THE SPECTRA OF THE BRIGHT STARS OF TYPES F5–K5

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ABSTRACT

Spectral types and luminosity classes have been obtained for 641 stars in the spectral range F5–K5 brighter than 5.50 visual magnitude and north of declination -20°. These types show the well-known absence of subgiants later than K1 and, in addition, show that the stars near zero absolute magnitude become plentiful extremely abruptly between G5 and G8. In the range G0–G5 we have 4 giants; at G8 we have 67. Color-magnitude diagrams show that this change occurs in a very small range of temperature.

New calibrations of the absolute magnitudes are made for all spectral types and luminosity classes which contain enough stars to yield significant results. For the most part these agree well with older determinations. A surprising result is that the K0 III–K2 III stars are about 0.8 mag. fainter, on the average, than the giants at G8 and in the classes K3–K5. That this is not merely a systematic effect in the classification is shown by the fact that the mean absolute magnitudes for all stars of luminosity classes II–IV show the same phenomenon.

Space velocities corrected for the solar motion have been computed for each star fainter than luminosity class II. In the spectral range G8–K1 it is found that spectroscopic differences exist among stars of the same spectral type and luminosity class. If these stars are separated spectroscopically, it is found that the velocity distributions within the different groups are also different. The two groups which contain 85 per cent of the stars are about equally numerous. They are separated by the fact that the G band and λ 4226 of *Ca* I are stronger relative to the remainder of the spectrum in one group than they are in the other. The velocity distributions indicate that the group with the stronger G band and λ 4226 is dynamically related to the group of weak-line stars in the earlier types and that the other group is dynamically related to the strong-line stars. In addition, two other groups exist which are characterized by peculiarities in the cyanogen absorption. One of these has fairly strong cyanogen which is characterized by a peculiar appearance of the region near λ 4150 and by a strengthening of the absorption in this region compared to that near λ 4120. Dynamically, these stars cannot be distinguished from the weak-line group. The fourth group is characterized by unusually weak cyanogen absorption. As has been known for some time, these stars are the "high-velocity" stars. Although some members of this group have fairly low velocities and some members of the weak-line group have fairly high ones, the mean velocities of the stars with weak *CN* is 95 km/sec, as compared to a mean of 41 km/sec for the weak-line group.

I. INTRODUCTION

As part of a program instigated some years ago by Dr. W. W. Morgan, covering all spectral types, spectra have been obtained of all nonvariable stars brighter than visual magnitude 5.50, north of declination -20°, and with Henry Draper spectral types in the range F0 to Ma. The revised types of 693 of these stars are in the interval F5–K5 inclusive. These spectra form an important collection of data for statistical studies of stars in this spectral range, both alone and combined with the large amount of additional data available for these stars. The majority have measured trigonometric parallaxes, all but a few binaries without orbits have published radial velocities, and all the stars have well-observed proper motions.

Of the 693 stars, 41 probably have composite spectra either because they are unresolved binaries or because they are visual binaries too close to separate on the slit-head of the Yerkes 40-inch spectrograph. These have been omitted from this discussion. In addition, 11 of the stars do not appear to belong anywhere on the normal Hertzsprung-Russell diagram. These will be discussed individually in the notes to Table 4. For each of the remaining 641 stars a spectral type, luminosity class, spectroscopic parallax and absolute magnitude, and, except for the supergiants, a space velocity have been determined. In addition, new calibrations have been made of the absolute magnitudes in many parts of the spectral type–luminosity class diagram, and the distributions of the stellar speeds have been discussed.

II. SPECTRAL TYPES

Each of the stars has been classified on the system of the Yerkes spectral atlas,[1] except that two minor changes in that system have been suggested recently by Dr. Morgan.[2] The stars of types F5–F8, such as β Del and υ Peg, which were previously assigned to luminosity class III, have now been assigned to luminosity class IV, and the former class IV stars, such as α CMi, have been included in class IV–V. The reason for this change is the fact that spectra of the stars of the older class III resemble the stars of class V more closely than those of class I*b*. The class III stars of types G2–K1 have been reclassified using new criteria and a system of types for the standard stars which provides a better correlation of spectral type with color. Dr. Morgan prepared a new list of standards for the types G8–K1 about a year and a half ago, basing his classification primarily on the appearance of the G-band region and, to a lesser extent, on the strength of λ 4226 of *Ca* I. For reasons mentioned below, the present author has also considered the strength of the hydrogen lines as an indicator of spectral type at G8 and K0 after the luminosity class of the star has been accurately determined. The use of this additional criterion does not change the spectral type assigned to any of the standard stars, nor does it lessen the correlation of spectral type with color.

Figure 1 illustrates the correlation between the Henry Draper and the revised spectral types. On the average, the agreement is good. The most notable features are the concentration of the HD G5 stars at G8 on the present system, the widespread and almost uniform distribution of the HD type K0 stars over the revised range G8–K3, and the sparing use of the types F8 and K2 in the *Henry Draper Catalogue*. Also, the mean revised type for the stars which were classified K2 in this catalogue is almost as late as K4. As mentioned in the preceding paragraph, the colors confirm the revised type G8 for most of the HD G5 stars. The mean color for the G8 giants is very nearly four-fifths of the way from that of the G0 giant to that of the K0 giants, and a smooth progression in color from class V to class II is preserved for each spectral type on the revised system. The relative scarcity of K1 stars in the revised types is probably a systematic effect in the present classifications, since the decision to use this type was not made until after the preliminary classifications were finished. However, the accuracy possible in the classification seems to warrant the use of this type.

Figure 2 shows the number of stars in each region of the spectral type–luminosity class array as well as the divisions in luminosity used at each spectral type. Two supergiants have been omitted, HR 8752 at G0 I*a* and ψ^1 Aur at K5 I*ab*. The supergiants are distributed uniformly in spectral type, and the low-luminosity stars show their expected behavior. The latter are plentiful at F5 and gradually diminish in number toward later spectral types and, hence, toward lower absolute magnitudes. This behavior is due to the selection effect introduced by the bright limiting apparent magnitude. However, other features of the diagram cannot be explained this easily. The most striking of these is the very sudden onset of giants at G8. Even on the older system the onset was fairly sudden at G5 but the new classifications have sharpened the boundary appreciably. Between G0 and G5 we have 4 stars in luminosity class III (i.e., as we shall see later, with absolute magnitudes near 0.0 mag.), while at G8 we have 67. The strong concentration of giants persists to later spectral types also, thinning out only gradually by K5. The stars in luminosity classes III–IV, II–III, and even II indicate the existence of the same phenomenon. An equally striking feature is the lack of stars fainter than the class III stars and later than K1. This cannot be due solely to selection effect, since the absolute magnitudes of these stars would be no greater than those of the F dwarfs and certainly not sufficiently lower

[1] Morgan, Keenan, and Kellman, *An Atlas of Stellar Spectra* (Chicago: University of Chicago Press, 1943).

[2] Private communication.

than the absolute magnitudes of the stars of the same luminosity class at G8 to account for their complete disappearance at K2.

III. ABSOLUTE MAGNITUDES

The existence of good proper motions and trigonometric parallaxes for the stars brighter than 5.5 mag. makes these stars useful for calibrating the luminosity classes in terms of absolute magnitude. For this reason new values of the mean absolute magnitudes have been determined for those classes which contain a sufficient number of stars brighter than this limit to make the new calibration useful.

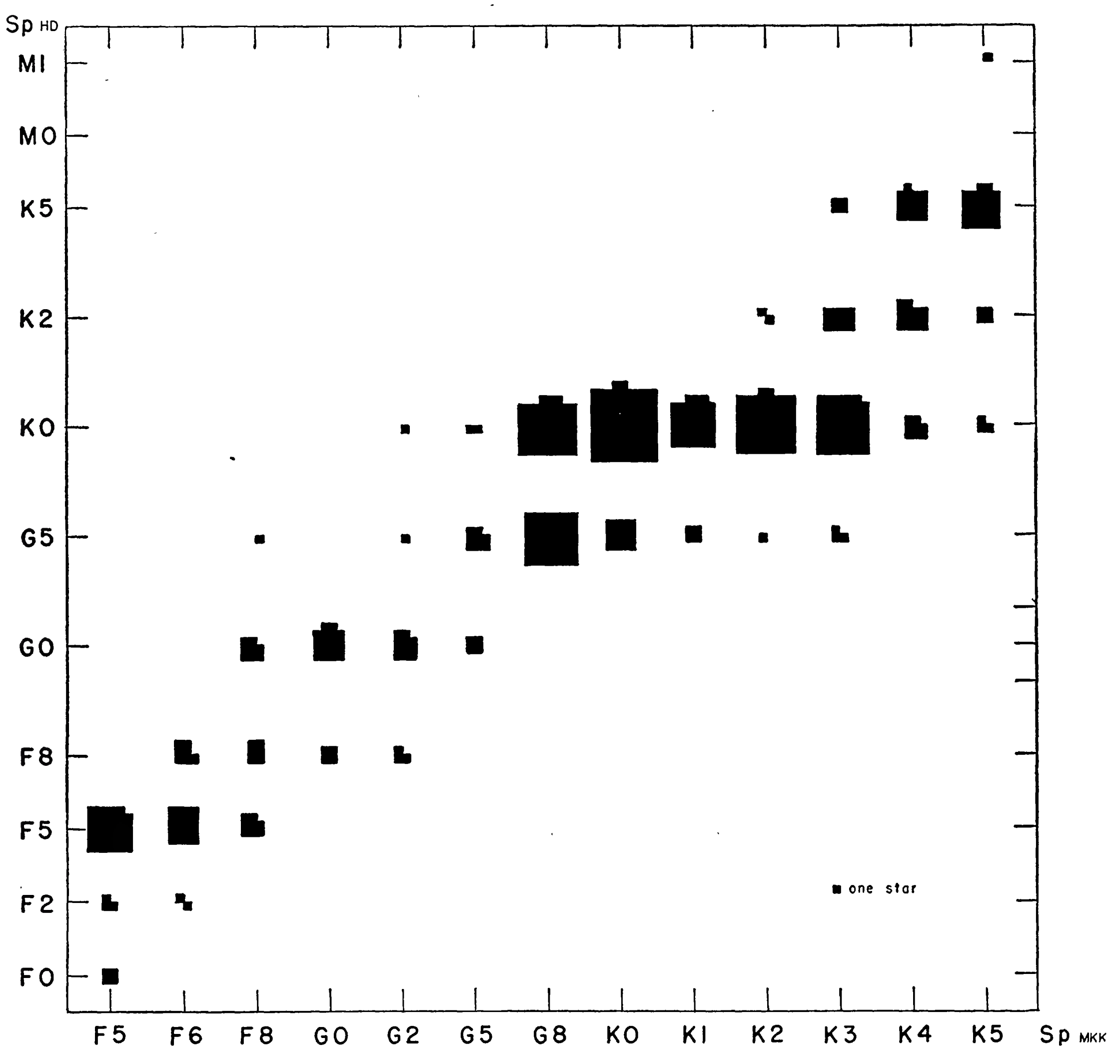

Fig. 1.—The correlations between the HD spectral type and the types on the system of the Yerkes spectral atlas. The area of each block represents the number of stars at that point on the diagram.

