$2.6 mm. Consideration of various possible sources of such quanta indicates that previously identified sources (stars, free-free emission, nonthermal emission) are inadequate, and that a new radiation component must be postulated. The implied effective blackbody radiation temperature for such a component, 3.2 ($+0.2,-0.5$)°K, may be compared with that of a component at $\lambda$4.4 cm, 3.5±1.0°K, recently found by Penzias and Wilson (Astrophys. J. 142, 419, 1965). If the components are in fact identical, the present observations verify the approximate blackbody nature of the spectrum over a 28:1 wavelength interval. The relevant wavelength studied here is not far from the expected blackbody maximum at $\lambda$0.8 mm. This interpretation is consistent with the suggestion by Dicke, Peebles, Roll, and Wilkinson (Astrophys. J. 142, 414, 1965), that blackbody radiation of approximately the observed temperature should be present as the result of processes occurring much earlier in the history of the universe.

Metallic Continuous Absorption Coefficients in the Solar Ultraviolet. OWEN GINGERICH, Smithsonian Astrophysical Observatory and JOHN C. RICH, Harvard College Observatory.—Computations with a hydrogenic approximation for the bound–free absorption coefficient from various neutral metals and with the Goldberg–Müller–Aller abundances indicate that silicon and magnesium should predominate over all other metals in the solar ultraviolet. New shock-tube results for silicon show that the experimental cross section for the ground state is $37\times10^{-18}$ cm$^2$, almost a factor of 10 larger than the hydrogenic value. For the first excited level (1D), the experi-