components of the Si IV doublet and the unresolved C IV doublet are found in ζ , ϵ , and ι shifted to shorter wavelengths by several angstroms. The Si IV doublet is also present in δ , shifted in a similar way. The velocities corresponding to these shifts are indicated in the table. The value for ι is uncertain because of poor lines and a lack of unshifted features for checking the wavelength scale. These displaced absorption features must be formed by gas escaping from the stars at high velocities indicating a significant mass loss from these early type giants and supergiants. Rough limits on the rate of mass loss can be obtained by assuming that the broadening of the lines is entirely by either Maxwellian Doppler velocities or radiation damping. For the widths of the lines in ζ Orionis the Doppler model gives $\sim 10^{-6} M_{\odot} \text{ yr}^{-1}$ while damping gives $\sim 10^{-4} M_{\odot} \text{ yr}^{-1}$.

Absorption lines about 8 Å wide are also visible at 1216 Å in ζ and δ , and are attributed to Lyman- α absorption by interstellar hydrogen atoms. Assuming broadening by radiation damping, the width corresponds to $\sim 10^{20}$ atoms cm^{-2} in the line of sight.

Predicted Coronal Lines in the Instrumental Infrared. GUIDO MÜNCH, *Mt. Wilson and Palomar Observatories*.—The ions Mg^{7+} , Al^{8+} , Si^{9+} , with $2s^22p$ ground state configurations and ionization potentials IP of 266, 330, and 401 eV, produce coronal lines at wavelengths near 3.032, 2.047, and 1.431 μ . The ion Si^{8+} with $2s^22p^2$ ground state and IP=351 eV produces lines at 2.587 and 3.859 μ . An estimate of the strength of these coronal lines has been made on the basis of assumed abundances and approximate theories of ionization and excitation. It has been found that the lines of Mg^{7+} , Si^{8+} , and Si^{9+} should be as strong as the iron coronal lines in the photographic region. In consideration of the detectivity of infrared detectors (PbS), estimates have been made of the signal to noise ratios that may be reached with optics of practical size during a total solar eclipse. The effects of atmospheric absorption have been taken into account to the extent justified by the uncertainties affecting the predicted wavelengths of the lines. The probability that the lines will be observable from ground notwithstanding atmospheric absorption and that they can be detected appear fairly high.

A Study of Active Regions in the Solar Corona Observed by OSO-I. WERNER M. NEUPERT, *NASA Goddard Space Flight Center*.—The extreme ultraviolet solar spectrum, including emission lines from nine successive stages of ionization of iron, was observed by OSO-I from March through June 1962. Iron line emission from specific active regions existing on the sun during that interval has been estimated

for successive solar rotations by comparing data acquired when only a single active region or a group of equivalent regions, appeared on the disk, to data taken in the absence of such regions. Fluxes at radio frequencies are analyzed in the same manner and are compared to the ultraviolet observations. The relative merits of the two types of measurements in determining coronal temperatures and densities is discussed. These data, combined with Ca^+ plage observations and limb observations of coronal forbidden lines, are applied to a schematic coronal model to obtain physical conditions in the coronal region associated with a Type E sunspot group at various states in its development. Using the ionization equilibrium for iron calculated by Burgess and Seaton (*Monthly Notices Roy. Astron. Soc.* **127**, 355, 1964), we infer an electron temperature of 4.2×10^6 °K and a density increase of approximately 10 times quiet coronal values at the time maximum development of the spot group. Under these conditions Fe XVI and Fe XVII represent the predominant stages of ionization of iron. Both temperature and density decrease as activity diminishes. For the region above the residual plage, after all spots have disappeared, we obtain 3×10^6 °K and a density of two or three times quiet coronal values. Additional properties of a model of the active region, including the abundance of iron, are discussed.

Radiation Spikes in H II Regions. THORNTON PAGE, *Wesleyan University and Smithsonian Astrophysical Observatory*.—Gravitational deflection of light, discussed by F. Zwicky [*Morphological Astronomy* (Springer-Verlag, Berlin, 1957), p. 215, 1957] and Stanley Liebes (*Phys. Rev.* **133**, B835, 1963) produces a long thin region of high radiation density behind a dense mass, M illuminated by a light source of radius R_0 at distance d . The flux density at distance z from M and y cm off-axis is

$$E(y,z) = \frac{2\pi I_0 R_0^2}{y} \left[\frac{GMz}{c^2(z+d)^3 d} \right]^{\frac{1}{2}}.$$

If the light source is a hot star, or supernova, or quasi-stellar object, and if there are hydrogen clouds nearby, an H II region will be formed to distance s_0 from the source (Strömgren, *Astrophys. J.* **89**, 526, 1939) where the flux density is

$$E_0 = 2\pi I_0 R_0^2 / s_0^2$$

and I_0 refers to the surface brightness of the source in Lyman continuum.

From these two equations, the contours of H II regions behind dark masses have been calculated. However, the absorption by un-ionized hydrogen near the throat of the spike reduces its length, and