For stars with appreciable trigonometric parallaxes, i.e., for stars in luminosity classes with mean absolute magnitudes fainter than −0.5 mag., the mean trigonometric parallax was computed for each group. For each star with more than one determination of its trigonometric parallax, individual values from Allegheny, Cape, Greenwich, McCormick, and Yale Observatories were averaged with equal weight, unless the probable errors of the individual determinations differed considerably. These values were taken from the back of the *General Catalogue of Stellar Parallaxes* (Yale, 1935). The resulting value was then reduced to the parallax which the star would have if it had the apparent magnitude 5.00 instead of its actual apparent magnitude. Negative parallaxes were divided by the same factor by which they would have had to be multiplied if they had been positive. These values were then averaged, weighting the value for each star according to the number of independent determinations. Although the parallaxes of most of the stars are too small to be of any use individually, the agreement among the reduced parallaxes is surprisingly good. If anything, the mean errors given in Table 1, which

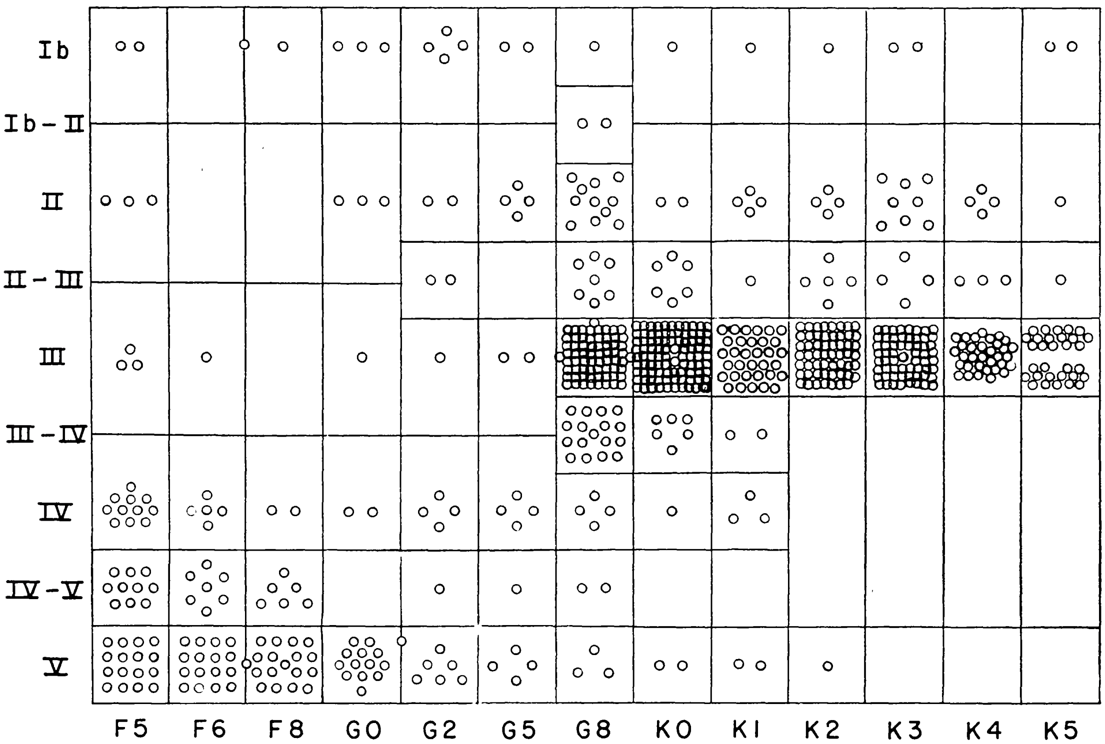

FIG. 2.—The spectral type–luminosity class array for the bright northern stars. Each circle represents one star. The lines indicate the number of types usually distinguished. Circles centered on a line indicate stars with in-between types.

have been computed on the assumption that one good determination of a trignonometric parallax has a mean error of 0".010, is overestimated. After this work had been completed, Dr. Strömgren pointed out[3] that it would be preferable to use the observed parallaxes directly. If an estimate is made of the mean absolute magnitude of a group of stars and is used to compute spectroscopic parallaxes, then a comparison of the mean unreduced trigonometric and the mean spectroscopic parallaxes will indicate the correction which must be applied to the assumed absolute magnitude. For three groups in different parts of the spectral type–luminosity diagram, this method was used. The results agreed with the first results within the mean errors of the determinations.

For groups with mean absolute magnitudes brighter than +3.0 the mean parallax was also computed from the proper motions. The observed motion for each star was also reduced to the value it would have if the star were actually of apparent magnitude 5.00. The sky north of declination −20° was divided into nine regions of approximately equal

[3] Private conversation.

TABLE 1

MEAN PARALLAXES

Spectral Type	Method	Number of Stars	$\bar{\pi}$ (m=5.00)	10+5 log $\bar{\pi}$	Adopted $\bar{M}$
F5 IV–F8 IV	$\bar{\pi}_{tr}$	14	0″.0227±0″.0018 m.e.	+1.8±0.2 m.e.	+1.9
F5 IV–F8 IV	$\bar{\mu}$	19	.0287 .0032	+2.3 .2	
F5 IV–V—G2 IV–V	$\bar{\mu}$	26	.0357 .0025	+2.8 .2	....
F5 IV–V—F6 IV–V	$\bar{\pi}_{tr}$	15	.0390 .0020	+3.0 .1	+2.8
F8 IV–V; G0 IV–G2 IV	$\bar{\pi}_{tr}$	9	.0421 .0023	+3.1 .1	+2.9*
F5 V	$\bar{\pi}_{tr}$	13	.0463 .0020	+3.3 .1	+3.3
F6 V	$\bar{\pi}_{tr}$	15	.0554 .0021	+3.7 .1	+3.6
F8 V	$\bar{\pi}_{tr}$	17	.0546 .0016	+3.7 .1	+3.9
G0 V–G2 V	$\bar{\pi}_{tr}$	19	.0786 .0016	+4.5 .0	+4.4*
G5 II–K5 II	$\bar{\mu}$	34	.0032 .0005	−2.5 .3	−2.6
G8, K0 II–III	$\bar{\mu}$	9	.0069 .0015	−0.8 .5	−0.9*
K1 II–III—K5 II–III	$\bar{\mu}$	14	.0066 .0018	−0.8 .6	−0.9*
G8 III	$\bar{\mu}$	65	.0088 .0010	−0.2 .2	
G8 III	$\bar{\upsilon}$	65	.0057 .003:	−1.1 ...	0.0
G8 III	$\bar{\pi}_{tr}$	49	.0114 .0012	+0.3 .2	
K0 III	$\bar{\mu}$	86	.0162 .0014	+1.0 .2	+0.7
K0 III	$\bar{\pi}_{tr}$	71	.0136 .0010	+0.7 .2	
K1 III	$\bar{\mu}$	32	.0148 .0009	+0.9 .1	+0.8
K1 III	$\bar{\pi}_{tr}$	22	.0155 .0017	+1.0 .2	
K2 III	$\bar{\mu}$	61	.0147 .0015	+0.8 .2	+0.9
K2 III	$\bar{\pi}_{tr}$	46	.0166 .0012	+1.1 .2	
K3 III	$\bar{\mu}$	59	.0114 .0016	+0.3 .3	+0.1
K3 III	$\bar{\pi}_{tr}$	42	.0106 .0012	+0.1 .2	
K4 III	$\bar{\mu}$	31	.0098 .0019	+0.0 .4	−0.1
K4 III	$\bar{\pi}_{tr}$	25	.0106 .0015	+0.1 .3	
K5 III	$\bar{\mu}$	31	.0090 .0007	−0.2 .2	−0.2
K5 III	$\bar{\pi}_{tr}$	26	.0095 .0016	−0.1 .4	
G5—K0 III–IV	$\bar{\mu}$	22	.0193 .0029	+1.4 .3	+1.3*
G5—K1 III–IV	$\bar{\pi}_{tr}$	19	.0187 .0019	+1.4 .2	
G5—K0 IV	$\bar{\pi}_{tr}$	6	.0526 .0044	+3.6 .2	+3.5*
K1 IV	$\bar{\pi}_{tr}$	3	0.038 0.004	+2.9 0.2	+2.9

* Individual mean absolute magnitudes were adopted as shown below.

F8 IV–V	+3.0	G8 II–III	−1.0	K1 III–IV	+1.3
G0 IV	+2.6	K0 II–III—K2 II–III	−0.8	G5 IV	+3.2
G2 IV	+2.9	K3 II–III—K5 II–III	−1.0	G8 IV	+3.5
G0 V	+4.3	G8 III–IV	+1.3	K0 IV	+3.5
G2 V	+4.6	K0 III–IV	+1.4	K1 IV	+2.9

area, and the mean proper motion was determined in each region. These mean motions were then used to compute mean parallaxes according to the formulae given by Smart.[4] These formulae involve the assumptions that the two-stream picture of stellar motions is valid and that there are an equal number of stars in each stream. In addition, the amount of the solar motion and the stream constants are required for their application. A solar motion of 20 km/sec was adopted.[5] For the stream constants the values found by Smart and Tannahill[6] in their study of the Cape proper motions were used. These formulae have the advantage that they make use of the total proper motion rather than just one component of this motion. As the observational errors in the proper motions are relatively small, each star was given equal weight in the solution. The mean error of the results is computed from the agreement of the results from individual regions of the sky.

The results of the solutions for the mean parallaxes are given in Table 1. In this table, π denotes parallax; μ, the total proper motion; υ, the component of the proper motion parallel to the solar motion; m, the visual apparent magnitude of a star; and M, the visual absolute magnitude of a star. It is evident that where the two methods of determining the mean parallax overlap the agreement between them is good. This table also gives the absolute magnitudes, found by assuming that all stars in each group have the same absolute magnitude, together with the approximate mean error of these values as indicated by the mean errors of the mean parallaxes. To obtain the true mean absolute magnitude, the correction $0.23\sigma_M^2$ must be applied where σ_M is the standard deviation of the absolute magnitudes of the stars in the group. It was estimated that this correction is about +0.1 mag., except for the dwarfs earlier than G0 for which the correction was ignored. This correction has been included in the adopted visual absolute magnitudes given in the final column of Table 1. A few values in this column, for the F stars and the class II–III stars in the range G8–K5, have been smoothed somewhat.

