amplitude characteristics of the echoes are studied; these vary both with range and time. For about 90% of the daily observations sufficient echo energy is received to compute a solar radar cross section. For about 25% of the observations sufficient energy is received to determine significant Doppler spectra at a number of range intervals. During transmission a linearly polarized wave is radiated, but the received echo consists of a large number of components with random polarizations. A frequency of 38 Mc/sec is used primarily because a large amount of coronal absorption is expected at higher frequencies. The region of the corona studied is about 0.4 solar radii above the photosphere. Echoes are obtained over an angular dimension about one degree in diameter and not just from the center of the disk.

The solar radar cross section varies considerably from day to day and month to month, but the yearly average cross section has varied in proportion to the average sunspot number. The Doppler spreading of the echo is of the order of 20 to 50 kc/sec, but the spreading changes somewhat with range and time. (A line-of-sight target motion of 3.9 km/sec produces a Doppler shift of 1 kc/sec.) This large Doppler spreading is due to mass motions or wave motions in the solar plasma with velocities of the order of 100 km/sec. It is possible that the observed effects are due to coronal motions that are largely radial. The echo has a preferential Doppler shift toward the positive Doppler frequencies, and this shift is greater for the earlier range intervals. This work is supported by the National Aeronautics and Space Administration.

UBV Photometry of DQ Cephei. R. L. JENKS AND LEON W. SCHROEDER, *Oklahoma State University* AND A. M. HEISER, *Dyer Observatory*.—The short-period variable DQ Cephei was observed photoelectrically in *UBV* on five nights in 1964 with the 24-in. Seyfert telescope at the Dyer Observatory. A refined period, based on data extending from Walker's (*Publ. Astron. Soc. Pacific* **64**, 192, 1952) observations to the present, has been obtained. Variations in the amplitude of the light curve from cycle to cycle were observed. The (*B-V*) and (*U-B*) variations have also been obtained. The position of the resulting typical short-period pulsating-variable loop in the (*B-V*), (*U-B*) diagram suggests this variable may be slightly reddened.

Flux Density Measurements of Planetary Nebulae at 1415 and 750 Mc/sec. MAY A. KAFTAN-KASSIM, *NRAO, Green Bank*.—Forty-nine planetary nebulae with measured $H\beta$ fluxes (Collins,

Daub, and O'Dell, *Astrophys. J.* **133**, 471, 1961; O'Dell, *Astrophys. J.* **138**, 293, 1963) were observed with the 300-ft radio telescope at Green Bank at frequencies of 1415 and 750 Mc/sec. The beamwidths are approximately 10' and 18', respectively. Thirty of those had measurable 1415 Mc/sec flux with a detection limit of 0.1 flux units and rms errors of 0.03 flux unit. At 750 Mc/sec only 18 were measured with a detection limit of 0.3 flux unit and rms errors of 0.07 flux unit.

Combining these measurements with those of Slee and Orchiston at about 2700 Mc/sec (Slee and Orchiston, *Australian J. Phys.* **18**, 187, 1965) and also those of Davies, Ferriday, Haslam, Moran, and Thomasson (Davies, Ferriday, Haslam, Moran, and Thomasson, *Nature* **206**, 809 1965), tentative spectra were obtained. As expected, most of the sources exhibit the flat spectrum of a thermal, optically thin nebula. Five planetaries IC 418, NGC 6543, NGC 7662, NGC 6826 and NGC 6572 show evidence of self-absorption even at 1415 Mc/sec. Nonthermal spectra with negative slopes of about -1 are found at the positions of NGC 6741, NGC 6781, and NGC 6833. NGC 3242 has a slope of -0.5 , but the position of 750 Mc/sec source is displaced from the optical position. All these nonthermal sources are either broadened, show structure, or are slightly displaced in position and the contribution from confusing sources cannot be ruled out.

A check on O'Dell's distance scale for the planetary nebulae (O'Dell, *Astrophys. J.* **135**, 371, 1962) can be made with the present data. An excellent correlation is obtained between the surface brightness at 1415 Mc/sec and $1/R^2$, where R is the radius of the nebula as obtained by O'Dell. A constant value is thus obtained for $F_{1415} \times (\text{distance})^2$ or total emitted flux. This indicates that the model used of completely ionized shells of approximately the same mass is essentially correct and hence also the distance scale based on this model.

The Expansion of the Orion Nebula. JAMES B. KALER, *University of Illinois Observatory*.—The spectrum of the Orion Nebula has recently been studied in detail by Kaler, Aller, and Bowen (*Astrophys. J.* **141**, 912, 1965). The principal plate of this study was taken at the coudé focus of the 100-in. telescope by Dr. I. S. Bowen, and also measured by him for wavelengths and identifications. These measurements have now been used to obtain radial velocities in the Orion Nebula for individual ions. Radial velocities relative to the average radial velocity of all the hydrogen lines were obtained for all the accurately measureable lines on the plate. If these velocities are plotted against ionization potential, it