where $I_d d\nu d\omega$ is the incident pencil of radiation, $\frac{1}{2}r_0^2(1 + \cos^2 \vartheta)$ is just the Thompson scattering-cross section, $1 - 2.5\Delta\lambda/\lambda + \epsilon$ represents the first order relativistic departures from Thompson scattering, ϵ being a very small quantity independent of the position in the line. The next factor represents the dispersion due to the Doppler effect with its maximum shifted to the red by the Compton shift δ .

The dispersion or half width of the frequency distribution is

$$D = 7.35 A \frac{\lambda}{4000} \left(\frac{T}{10,000} \right)^{\frac{1}{2}} (1 - \cos \vartheta)^{\frac{1}{2}}. \quad (4)$$

The position of the maximum is found by differentiating (3). This gives the resulting shift for single scattering

$$\delta\lambda = 0.024 A \left[1 - 1.4 \left(\frac{\lambda}{4000} \right) \left(\frac{T}{10,000} \right) \right] (1 - \cos \vartheta). \quad (5)$$

In the table the dispersion and shift are given in Angstrom units along with the velocity corresponding to these shifts for a number of different temperatures.

$\lambda = 4000 \text{ \AA}$ Temperature	Disp.	Shift	$\vartheta = 90^\circ$ km/sec
10,000°	7.4 A	-0.010 A	- 0.75
20,000	10.4	- .045	- 3.4
40,000	14.6	- .113	- 8.2
60,000	18.0	- .185	- 13.0
80,000	20.8	- .25	- 19.0
100,000	22	- .32	- 24.0
500,000	52	-1.7	-128
1,000,000	74	-3.4	-255

These results are directly applicable to the light of the inner K-corona where it is almost wholly due to single scattering by electrons. The Fraunhofer lines are very shallow nearly invisible depressions broadened by electron scattering and shifted about -150 km/sec to the violet (if the temperature is 50,000°) due to scattering with a shift to the red due to the ejection velocities superimposed on this shift.

For application to stellar atmospheres appeal must be made to the equation of transfer, in which the contribution to the source function by electron scattering is found by integrating (3) over all solid angles and wave lengths. The transfer problem in the approximation where the shift is neglected has been investigated by G. Münch. The broadening is found to be most important in the wings. The effect of multiple scattering on the shift has been considered by S. Chandrasekhar, where it is found that for sufficiently great optical depths in electrons the shift is several times the basic single scattering shift of the table. The shift is most important in the center of a line, therefore it is reasonable to assume that the center of a line will be given by the application of Chandrasekhar's solution and the wings will behave in the manner described by Münch.

Since this process has a mechanism for both

broadening and shifting lines, a phenomenon familiar in extremely hot stars such as Wolf-Rayets, it is important to determine the part played by electron scattering. Further it is tempting to hope that electron scattering may assist in explaining the γ -line anomaly believed to exist in some Wolf-Rayet binaries, the negative K term found by Shajn for B and A supergiants and the difficulties that are encountered in explaining Wolf-Rayet-like nuclei of some planetary nebula for which the nebula does not share any of the 1000 km/sec or so of the expansion inferred from the nuclear spectrum.

Calculations of a model stellar atmosphere for an O 9 supergiant indicate that the optical depth in electrons above the layers in which the lines are formed is between 1 and 2, which is sufficient to produce important effects. In general one may say that if the effective gravity is very low, as is required in early supergiants in order to explain the intensity ratios of various lines, and if the temperature is high, then electron scattering plays a predominant role. Wolf-Rayets meet these requirements for there the effective gravity is apparently near zero if matter is to be thrown off.

The work now in progress is to calculate model stellar atmospheres for hot stars in order to determine the optical depth in electrons, to determine the effect of radiation pressure in reducing the gravity and finally to consider the transfer problem in extended spherical atmospheres which will enhance the effect of electron scattering.

*Yerkes Observatory,
Williams Bay, Wis.*

Dodson, Helen W. and Ruth Hedeman. Positions of solar flares within a spot group.