Figure 3 shows a plot of the adopted visual absolute magnitudes in this region of the H-R diagram. The points connected by dotted lines are from an article by Keenan and Morgan.[7] The remainder are from the new solutions. Of particular note is the sharp drop in absolute magnitude for the giants between G8 and K0, followed by the equally steep rise between K2 and K3. The results in Table 1 leave little doubt that this behavior is real. In addition, the second method of employing the trigonometric parallaxes mentioned above also supports the sharp drop between G8 and K0. Finally, at G8, an additional solution was made, using the upsilon components of the proper motion. This solution has decidedly less weight than that using the total proper motions, both because of the loss of one component of the motion and because of the varying weights in different parts of the sky and, hence, the low weight in some regions. However, it supports the high luminosity at G8 III. The point at K1 IV is uncertain, but it is definitely above the point for K0 IV.

Table 2 gives the mean absolute magnitude for each spectral type for all luminosity classes except class I and, for stars later than the sun, class V. The stars omitted are too few to have much real influence on the mean, but they lie far enough from the mean to cause spurious fluctuations from one spectral type to the next. Although these mean absolute magnitudes refer only to the stars in this study and may not be valid for other groups of stars, such as those in a particular galactic latitude or with fainter apparent magnitudes, they do illustrate the characteristics of this material. The mean absolute magnitudes for the stars earlier than G5 behave as one would expect. Among the later-type stars the same behavior can be noted as was found in the giants of these classes.

[4] *Stellar Dynamics* (Cambridge: At the University Press, 1938).

[5] Based on the results of Nordström, *Lund Medd.*, Ser. II, No. 79, 1936.

[6] *M.N.*, **100**, 30, 1939.

[7] *Astrophysics*, ed. J. A. Hynek (New York: McGraw-Hill Book Co., 1951).

Hence this behavior is not a product of the classification system. If we omit the dwarfs, the K0–K2 stars are definitely fainter as a group than are those stars either at G8 or later than K2.

The data shown in Figures 2 and 3 are combined in Figure 4, which illustrates a schematic color-magnitude diagram for the stars included in this study. The mean color for each spectral type and luminosity class was determined from the $B-V$ colors measured by H. L. Johnson.[8] The area of the color-magnitude diagram was then divided

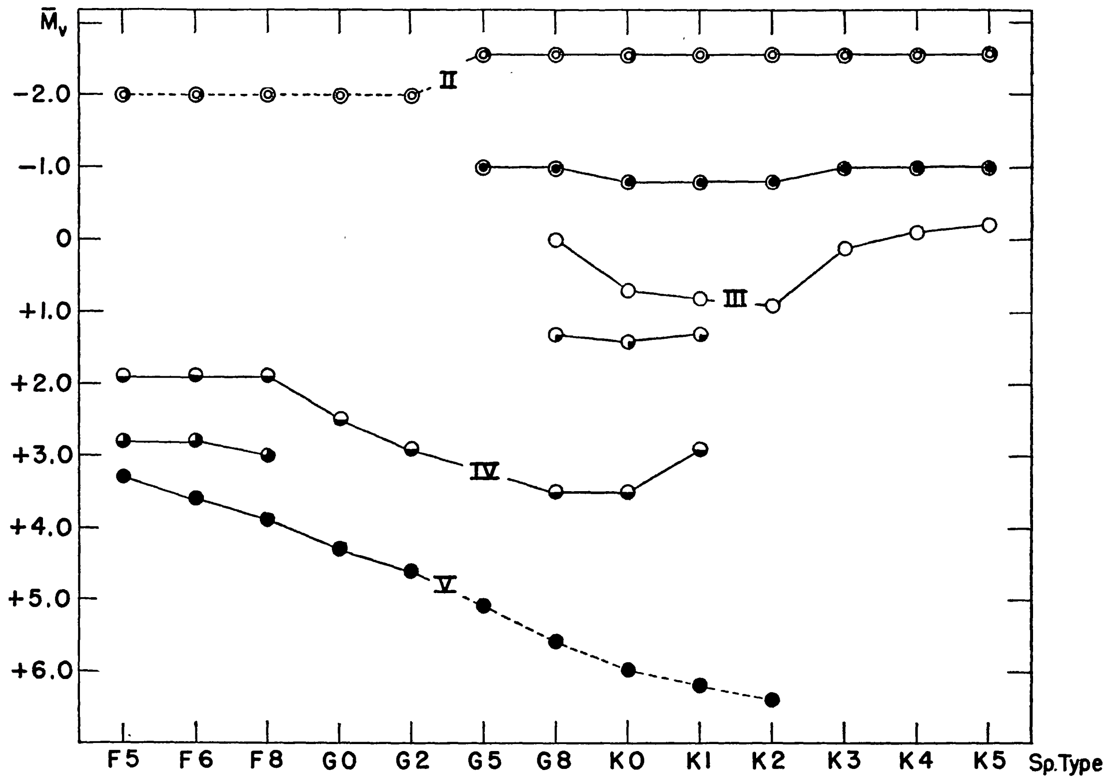

FIG. 3.—Mean absolute magnitudes for stars in the range F5–K5. Roman numerals indicate the main luminosity classes. The remaining lines are for luminosity classes II–III, III–IV, and IV–V. The dotted lines connect values given by Keenan and Morgan. The remaining points are based on new results.

TABLE 2

MEAN ABSOLUTE MAGNITUDES TO LIMITING MAGNITUDE 5.50 FOR MIXED LUMINOSITY CLASSES

Spectral Type	$\bar{M}$	Spectral Type	$\bar{M}$
Classes II–V:		*Classes II–IV:*	
F5	+2.2	G5	+0.7
F6	+3.0	G8	+0.1
F8	+3.5	K0	+0.6
G0	+3.2	K1	+0.6
G2	+2.1	K2	+0.5
		K3	−0.3
		K4	−0.4
		K5	−0.3

[8] *Ap. J.* (in press).

into cells, each centered on the mean $B-V$ and mean absolute magnitude, on the HRP system, for the stars in a given cell in the spectral type–luminosity class diagram and with the boundaries approximately midway between adjacent centers. In each of the cells constructed in this way, a circle was drawn for each star found to have the corresponding spectral type and luminosity class. Hence no circle on the diagram represents a particular star, but the result should be similar to that which we would obtain if we knew the color and absolute magnitude for each star individually. However, the width of the giant sequence for the late-type stars is indeterminate. Figure 4, again, shows the same features

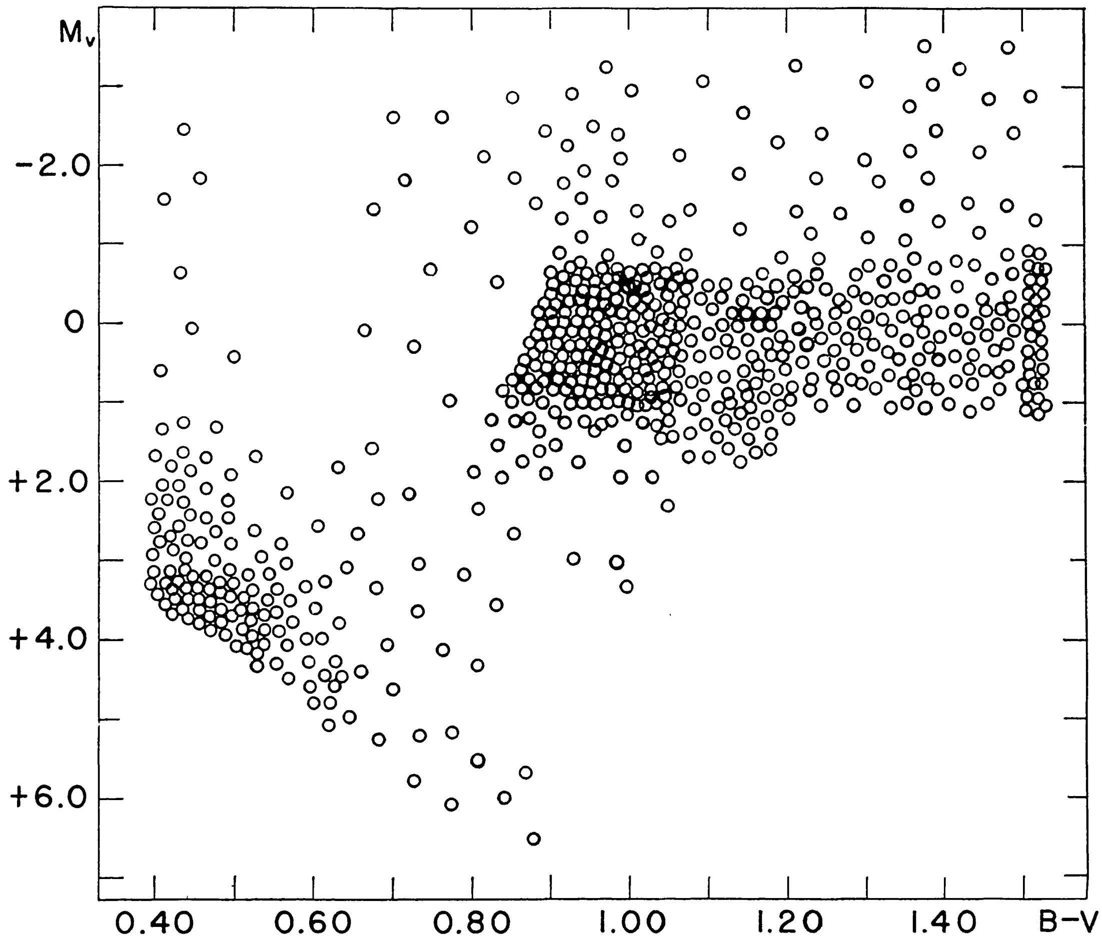

FIG. 4.—A schematic color-magnitude diagram for the bright northern stars. Each circle represents one star, but not a particular star.

as Figure 2. Stars with absolute magnitudes greater than +2.0 are entirely absent for colors greater than 1.4 mag., and stars with absolute magnitudes between −1.0 and +1.0 are scarce for colors between 0.45 and 0.82 mag. On this diagram the spectra merely form an intermediate step in obtaining the position of a given star. Hence the sharp onset for the late-type giants is probably real. If it is not real, then the giants are even more crowded at the color 0.85 or 0.86 mag., since the mean color of the stars cannot be changed appreciably.

