metal-to-hydrogen ratios in the long-period Cepheids of the Magellanic Clouds do not differ by large factors, if at all, from the ratios in similar Cepheids in the galaxy. The large photometric errors were due to the stars' being too faint for the telescope–photomultiplier combination. If one had a photomultiplier carefully selected to have high quantum efficiency, then the average of 30 observations with a 60-in. telescope could give a metal index with a probable error of ± 0.01 mag. Then the main source of error would be errors in the estimate of the interstellar reddening of each star.

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Spectrophotometric Studies of Three Extremely Red Stars. ROBERT F. WING, HYRON SPINRAD, AND L. V. KUHI, *Lick Observatory and Berkeley Astronomical Department*.—We have obtained the following observational material for three objects discovered to be extremely red by Neugebauer, Martz, and Leighton (*Astrophys. J.* **142**, 399, 1965)—the Taurus object, the Cygnus object and TX Cam:

- (1) *UBV* photometry of the Taurus object and TX Cam;
- (2) Low-dispersion blue spectrograms of the Taurus object;
- (3) Two 32 Å/mm coudé spectrograms of the Taurus object centered at $\lambda 10\,800$ Å; and
- (4) Infrared scanner measurements (8000–11 000 Å) of the molecular band strengths and energy distributions of all three objects.

That the Taurus object is a Mira-type variable is indicated by its light variation (both visual and infrared), its ultraviolet excess, the strength of its hydrogen emission lines ($H\gamma$ – $H11$ and $P\gamma$), and its irregular Balmer decrement. Its oxide bands (TiO, VO and H_2O) are abnormally weak at all phases observed but strengthen with decreasing temperature; we suggest that the Taurus object has a low O/C ratio, as in stars of type S. TX Cam, on the other hand, appears to be a normal, but unusually cool, M-type variable. The molecular hydrogen abundance of the Taurus object is comparable to that of Mira near minimum; its radial velocity is about +60 km/sec.

The Cygnus object remains enigmatic in that no substantial variations in temperature, magnitude or spectrum have been detected; it is the coolest star known to date. We were unable to detect H_2O , and the bands of TiO and VO are weaker even than in the Taurus object, corresponding to a spectral type

of M6. It cannot be a dwarf since in a dwarf at this temperature TiO and VO would be condensed while H_2O would still be gaseous. Likewise partial condensation of TiO and VO in a cool giant, although plausible, cannot explain the H_2O deficiency. It appears that the Cygnus object, like the Taurus object, has a low O/C ratio.

Satellite Roles in Radio Emission from Jupiter.

J. WITTING, *IIT Research Institute, Astro Sciences Center*.—Jupiter I is known to influence quite strongly the probability of decameter wavelength radio emission from Jupiter. It is shown that the direct scattering of electrons of 40 keV by the satellite produces particle lifetimes of the order of months, probably much longer than lifetimes required by the intensity of the bursts. It is also shown, however, that Alfvén waves which propagate along magnetic fields without radial attenuation can be generated by the moving satellite. This might provide a mechanism for triggering plasma instabilities leading to decameter bursts.

Radio emission from Jupiter at decimeter wavelengths implies a radiation belt of relativistic electrons near the orbit of Jupiter V. It is shown that Jupiter V scatters relativistic electrons out of the belt in less than 2 yr, either by direct impact or reflection from large-amplitude Alfvén waves generated by the moving satellite. This lifetime is small compared to the lifetime of highly relativistic electrons against radio emission. This implies either that electron densities are larger than those given by Chang and Davis (1962) or that the magnetic field near Jupiter V is greater than 1 G. If large-amplitude Alfvén waves are present, they provide a means of accelerating electrons through Fermi acceleration, such that electron energies follow a power law spectrum having exponent of the order of -1 , which is consistent with decimeter observations.

Helium Content of Population II. N. J. WOOLF, *The University of Texas and Goddard Institute for Space Studies, NASA*.—The H-R diagrams of globular clusters are susceptible to analysis for age, heavy element content, helium content, and distance modulus. This is because the diagrams can be considered to have four independent characteristics: a main sequence, a turnoff point, a turnup into the subgiants, and a rolloff to the reddest supergiants. These characteristics are affected differently by the parameters. In principle the horizontal branch is also available for analysis, but until its interpretation is certain, one has no theory that can be used.

Because of difficulties that result from blanketing, the present analysis has been confined to a differential