detectable change in tube characteristics. When the tubes are cooled with dry ice, exposures of one hour at $16\frac{1}{2}$ kv can be made which show very little background of internal origin.

The gain over unaided photography in the region from 0.9 to $1.1\ \mu$ is at least 500. Above $1.1\ \mu$ the effective gain has not been evaluated because comparative spectra of stars have not been obtained by unaided photography. Because of its relatively poor resolution in the blue, the effective gain of a tube with an S-11 cathode over unaided photography is only about ten.

The chief drawback of these electrostatic tubes is their small area of sharp focus. Recently, magnetically focused slotted-window tubes which have good focus over a distance of 35 mm have been made at ITT Laboratories.

This work was supported in large part by a grant from the National Science Foundation to the Carnegie Institution of Washington.

The Spectra of Planetary Nebulae and Stars in the Near Infrared. L. W. FREDRICK, *Lowell Observatory, Flagstaff, Arizona*.—Spectra of five planetary nebulae and selected late-type stars have been obtained in the $1\text{-}\mu$ region at dispersions of 109 Å/mm and 61 Å/mm at the phosphor of a mica-window image tube.

Planetary nebulae in general have been found to show only the 10830 line of helium. However, on our spectra NGC 7027 shows $P\gamma$, δ , ϵ S [III] (9532 Å) and a few unidentified lines. Estimates of the relative strengths of these lines are given.

In the region of 10670–11000 Å the spectra of the late-type—and especially carbon—stars present many new line or band features. The carbon stars show 36 lines or bands in the infrared region where 10 had previously been reported (McKeller 1954). One of these 36 lines, present in all late-type stars, is the Sr II 10915 line predicted for M- and S-type stars by Keenan (1957). A number of stars show emission changes in strength from night to night, especially a line at 10870 close to the CN band head at 10876.

A few spectra have been taken to the redward of $1.1\ \mu$. Of interest are the two Na lines at 11381 and 11404 which are imbedded in the φ water-vapor band. An unidentified band-like feature occurs at 12570 Å in Mira.

This work has been supported in part by a grant from the NSF to the Carnegie Institution of Washington.

Proposed Observations of Polarization and Interstellar Reddening from above the Ozone with High-Altitude Balloons. THOMAS GEHRELS, *Indiana University*.—The polarization of Venus, Mars,

and the moon increases strongly towards the ultraviolet (Gehrels, *Lowell Obs. Bull.* 4, 300, 1960), probably due to scattering either by molecules or by very small particles. It is proposed to extend the intercomparison of Venus, Mars, and the moon, with polarization measures down to 2000 Å. The earth as a planet, observed from a high-altitude balloon, would also be included in the intercomparison.

The wavelength dependences of interstellar reddening (Whitford, *Astron. J.* 63, 201, 1958) and interstellar polarization (Gehrels, *Astron. J.* 65, 470, 1960) can be interpreted with the Mie theory, using calculations made by van de Hulst, and particles with diameters of about $0.3\ \mu$ are inferred. However, no firm distinction between metallic and dielectric particles has as yet been made. Also, there are conflicting theories that explain the observations in terms of scattering by ions or by particles much smaller than $0.3\ \mu$. Measures at 2200 Å, of stars at different galactic longitude, may be decisive because of the peculiar wavelength dependence predicted by the Mie theory.

The absorption in the earth's atmosphere between 2000 and 3000 Å is due to ozone which, however, is mostly below 110 000 ft altitude (Goldberg, *The Earth as a Planet*, edited by Kuiper, Chap. 9; Epstein and Adel, *Arizona State College Rept.* HA-9, 1956). The limiting magnitude of our photometer and integrators (Gehrels and Teska, *Publs. Astron. Soc. Pacific* 72, 115, 1960) with a 36-inch telescope on the ground is near 14.0 mag. About a dozen fifth-magnitude stars, of early spectral type, would be easily observable with the proposed 8-inch telescope mounted in the gondola wall.

Observations at 2200, 2850, and 3250 Å are planned for a series of flights above 110 000 feet, using 10^7 cu ft balloons. With support from the Office of Naval Research, an orientation flight was made in July 1960, and the photometer is now being modified and tested at 2200 and 2850 Å.

Decay Intervals of Extinct Radionuclides in Meteorites and in the Earth. GORDON G. GOLES, Graduate Student AND EDWARD ANDERS, Ph.D., Associate Professor of Chemistry—*Enrico Fermi Institute for Nuclear Studies and Department of Chemistry, University of Chicago*.—Iodine abundances in chondritic meteorites were determined by neutron activation analysis. From these data and information on meteoritic xenon published by Reynolds, I^{129} - Xe^{129} decay intervals for several meteorites (97 million years to ≥ 190 million years) and for the earth (≥ 210 million years) were calculated. A dating method based upon the Pu^{244} spontaneous-fission decay to Xe^{136} is proposed, and a Pu - Xe decay interval of 290 million years is calculated for the earth, indicating that the earth formed nearly 200 million years later than the meteorites. Possible