The general features shown in Figure 4 are not new. In 1913 H. N. Russell made the statement: "It is further noteworthy that all the stars of classes K5 and M which appear on our diagram are either very bright or very faint. There are none comparable with the

Sun in brightness."[9] In 1922 H. D. Curtis[10] published an H-R diagram, based on all parallaxes available at the time and on the HD spectral types, which is surprisingly similar to the color-magnitude diagram shown in Figure 4. In the same year Hertzsprung[11] called attention to the fact that, if the quantity $m + 5 \log \mu$, where m is the apparent magnitude and μ is the total proper motion, is plotted against the reciprocal color temperature, then, for stars about 5 mag. brighter than the sun, there is a "marked gap" on the diagram between the red stars and the blue stars. Comparing his diagram with his table of the colors corresponding to each spectral type, we see that the gap is between stars of spectral type A5 and stars slightly later than G2 on the HD system. During the succeeding thirty years the edges of this gap have tended to become less well defined in the literature, and the red edge of the gap has progressed steadily toward the violet, until some modern authors have placed this edge near F5 or even earlier. Further evidence that the giants actually start abruptly near G8 is furnished in Figure 5, which shows two diagrams similar to Figure 4 but derived from independent sets of data. Figure 5*a* is a plot of the colors measured by Bottlinger[12] against the absolute magnitudes computed from the trigonometric parallaxes. Figure 5*b* is a plot of the infrared colors measured by J. S. Hall[13] against the absolute magnitudes which the stars would have if each had a tangential motion of 20 km/sec. That is, $P = m_v + 5 \log \mu + 1.87$. Both figures contain all the stars plotted in Figure 4 for which the necessary data are available, and the mean colors of G0 V and G8 III stars have been indicated on each. Since these diagrams are very similar to Figure 4, we may conclude that the Hertzsprung gap extends through G5 and has a very sharp boundary at a temperature between that of a G5 giant and a G8 giant.

IV. VELOCITY DISTRIBUTIONS

Nearly two years ago it was shown that among the late F- and early G-type stars two groups of stars could be distinguished in the same spectral type and luminosity class by small spectroscopic differences.[14] It was also shown that the members of these two groups, which occur in nearly equal numbers among the bright northern stars, have different velocity distributions. The stars in one of these groups have systematically weaker lines than those in the other group, and the two groups have been identified accordingly as the strong-line and the weak-line stars. β Vir is representative of the strong-line group, and ι Psc of the weak-line group.

In the course of classifying the remainder of the stars, it was found that spectroscopic differences also exist among stars of the same luminosity class and spectral type in the range G8–K1. Eighty-five per cent of these stars belong to one of two groups. In one of these, both the G band and *Ca* I 4226 are stronger than in stars of the same type in the other group. The two K0 III stars, HR 4126 and 2 Dra, are examples of the members of each group, and the differences between these stars are typical. Relative to the strength of *Fe* I 4045, λ 4226 is stronger in the spectrum of 2 Dra than it is in the spectrum of HR 4126. This alone might be explained if 2 Dra were later in type or lower in luminosity. However, the G band is also stronger in 2 Dra, and this would indicate an earlier type; the strength of the cyanogen and the ratio of λ 4077 to λ 4063 indicate that 2 Dra cannot be appreciably fainter than HR 4126. Figure 6 illustrates the velocity distributions for the stars in the two groups together with the velocity distributions

[9] *Pop. Astr.*, **22**, 275, 1914. The giant and dwarf sequences had been recognized by Hertzsprung nine years earlier, but Russell seems to have been the first to emphasize that there were no stars of intermediate absolute magnitude among the late K- and M-type stars, although such stars existed in earlier types.

[10] *Pub. A.S.P.*, **34**, 33, 1922.

[11] *Leiden Ann.*, **14**, Pt. 1, 1922.

[12] *Veröff. u. Sternw Berlin-Babelsberg*, Vol. **3**, No. 4, 1923.

[13] *Ap. J.* **79**, 145, 1934.

[14] N. G. Roman, *Ap. J.*, **112**, 554, 1950.

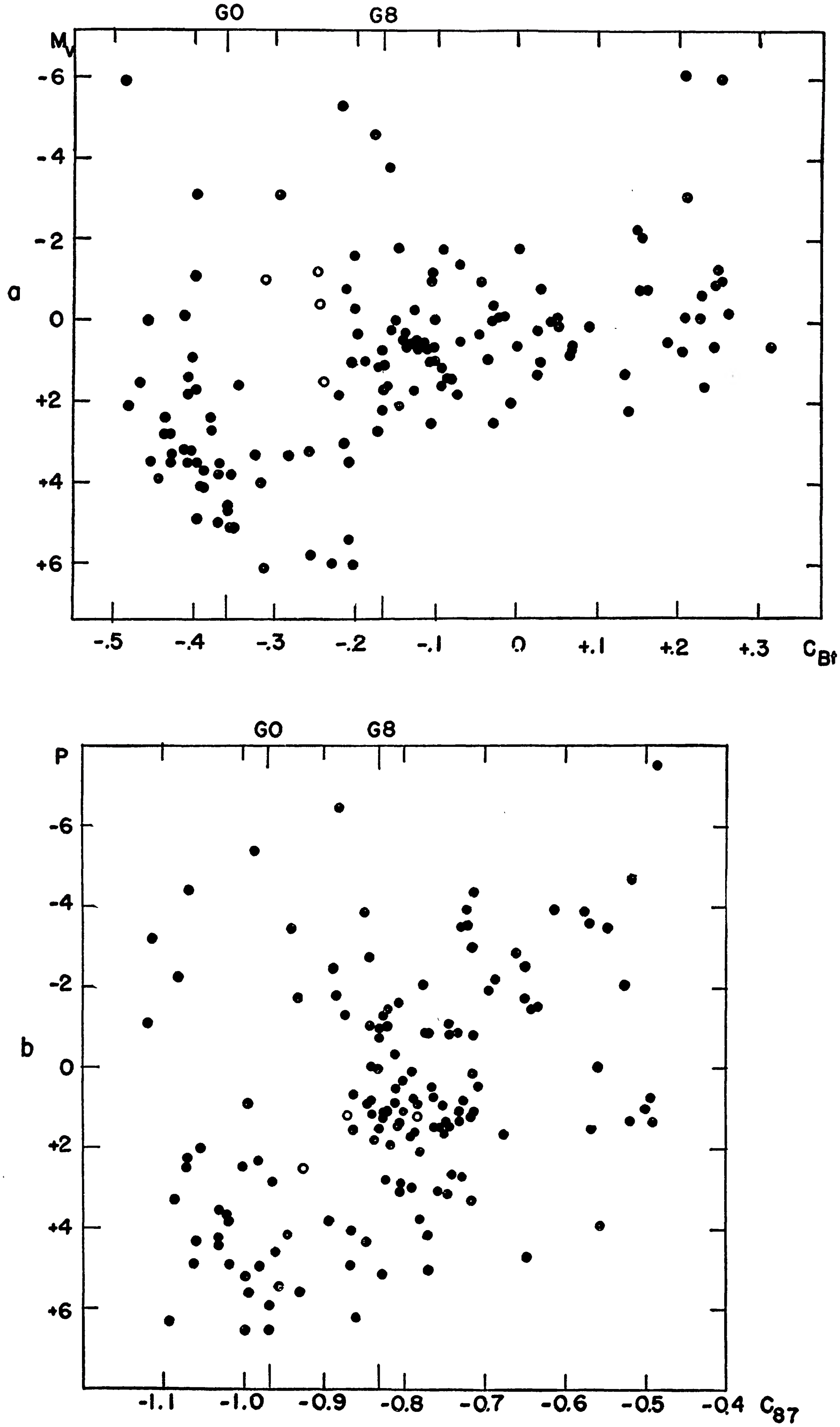

FIG. 5.—Color-magnitude diagrams for the bright northern stars: *a*, a plot of the visual absolute magnitudes determined from trigonometric parallaxes and the colors measured by Bottlinger; *b*, a plot of visual magnitudes determined from hypothetical parallaxes (i.e., the assumption that each star has a tangential velocity of 20 km/sec) and the colors measured by Hall.

for the strong- and weak-line groups in the earlier types for comparison. (Thirty-seven stars have been added to the diagrams shown in the earlier paper.) Table 3 contains, for each group, the number of stars, the mean velocity, and the standard deviation of the velocities. These show that one group of the late-type stars can be identified dynamically with the strong-line group in the earlier stars and the other with the weak-line group. For this reason, although the names are no longer descriptive, the group of stars resembling HR 4126, which appears similar dynamically to the strong-line stars of earlier type,

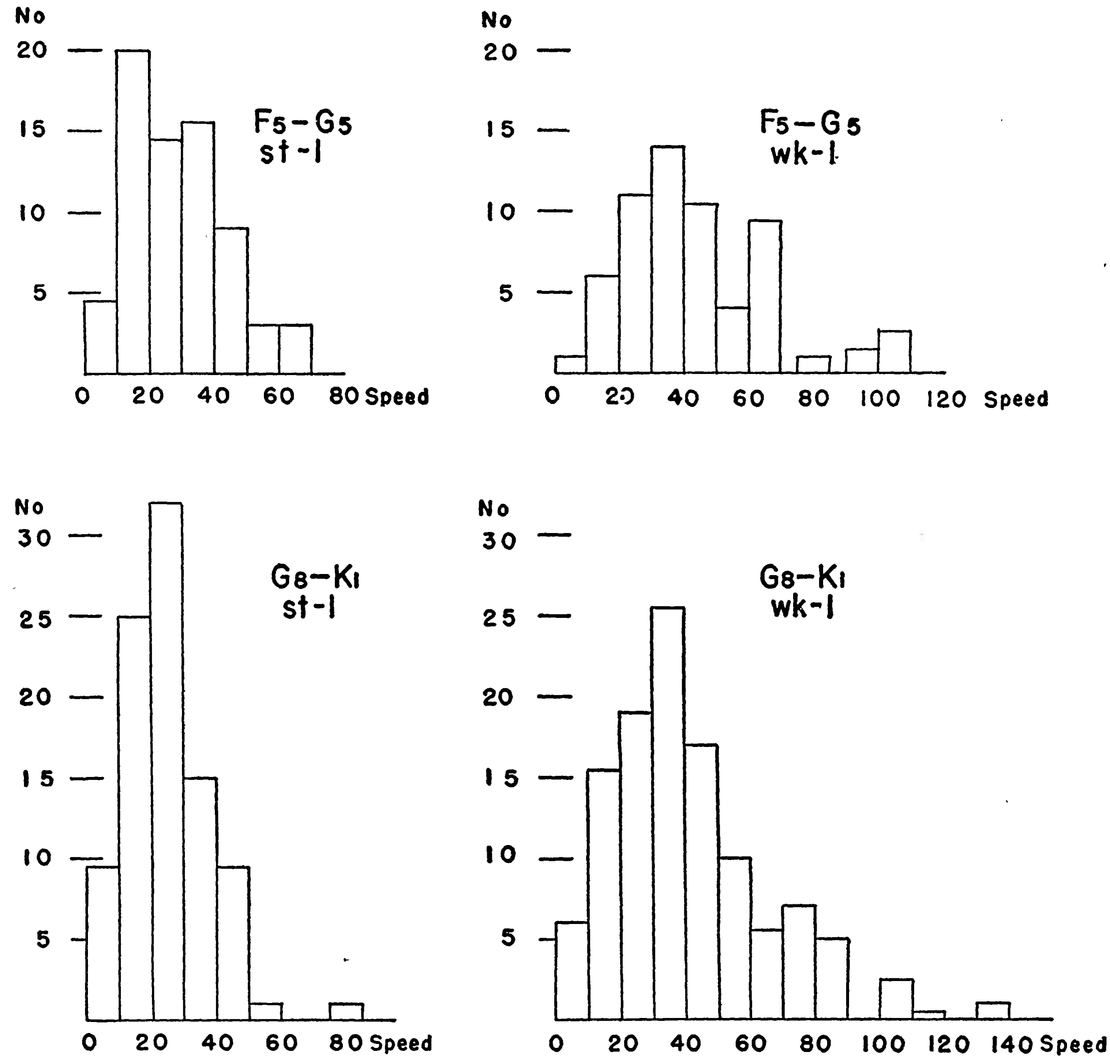

FIG. 6.—The frequency distributions of the speeds in the strong- and weak-line groups in the spectral ranges F5–G5 and G8–K1.

has been called the strong-line group and the group of stars resembling 2 Dra has been called the weak-line group.