The 50-foot tower telescope and Stone spectroheliograph of the McMath-Hulbert Observatory were used during the recent sun spot maxi-

imum to secure continuous photographic records of active areas during the sunlit hours of their transit across the solar disk. The records for three of these areas, viz. Mount Wilson No. 8129, 8745, and the complex region comprising the three spots 8767-8769 have been examined for data regarding the detailed position of flares. The results of the analysis can be summarized as follows:

- (1) Some flares appear as long bright ropes or filaments; others as small bright dots. The composite plot or locus of flare positions, however, suggests a certain underlying continuity for both types; flares seem to lie along axes or chains, some of which are curved.
- (2) Flares occur repeatedly in the same location.
- (3) Although flares occur most often in the region between spots, or close to and over the penumbrae of spots, they do, upon occasion, seem to occur exactly over the umbrae of spots.
- (4) Many flares seem to follow, in part, channels already established by the dark filaments (prominences seen in projection). The relationships are not clear: some flares apparently lie along the sides of filaments; in other cases, they seem to form limiting boundaries; at still other times, the phenomena appear to be independent.
- (5) Although some filaments have been observed to disappear shortly after the outbreak of a great flare, the spectroheliograms here studied indicate that certain filaments can persist even though they are adjacent to, or even apparently over, a bright flare.

*Observatory, University of Michigan,
Ann Arbor, Mich.*

Edmondson, F. K., Edith M. Janssen and A. N. Vyssotsky. Luminosity distribution and secular parallaxes of tenth magnitude K stars.

As reported previously¹ spectrograms have been obtained in connection with Edmondson's radial velocity program for some 700 tenth magnitude Ko and K2 stars selected from the *McCormick Proper Motion Catalogues*.² Classification of these according to the Yerkes two-dimensional system³ has been carried through by Miss Janssen, who had, at the time, no

information as to the positions of the stars in the sky, nor as to their proper motions. This classification indicates that 21 of the stars are earlier than G8 or later than K3; 47 additional spectrograms cannot be classified accurately. The luminosity distribution of the remaining stars is given in the second and third columns of Table I. Here 355 stars contribute to the percentages in low latitudes, and 313 to those in high latitudes. A combination of these percentages with the numbers of Ko and K2 stars between magnitudes 10.0 and 11.0 in the *Second McCormick Catalogue* gives the numbers of stars per ten square degrees; these appear in the last two columns of Table I. Preliminary values for the secular parallaxes of the four luminosity groups are given in Table II. It will be noticed that these are not as yet based on the entire material.

TABLE II. CENTENNIAL SECULAR PARALLAXES

Group	No. of stars	Mag.	$\overline{h/r}$
Luminosity > III	21	10.4	$0.6 \pm .4$
III	383	10.4	$0.9 \pm .1$
III > Lum. > V	141	10.5	$1.6 \pm .2$
V	55	10.6	$4.0 \pm .7$

A comparison of the luminosity distribution in low latitudes with that derived from Stenquist's spectrophotometric study⁴ is given in Table III. Here the limiting absolute magnitudes

TABLE III. COMPARISON WITH STENQUIST

Stenquist M_{pv}	0°-20° per cent	E., J., & V. Luminosity	0°-30° per cent
Btr. than -0.5	4	Btr. than III	4
-0.5 to +1.5	70	III	70
+1.5 to +4.5	21	III > Lum. > V	20
+4.5 and ftr.	5	V	6

for the arbitrary luminosity groupings of Stenquist's material have been chosen so that the percentages may be about the same as those in our own low latitude material. In other words this is an indirect method of assigning luminosity limits for the Yerkes classes. The secular parallaxes indicate somewhat fainter mean luminosities in the first two groups, if interstellar absorption is neglected. The mean absolute magnitudes derived from the secular parallaxes of the last two groups are 3.3 and 5.3 respectively.

1. *A. J.* **54**, 35, 1948.
2. *Pub. McCormick Obs.* **7**, 1937 and **10**, 1948.
3. Morgan, Keenan and Kellman, *Atlas of Stellar Spectra*, 1943.
4. *A. J.* **53**, 83, Table 8.IX, 1948.

*Goethe Link Observatory,
Indiana University,
and McCormick Observatory,
University, Va.*

TABLE I. DISTRIBUTION OF TENTH MAGNITUDE K STARS

Latitude	Percentages		Frequencies	
	0°-30°	31°-90°	0°-30°	31°-90°
Luminosity > III	4	3	2	$\frac{3}{4}$
III	70	59	37	15
III > Lum. > V	20	26	11	6
V	6	12	3	3
Total	100	100	53	25