The remaining 15 per cent of the stars of types G8–K1 appear to belong to neither of these groups spectroscopically but to one of the groups represented by the K0 III stars illustrated in Figure 7. Stars in these groups seem to share the characteristics of the weak-line group to the extent that the G band and λ 4226 tend to be strong compared with the remainder of the spectrum, but, in addition, the *CN* band is peculiar. In stars like

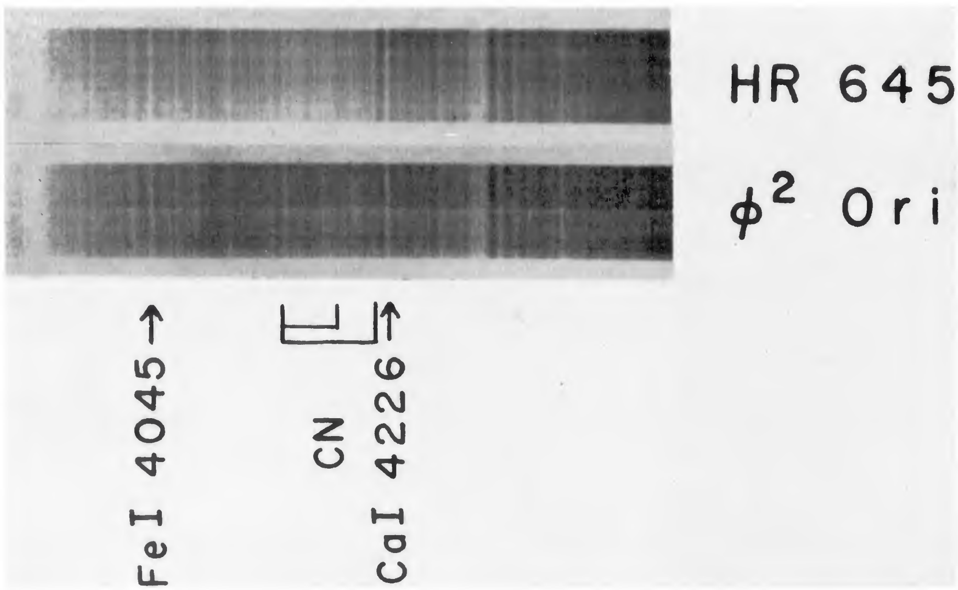

FIG. 7.—Two K0 III stars with peculiar *CN*. HR 645 belongs to the 4150 group. ϕ^2 Ori belongs to the group with weak *CN*. Both stars are high-velocity stars, and the two must be fairly similar in temperature and luminosity.

HR 645, not only is the absorption in the region between λ 4145 and λ 4175 stronger than in the region between λ 4175 and λ 4215, but also the appearance is different. Similar stars have been found on objective-prism plates at the Case Observatory by Dr. Nassau and his associates. They are recognized on low dispersion by the fact that the λ 4150 region of *CN* is too strong compared with the region more to the red. Hence they have been called "4150 stars." In addition, the entire *CN* band appears too strong for the strength of the hydrogen lines and of λ 4077. On the other hand, in stars like ϕ^2 Ori, the

TABLE 3

CHARACTERISTICS OF THE VELOCITY DISTRIBUTIONS

Group	Number of Stars	Mean Speed (Km/Sec)	Standard Deviation (Km/Sec)
	F5–G5 (except G2 and G5 III and IV)		
Strong-line	70	28.4± 1.7	14.5
Weak-line	61	42.7± 2.8	22.2
	G5–K1, II–III to IV		
Strong-line	91	24.7± 1.3	12.6
Weak-line	113	40.9± 2.3	24.1
4150	25	42.1± 8.3	41.6
Weak *CN*	12	95.6±13.7	47.4

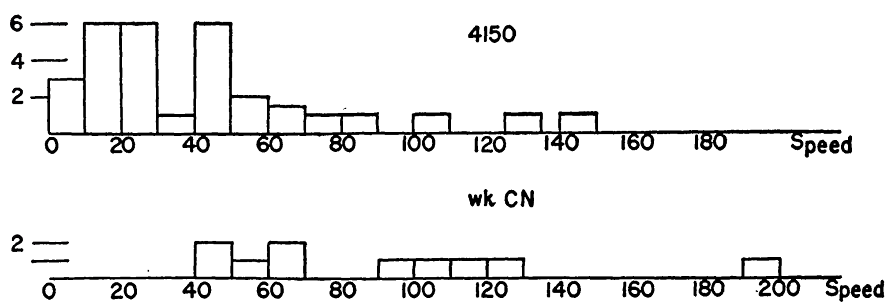

FIG. 8.—The frequency distributions of the speeds of the 4150 stars and of the stars with weak *CN*

CN is too weak for the strength of λ 4077 and for the luminosities indicated by trigonometric parallaxes.

Table 3 also gives the characteristics of the velocity distributions for these groups of stars, and Figure 8 illustrates these distributions. It is seen that the velocity distribution for the 4150 stars is similar to that for the weak-line stars, although spectroscopically they form a distinct group. The dispersion is higher, but for such a small number of stars this difference may not be significant. On the other hand, the stars with weak *CN* definitely form a separate group dynamically. The mean velocity is decidedly higher than that for the other groups, and the distribution of the velocities also appears different, although it should be remembered that Figure 8 contains very few stars. This is definitely a high-velocity group of stars, and it has been recognized for some time both in globular clusters[15] and among the high-velocity stars.[1] More recently, both stars in globular clusters and the high-velocity stars have been recognized as objects belonging to Baade's population II, and the weak *CN* has been identified as a characteristic of this population.[16] It should be noted, however, not only that some members of this group have velocities lower than the 63 km/sec limit but also that stars in the weak-line and in the 4150 groups have velocities which are above this limit. For example, the velocity of HR 645 is 143 km/sec.

Spectroscopic differences exist also among stars later than K1. The 4150 stars seem to be fairly numerous at K2, and the stars with weak *CN* are also certainly present at this type (for example, α Boo).

Several lines of evidence support the above conclusions. The addition of 37 stars to the 98 previously discussed with spectral types in the range F5–G5 has had no appreciable effect on the velocity characteristics of the strong- and weak-line groups. Among the later-type stars, the velocity characteristics of each group show clearly in each spectral type separately. Hence the divisions are almost certainly real. Throughout the region of the H-R diagram included in this investigation, the mean reduced trigonometric parallaxes for the strong- and weak-line stars of the same spectroscopic absolute magnitude agree within their mean errors. In addition, in each group, the mean radial velocity agrees with the mean velocity from one component of the tangential motion in both the earlier and later spectral types. Thus the higher mean velocities for some groups cannot result from the use of values of the spectroscopic absolute magnitudes which are too high for these groups. The galactic concentration tells us nothing: all the stars seem to be fairly uniformly distributed in a direction perpendicular to the galactic plane up to the relatively small distances reached in this investigation.

Table 4 lists the stars brighter than 5.50 mag., north of declination $-20°$, with revised spectral types between F5 and K5, with the exception of variable stars, stars with composite spectra, and stars in three lists which have been published recently.[14, 17] The table includes the name or HR number of each star, its 1900 position, the visual apparent magnitude corrected for the light of the fainter component in close visual double stars and two-line spectroscopic binaries, the spectral type, the spectroscopic parallax and absolute magnitude, the group (strong-line, weak-line, 4150, or weak *CN*) to which the star belongs, and its space velocity corrected for the usual solar motion of 20 km/sec toward $\alpha = 18^h04^m$ and $\delta = +28°$. The abbreviations "st-l," "wk-l," and "wk CN" stand for "strong-line," "weak-line," and "weak *CN*," respectively; an "n" at the end of a line indicates a note on that star at the end of the table. The remaining symbols have their usual meanings.

I am indebted to Dr. W. W. Morgan not only for the use of a large number of plates but also for many helpful discussions and for lists of revised spectral types for the standard stars.

[15] B. Lindblad, *Ap. J.*, **55**, 85, 1922, and D. M. Popper, *Ap. J.*, **105**, 204, 1947.

[16] W. Baade, *Ap. J.*, **100**, 137, 1944, and Keenan, Morgan, and Münch, *A.J.*, **53**, 194, 1948.

[17] Morgan and Roman, *Ap. J.*, **112**, 362, 1950, and W. P. Bidelman, *Ap. J.*, **113**, 304, 1951.

Table 4

Spectroscopic Results

Name	α (1900)	δ	m	Spectral Type	M	Group	π sp	Speed (Km/Sec)
33 Psc	$0^h\ 0^m.2$	− 6°16'	4.68	K1 III	+0.8	4150	0".017	40
6 Cet	0 6.2	−16 1	5.05	F6 V	+3.6	wk-1	.051	32
HR 37	0 7.1	−18 30	5.47	K5 III	−0.2		.0073	26
ι Cet	0 14.3	− 9 23	3.75	K2 III	+0.9		.027	26
13 Cet	0 30.1	− 4 9	5.73	F8 V	+3.9	wk-1	.043	32
HR 152	0 31.3	+43 56	5.44	K5 III	−0.2		.0074	50
ε And	0 33.3	+28 46	4.52	G8 III	+0.0	wk CN	.0125	156
δ And	0 34.0	+30 19	3.49	K3 III*	+0.1		.021	18
α Cas	0 34.8	+55 59	2.47	K0 II-III	−0.8	st-1	.022	6
32 And	0 35.7	+38 55	5.42	G8 III	0.0	st-1	.0082	22
β Cet	0 38.6	−18 32	2.24	K0 III	+0.7	st-1	.049	15
ϕ^1 Cet	0 39.2	−11 9	4.93	K0 III	+0.7	st-1	.014	34
ζ And	0 42.0	+23 43	4.30	K1 II	−2.6		.0042	
δ Psc	0 43.5	+ 7 2	4.55	K5 III	−0.2		.011	39
64 Psc	0 43.7	+16 24	5.23	F8 V	+3.9	st-1	.054	19
υ^1 Cas	0 49.1	+58 26	4.95	K2 III	+0.9		.0155	32
υ^2 Cas	0 50.7	+58 38	4.83	G8 III-IV	+1.3	wk-1	.020	56
ϕ^3 Cet	0 51.0	−11 49	5.49	K4 III	−0.1		.0076	42
η And	0 51.9	+22 53	4.62	G8 III-IV	+1.3	st-1	.022	24
HR 285	0 55.0	+85 43	4.52	K2 II-III	−0.8		.0086	34
ε Psc	0 57.8	+ 7 21	4.45	K0 III	+0.7	wk-1	.018	41
μ Cas	1 1.6	+54 26	5.26	G5 Vp*				
η Cet	1 3.6	−10 43	3.60	K2 III	+0.9		.029	27
χ Psc	1 6.1	+20 30	4.89	K0 III	+0.7	st-1	.0145	17
τ Psc	1 6.2	+29 34	4.70	K0 III-IV	+1.4	st-1	.022	31
φ Psc	1 8.3	+24 3	4.64	K0 III	+0.7	st-1	.016	12
ξ And	1 16.5	+45 0	4.99	K0 III-IV	+1.4	st-1	.019	17
ψ Cas	1 18.9	+67 36	4.96	K0 III	+0.7	4150	.014	20
θ Cet	1 19.0	− 8 42	3.83	K0 III	+0.7	wk-1	.024	48
46 Cet	1 20.7	−15 7	5.19	K3 III	+0.1		.0095	31
49 And	1 24.1	+46 30	5.33	K0 III	+0.7	4150	.011	17
μ Psc	1 24.9	+ 5 38	5.12	K4 III	−0.1		.0090	144
η Psc	1 26.1	+14 50	3.72	G8 III*	0.0	st-1	.018	16
χ Cas	1 27.4	+58 43	4.88	K0 III	+0.7	wk-1	.0145	30
40 Cas	1 30.5	+72 32	5.50	G8 II-III	−1.0	wk-1	.060	25
50 Cet	1 31.1	−15 54	5.48	K2 III	+0.9		.012	22
51 And	1 31.9	+48 7	3.77	K3 III*	+0.1		.019	26
χ And	1 33.4	+43 52	5.17	G8 III	0.0	wk-1	.0092	32
HR 483	1 35.7	+42 7	5.10	G2 V*	+4.6	st-1	.079	32
ν Psc	1 36.2	+ 4 59	4.68	K3 III	+0.1		.012	26
107 Psc	1 37.1	+19 47	5.32	K1 V*	+6.2		.151	46
HR 500	1 37.7	− 4 12	5.27	K3 II-III	−1.0		.0056	48
τ Cet	1 39.4	−16 28	3.65	G8 V*	+5.6		.245	60
ο Psc	1 40.1	+ 8 39	4.50	K0 III	+0.7	st-1	.017	26
ζ Cet	1 46.5	−10 50	3.92	K2 III	+0.9		.025	9
α Tri	1 47.4	+29 6	3.58	F5 IV*	+1.9	wk-1	.046	24
ξ Psc	1 48.4	+ 2 42	4.84	K0 III	+0.7	wk-1	.015	30
ι Ari	1 51.9	+17 20	5.16	K1 p				
49 Cas	1 56.0	+75 38	5.30	G8 III	0.0	wk-1	.0086	26
γ And A	1 57.8	+41 51	2.28	K2 III	+0.9		.053	18
α Ari	2 1.5	+22 59	2.23	K2 III*	+0.9		.054	18
60 And	2 7.0	+43 46	5.08	K4 III	−0.1		.0092	52
HR 645	2 7.0	+50 36	5.40	K0 III	+0.7	4150	.0115	143
η Ari	2 7.2	+20 44	5.35	F5 V	+3.3	st-1	.039	13
ξ^1 Cet	2 7.7	+ 8 23	4.54	G8 II	−2.3		.0038	
64 And	2 17.8	+49 33	5.49	G8 III	0.0	st-1	.0080	16
65 And	2 18.9	+49 50	4.86	K4 III	−0.1		.010	7
14 Tri	2 26.0	+35 42	5.35	K5 III	−0.2		.0077	48
HR 737	2 26.3	+ 1 50	5.44	K3 III	+0.1		.0085	17
HR 743	2 28.5	+72 23	5.34	G8 III	0.0	wk-1	.0085	37

Table 4 (continued)

Name	α (1900)	δ	m	Spectral Type	M	Group	π sp	Speed (Km/Sec)
ν Cet	$2^h30^m.6$	+ 5° 9'	5.02	G8 III	0.0	st-1	0″0099	28
ε Cet	2 34.7	-12 18	5.01	F5 IV-V	+2.8	wk-1	.036	25
39 Ari	2 42.0	+28 50	4.62	K1 III	+0.8	st-1	.017	42
17 Per	2 45.4	+34 39	4.67	K5 III	-0.2		.0105	19
20 Per	2 47.4	+37 56	5.32	F4 V	+3.3		.039	9
η Eri	2 51.5	- 9 18	4.05	K1 III-IV	+1.3	wk-1	.028	44
24 Per	2 52.9	+34 47	4.97	K2 III	+0.9		.0155	51
HR 918	2 58.0	+56 19	5.08	K0 II-III	-0.8	wk-1	.0066	83
κ Per	3 2.7	+44 29	4.00	K0 III	+0.7	wk-1	.022	42
ω Per	3 4.8	+39 14	4.82	K1 III	+0.8	st-1	.016	24
δ Ari	3 5.9	+19 21	4.53	K2 III	+0.9		.019	32
94 Cet	3 7.7	- 1 34	5.14	F8 V	+3.9	st-1	.057	8
HR 969	3 9.1	+50 34	5.29	G5 II	-2.3		.0030	
HR 991	3 12.5	+33 51	4.92	K2 II	-2.6		.0031	
HR 999	3 14.3	+28 41	4.72	K3 II-III	-1.0		.0072	15
63 Ari	3 17.0	+20 23	5.25	K3 III	+0.1		.0093	32
o Tau	3 19.4	+ 8 41	3.80	G8 III*	0.0	st-1	.017	45
σ Per	3 23.6	+47 39	4.55	K3 III	+0.1		.013	29
5 Tau	3 25.4	+12 36	4.28	K0 II-III	-0.8	st-1	.0095	13
36 Per	3 25.5	+45 43	5.35	F4 III*	+0.2		.0093	63
δ Eri	3 38.5	-10 6	3.72	K0 IV*	+3.5	wk-1	.091	53
32 Eri A	3 49.3	- 3 15	4.95	G8 III	0.0	st-1	.010	17
HR 1249	3 57.5	- 0 33	5.42	F6 V	+3.6	st-1	.043	19
37 Tau	3 58.8	+21 49	4.50	K0 III	+0.9	st-1	.019	13
HR 1257	3 58.9	+ 2 33	5.39	F6 IV	+1.9	wk-1	.020	46
39 Eri	4 9.6	-10 30	5.13	K3 III	+0.1		.0098	74
HR 1327	4 11.3	+64 54	5.40	G5 III	0.0	wk-1	.0082	33
54 Per	4 13.9	+34 20	5.10	G8 III	0.0	4150	.0095	41
γ Tau	4 14.1	+15 23	3.86	K0 III*	+0.7	st-1	.023	30
φ Tau	4 14.2	+27 7	5.06	K1 III	+0.8	wk-1	.014	20
δ Tau	4 17.2	+17 18	3.93	K0 III*	+0.7	st-1	.023	31
HR 1390	4 19.7	+31 13	5.33	K1 III	+0.8	wk-1	.012	42
π Tau	4 21.0	+14 29	4.94	G8 III	0.0	st-1	.010	20
75 Tau	4 22.7	+16 8	5.29	K2 III	+0.9		.013	25
ε Tau	4 22.8	+18 58	3.63	K0 III*	+0.7	wk-1	.026	31
θ' Tau	4 22.9	+15 44	4.04	K0 III*	+0.7	st-1	.022	32
45 Eri	4 26.8	- 0 16	4.97	K3 II-III	-1.0		.0064	6
HR 1452	4 29.4	- 9 11	5.50	K4 II-III	-1.0		.0050	116
α Tau	4 30.2	+16 19	1.06	K5 III*	-0.2		.056	41
3 Cam	4 32.0	+52 53	5.31	K0 III	-0.7	st-1	.012	44
53 Eri	4 33.6	-14 30	3.98	K2 III	-0.9		.024	41
HR 1523	4 41.6	+81 2	5.32	K3 III	+0.1		.0090	32
HR 1533	4 43.2	+37 19	5.10	K4 II	-2.6		.0029	
60 Eri	4 45.7	-16 23	5.16	K0 III	+0.7	wk-1	.013	34
2 Aur	4 45.9	+36 32	5.04	K3 III	+0.1		.010	33
o^2 Ori	4 50.7	+13 21	4.28	K2 III	+0.9		.021	26
104 Tau	5 1.5	+18 31	5.79	G4 V	+4.9	st-1	.066	36
68 Eri	5 3.8	- 4 35	5.23	F5 V	+3.3	wk-1	.041	13
HR 1684	5 6.0	+15 55	5.36	K5 III	-0.2		.0077	26
HR 1686	5 6.1	+79 7	5.16	F6 V	+3.6	wk-1	.049	36
ρ Ori	5 8.1	+ 2 45	4.64	K3 III	+0.1		.0125	24
16 Aur	5 11.6	+33 16	4.81	K3 III	+0.1		.0115	64
109 Tau	5 13.3	+22 0	5.14	G8 III	0.0	wk-1	.0093	27
21 Ori	5 14.0	+ 2 30	5.45	F5 II	-2.0		.0032	
σ Aur	5 17.9	+37 18	5.22	K4 III	-0.1		.0086	30
111 Tau	5 18.6	+17 17	5.14	F8 V	+3.9	st-1	.057	33
29 Ori	5 19.1	- 7 54	4.21	G8 III	0.0	wk-1	.014	38
27 Ori	5 19.4	- 0 59	5.15	K0 III	+0.7	wk-1	.013	58
φ Aur	5 21.0	+34 24	5.26	K3 p				n

Table 4 (continued)

Name	α (1900)	δ	m	Spectral Type	M	Group	π sp	Speed (Km/Sec)
31 Ori	$5^h24^m.7$	− 1°10'	4.97	K5 III	−0.2		0".0092	9
φ² Ori	5 31.4	+ 9 14	4.39	K0 III	+0.7	wk CN	.018	109
51 Ori	5 37.3	+ 1 26	5.24	K1 III	+0.8	wk-1	.013	74
τ Aur	5 42.3	+39 9	4.64	G8 III	0.0	wk-1	.012	31
132 Tau	5 42.9	+24 32	5.02	G8 III	0.0	4150	.0099	4
ν Aur	5 44.6	+39 7	4.18	K0 III	+0.7	st-1	.020	21
χ¹ Ori	5 48.5	+20 16	4.62	G0 V	+4.3	st-1	.086	30
δ Aur	5 51.3	+54 17	3.88	K0 III*	+0.7	wk-1	.023	19
HR 2113	5 55.1	− 3 5	4.68	K2 III	+0.9		.0175	14
37 Cam	6 1.2	+58 57	5.42	G8 III	0.0	wk-1	.0082	47
36 Cam	6 2.8	+65 44	5.39	K2 II-III	−0.8		.0058	9
κ Aur	6 9.0	+29 32	4.45	G8 III	0.0	wk-1	.013	83
71 Ori	6 9.0	+19 12	5.18	F6 V	+3.6	st-1	.048	25
γ Mon	6 10.0	− 6 15	4.09	K3 III	+0.1		.016	23
74 Ori	6 10.8	+12 18	5.11	F5 IV-V	+2.8	wk-1	.034	41
HR 2260	6 13.3	−16 47	5.28	K3 III	+0.1		.0091	29
45 Aur	6 13.7	+53 30	5.41	F5 III	+0.2	st-1	.0091	33
5 Lyn	6 18.1	+58 28	5.48	K4 III	−0.1		.0077	15
HR 2305	6 19.5	−11 28	5.39	K3 III	+0.1		.0088	55
HR 2379	6 26.7	−12 19	5.33	K3 III	+0.1		.0090	25
ψ² Aur	6 32.2	+42 35	5.09	K3 III	+0.1		.010	15
ν² CMa	6 32.3	−19 10	4.14	K1 IV	+2.9	st-1	.057	20
ν³ CMa	6 33.5	−18 9	4.65	K1 III	+0.8	st-1	.017	22
HR 2450	6 34.7	−14 3	4.97	K2 II	−2.6		.0031	
ψ⁴ Aur	6 35.8	+44 37	5.17	K5 III	−0.2		.0084	83
13 Lyn	6 38.3	+57 16	5.47	K0 III	+0.7	wk-1	.011	20
30 Gem	6 38.4	+13 20	4.65	K1 III	+0.8	st-1	.017	4
56 Aur	6 39.5	+43 41	5.34	G0 V	+4.3	st-1	.062	43
ψ⁶ Aur	6 40.0	+48 54	5.28	K1 III	+0.8	st-1	.013	25
17 Mon	6 41.9	+ 8 9	5.00	K4 III	−0.1		.0104	33
18 Mon	6 42.7	+ 2 31	4.70	K0 III	+0.7	st-1	.016	9
ψ⁷ Aur	6 43.7	+41 54	5.04	K3 III	+0.1		.0102	69
HR 2527	6 45.5	+77 6	4.75	K4 III	−0.1		.0107	43
θ CMa	6 49.6	−11 55	4.25	K4 III	−0.1		.0135	90
HR 2649	6 58.1	+11 6	5.25	K3 III	+0.1		.0092	7
63 Aur	7 4.8	+39 29	5.07	K4 II-III	−1.0		.0061	57
τ Gem	7 4.8	+30 25	4.48	K2 III	+0.9		.019	14
20 Mon	7 5.3	− 4 5	5.02	K0 III	+0.7	wk-1	.014	101
18 Lyn	7 7.2	+59 49	5.33	K2 III	+0.9		.013	83
65 Aur	7 15.4	+36 57	5.21	K0 III	+0.7	wk-1	.0125	33
66 Aur	7 17.2	+40 52	5.28	K0 III	+0.7	4150	.012	18
57 Gem	7 17.4	+25 15	5.08	G8 III	0.0	wk-1	.0096	28
ι Gem	7 19.5	+28 00	3.89	K0 III	+0.7	wk-1	.023	19
ε CMi	7 20.2	+ 9 28	5.07	G8 III	0.0	st-1	.0097	24
63 Gem	7 21.8	+21 39	6.01	F5 IV-V	+2.8	st-1	.023	17
22 Lyn	7 22.3	+49 53	5.36	F6 V	+3.6	st-1	.044	36
γ CMi	7 22.7	+ 9 8	4.60	K3 III	+0.1		.013	41
65 Gem	7 23.6	+28 7	5.09	K2 III	+0.9		.015	23
6 CMi	7 24.2	+12 13	4.85	K2 III	+0.9		.016	31
HR 2896	7 28.8	+31 11	5.83	K0 III	+0.7	wk-1	.0094	28
υ Gem	7 29.8	+27 7	4.22	K5 III	−0.2		.013	38
25 Mon	7 32.3	− 3 53	5.17	F5 III	+0.2	wk-1	.010	41
HR 2959	7 35.8	−15 2	5.15	K3 II	−2.6		.0028	
α Mon	7 36.5	− 9 19	4.07	K0 III	+0.7	wk-1	.021	11
σ Gem	7 37.1	+29 8	4.26	K1 III	+0.8	st-1	.020	58
76 Gem	7 38.0	+26 1	5.40	K5 III	−0.2		.0075	10
κ Gem	7 38.4	+24 38	3.68	G8 III*	0.0	st-1	.018	9
β Gem	7 39.2	+28 16	1.21	K0 III*	+0.7	wk-1	.079	33
81 Gem	7 40.3	+18 45	5.02	K5 III	−0.2		.0090	77
6 Pup	7 45.2	−16 59	5.54	K3 III	+0.1		.0081	76

Table 4 (continued)

Name	α (1900)	δ	m	Spectral Type	M	Group	π sp	Speed (Km/Sec)
HR 3075	$7^h48^m.2$	+74°11'	5.56	K3 III	+0.1		0".0081	41
14 CMi	7 53.2	+ 2 29	5.40	K0 III	+0.7	wk-1	.0115	83
27 Mon	7 54.7	- 3 24	5.06	K2 III	+0.9		.015	47
28 Mon	7 56.1	- 1 7	4.88	K4 III	-0.1		.0103	46
HR 3145	7 57.1	+ 2 37	4.52	K2 III	+0.9		.019	58
χ Gem	7 57.4	+28 4	5.04	K2 III	+0.9		.015	20
55 Cam	8 2.9	+68 46	5.48	G8 II	-2.6		.0024	
19 Pup	8 6.6	-12 38	4.68	K0 III	+0.7	wk-1	.016	21
HR 3212	8 6.7	- 7 28	5.36	G8 III	0.0	st-1	.0084	30
20 Pup	8 8.7	-15 29	5.05	G5 II	-2.3		.0034	
β Cnc	8 11.1	+ 9 30	3.76	K4 III	-0.1		.017	10
31 Lyn	8 16.0	+43 31	4.43	K5 III	-0.2		.012	30
HR 3306	8 20.6	+ 7 53	5.23	G8 II	-2.6		.0027	
η_2 Cnc	8 26.9	+20 47	5.52	K3 III	+0.1		.0082	24
π^2 UMa	8 31.5	+64 41	4.76	K2 III	+0.9		.017	30
σ Hya	8 33.5	+ 3 42	4.54	K2 III	+0.9		.019	14
6 Hya	8 35.3	-12 7	5.15	K4 III	-0.1		.0089	41
9 Hya	8 37.1	-15 35	4.98	K1 III	+0.8	st-1	.0145	34
δ Cnc	8 39.0	+18 31	4.17	K0 III	+0.7	wk-1	.020	42
ι Cnc	8 40.7	+29 8	4.20	G8 II	-2.6		.0044	
12 Hya	8 41.7	-13 11	4.44	G8 III	0.0	wk-1	.013	31
35 Lyn	8 45.3	+44 6	5.24	K0 III	+0.7	wk-1	.012	37
ρ^2 Cnc	8 49.7	+28 19	5.25	G8 II-III	-1.0	st-1	.0056	17
ζ Hya	8 50.1	+ 6 20	3.30	K0 III	+0.7	4150	.030	17
σ^1 UMa	8 59.6	+67 17	5.33	K5 III	-0.2		.0079	20
HR 3612	9 0.2	+38 51	4.71	G8 Ib-II	-3.6		.0022	
ω Hya	9 0.7	+ 5 30	5.41	K2 II-III	-0.9		.0058	16
τ Cnc	9 2.0	+30 3	5.38	G8 III	0.0	wk-1	.0083	24
τ UMa	9 2.7	+63 55	4.74	A7 m				n
ξ Cnc	9 3.6	+22 27	5.22	K0 III	+0.7	st-1	.0125	27
17 UMa	9 8.4	+57 10	5.48	K5 III	-0.2		.0073	29
23 Hya	9 11.7	- 5 56	5.40	K2 III	+0.9		.0125	32
26 Hya	9 15.0	-11 33	4.94	G8 III	0.0	st-1	.010	18
27 Hya	9 15.6	- 9 8	4.97	G8 III-IV	+1.3	st-1	.018	16
κ Leo	9 18.8	+26 37	4.81	K2 III	+0.9		.018	23
α Hya	9 22.7	- 8 14	2.16	K3 III	+0.1		.039	24
HR 3751	9 22.9	+81 46	4.58	K3 III	+0.1		.013	9
24 UMa	9 25.6	+70 16	4.57	G5 IV	+3.2	st-1	.053	31
λ Leo	9 26.0	+23 25	4.48	K5 III	-0.2		.0115	21
6 Leo	9 26.6	+10 9	5.28	K3 III	+0.1		.0092	17
ξ Leo	9 26.6	+11 45	5.12	K0 III	+0.7	wk-1	.013	34
10 LMi	9 28.1	+36 51	4.62	G8 III	0.0	st-1	.012	24
HR 3809	9 28.8	+40 4	4.99	K0 III	+0.7	wk-1	.014	25
11 LMi	9 29.7	+36 16	5.48	G8 IV-V	+4.6		.067	37
10 Leo	9 31.9	+ 7 17	5.14	K1 III	+0.8	wk-1	.014	17
HR 3834	9 33.3	+ 5 6	4.78	K3 III	+0.1		.012	60
27 UMa	9 33.8	+72 42	5.39	K0 III	+0.7	st-1	.012	12
ι Hya	9 34.8	- 0 41	4.10	K3 III	+0.1		.016	33
43 Lyn	9 35.8	+40 13	5.50	G8 III	+0.0	wk-1	.0079	34
υ^1 Hya	9 46.7	-14 23	4.29	G8 III	0.0	st-1	.014	36
μ Leo	9 47.1	+26 29	4.10	K2 III	+0.9		.023	31
31 Leo	10 2.6	+10 29	4.58	K4 III	-0.1		.0115	40
HR 3991	10 5.2	-12 19	5.42	F5 V	+3.3	st-1	.038	14
λ Hya	10 5.7	-11 52	3.83	K0 III	+0.7	4150	.024	27
γ Leo	10 14.5	+20 21	2.61	K0 III	+0.7	wk CN	.042	65
μ Hya	10 21.3	-16 20	4.06	K4 III	-0.1		.015	42
β LMi	10 22.1	+37 13	4.51	G8 III-IV	+1.3	st-1	.023	14
HR 4126	10 26.6	+76 14	5.04	K0 III	+0.7	st-1	.014	26
48 Leo	10 29.6	+ 7 28	5.17	G8 II-III	-1.0	wk-1	.0059	87
37 LMi	10 33.1	+32 30	4.77	G2 II	-2.0		.0044	

Table 4 (continued)

Name	α (1900)	δ	m	Spectral Type	M	Group	π sp	Speed (Km/Sec)
φ Hya	$10^h 33^m.7$	$-16^\circ 21'$	5.11	K0 III	+0.7	st-1	0".015	25
58 UMa	10 35.1	+66 14	5.17	K2 III	+0.9		.014	42
HR 4181	10 35.9	+69 36	5.23	K3 III	+0.1		.0094	16
ν Hya	10 44.7	−15 40	3.32	K2 III	+0.9		.033	49
44 UMa	10 47.5	+55 7	5.36	K3 III	+0.1		.0089	20
46 LMi	10 47.7	+34 45	3.92	K1 III	+0.8	wk-1	.024	59
46 UMa	10 50.2	+34 2	5.23	K1 III	+0.8	wk-1	.024	30
α Crt	10 54.9	−17 46	4.20	K0 III	+0.7	4150	.020	105
58 Leo	10 55.4	+ 4 9	5.05	K1 III	+0.8	wk-1	.014	25
61 Leo	10 56.7	− 1 57	4.97	K5 III	−0.2		.0092	34
α UMa	10 57.6	+62 17	1.95	K0 III*	+0.8	st-1	.055	8
ψ UMa	11 4.0	+45 2	3.15	K1 III	+0.8	wk-1	.034	11
HR 4365	11 10.6	+13 51	5.48	K3 III	+0.1		.0084	21
ν UMa	11 13.1	+33 38	3.71	K3 III	+0.1		.019	22
δ Crt	11 14.3	−14 14	3.82	G8 III-IV	+1.3	wk-1	.031	41
λ Crt	11 18.4	−18 14	5.15	F5 IV	+1.9	st-1	.022	48
ε Crt	11 19.6	−10 19	5.07	K5 III	−0.2		.0088	22
τ Leo	11 22.8	+ 3 24	5.18	G8 II-III	−1.0	st-1	.0058	40
87 Leo	11 25.2	− 2 27	5.07	K4 III	−0.1		.0092	34
2 Dra	11 30.2	+69 53	5.36	K0 III	+0.7	wk-1	.012	75
υ Leo	11 31.8	− 0 16	4.47	G9 III	+0.3	wk-1	.015	31
92 Leo	11 35.6	+21 54	5.43	K0 III	+0.7	wk-1	.012	13
3 Dra	11 36.9	+67 18	5.48	K3 III	+0.1		.0084	31
ζ Crt	11 39.7	−17 48	4.90	G8 III	0.0	st-1	.0105	39
χ UMa	11 40.8	+48 20	3.85	K0 III*	+0.7	wk-1	.024	17
HR 4521	11 41.6	+56 11	5.41	K3 III	+0.1		.0087	28
o Vir	12 0.1	+ 9 17	4.24	G8 III*	0.0	wk-1	.014	67
7 Com	12 11.3	+24 30	5.06	K0 III	+0.7	wk-1	.013	26
HR 4668	12 11.5	+33 37	5.08	K1 III	+0.8	st-1	.014	47
16 Vir	12 15.3	+ 3 52	5.10	K0 III	+0.7	wk CN	.013	96
11 Com	12 15.7	+18 21	4.91	G8 III	0.0	wk-1	.0105	73
HR 4699	12 15.8	−13 1	5.36	K1 III	+0.8	st-1	.012	30
5 CVn	12 19.2	+52 7	4.97	G7 III	0.0	st-1	.010	28
6 CVn	12 20.9	+39 34	5.22	G8 III-IV	+1.3	wk-1	.017	5
15 Com	12 22.0	+28 49	4.56	K1 III-IV	+1.3	4150	.022	14
HR 4783	12 28.7	+33 48	5.43	K0 III	+0.7	wk-1	.0115	31
χ Vir	12 34.1	− 7 27	4.78	K2 III	+0.9		.017	19
27 Com	12 41.7	+17 7	5.33	K3 III	+0.1		.0089	63
35 Com	12 48.4	+21 47	5.10	G8 III	0.0	st-1	.0095	6
37 Com	12 55.5	+31 20	5.08	K1 p				n
9 Dra	12 56.1	+67 8	5.50	G8 III	0.0	wk CN	.0079	69
ε Vir	12 57.2	+11 30	2.95	G9 III	+0.3	st-1	.030	29
41 Com	13 2.4	+28 10	4.90	K5 III	−0.2		.0094	46
49 Vir	13 2.7	−10 12	5.26	K1 III	+0.8	st-1	.013	27
HR 4997	13 9.2	+40 41	5.05	K0 III	+0.7	st-1	.0135	14
57 Vir	13 10.6	−19 25	5.32	K1 IV	+2.9	4150	.033	72
HR 5013	13 12.3	+14 12	5.45	K3 III	+0.1		.0085	43
63 Vir	13 17.7	−17 13	5.45	K0 III	+0.7	wk-1	.011	24
69 Vir	13 22.1	−15 27	4.89	K1 III	+0.8	4150	.015	29
76 Vir	13 27.7	− 9 39	5.43	K0 III	+0.7	wk-1	.011	8
89 Vir	13 44.4	−17 38	5.11	K1 III	+0.8	st-1	.014	40
υ Boo	13 44.7	+16 18	4.28	K5 III	−0.2		.0126	29
6 Boo	13 45.0	+21 46	5.06	K4 III	−0.1		.0093	32
90 Vir	13 49.6	− 1 1	5.30	K2 III	+0.9		.013	12
9 Boo	13 52.0	+27 59	5.18	K3 III	+0.1		.0096	45
κ Vir	14 7.6	− 9 48	4.31	K3 III	+0.1		.014	61
4 UMi	14 9.2	+78 1	5.00	K3 III	+0.1		.0104	23
15 Boo	14 10.0	+10 34	5.36	K0 III	+0.7	wk-1	.012	59
α Boo	14 11.1	+19 42	0.24	K2 III	+0.9		.135	69
HR 5361	14 13.8	+35 58	4.83	K1 III	+0.8	st-1	.016	21

Table 4 (continued)

Name	α (1900)	δ	m	Spectral Type	M	Group	π sp	Speed (Km/Sec)	
υ Vir	$14^h14^m.4$	$-1^{\circ}48'$	5.24	G8 III	0.0	4150	0".0089	56	
20 Boo	14 15.0	+16 46	4.97	K3 III	+0.1		.0106	58	
φ Vir	14 23.0	- 1 47	4.97	G2 III	+0.2		.011	45	
ρ Boo	14 27.5	+30 49	3.78	K3 III*	+0.1		.018	37	
5 UMi	14 27.7	+76 8	4.37	K4 III	-0.1		.013	28	
31 Boo	14 36.7	+ 8 35	5.03	G8 III	0.0	wk-1	.010	19	
o Boo	14 40.6	+17 23	4.69	K0 III	+0.7	st-1	.016	10	
11 Lib	14 45.3	- 1 53	5.05	G8 III-IV	+1.3	wk-1	.018	103	
HR 5541	14 46.6	+37 41	5.50	K0 III-IV	+1.4	wk-1	.015	79	
β UMi	14 51.0	+74 34	2.24	K4 III*	-0.1		.034	51	
ω Boo	14 57.7	+25 24	4.93	K4 III	-0.1		.0098	36	
110 Vir	14 57.9	+ 2 29	4.62	K0 III	+0.7	st-1	.0175	13	
β Boo	14 58.2	+40 47	3.63	G8 II-III	-1.0	st-1	.012	15	
ψ Boo	15 0.2	+27 20	4.67	K2 III	+0.8		.018	34	
ν Lib	15 1.1	-15 52	5.28	K5 III	-0.2		.0080	13	
HR 5635	15 3.4	+54 56	5.21	G8 III	0.0	wk-1	.0090	52	
δ Boo	15 11.5	+33 41	3.54	G8 III*	0.0	wk CN	.0195	43	
HR 5691	15 13.5	+67 44	5.23	F8 V	+3.9	st-1	.054	63	
6 Ser	15 16.0	+ 1 4	5.48	K3 III	+0.1		.0083	56	
11 UMi	15 17.2	+72 11	5.14	K4 III	-0.1		.0090	18	
ι Dra	15 22.7	+59 19	3.47	K2 III*	+0.9		.031	14	
ν^1 Boo	15 27.3	+41 10	5.15	K5 III	-0.2		.0084	21	
37 Lib	15 28.7	- 9 43	4.83	K1 III	+0.8	wk-1	.013	131	
γ Lib	15 29.9	-14 27	4.02	G8 III-IV	+1.3	wk-1	.029	30	
16 Ser	15 31.7	+10 21	5.40	K0 p					n
φ Boo	15 34.2	+40 41	5.41	G8 IV	+3.5	st-1	.0078	20	
θ UMi	15 34.4	+77 41	5.33	K5 III	-0.2		.0078	20	
κ Lib	15 36.2	-19 21	4.96	K5 III	-0.2		.0093	43	
α Ser	15 39.3	+ 6 44	2.75	K2 III*	+0.9		.043	34	
ω Ser	15 45.2	+ 2 30	5.33	G8 III	0.0	wk-1	.0085	35	
δ CrB	15 45.4	+26 23	4.73	G5 III-IV	+1.7	wk-1	.025	14	
ρ Ser	15 46.9	+21 17	4.38	K5 III	-0.2		.0096	49	
κ CrB	15 47.5	+35 58	4.77	K0 III-IV	+1.4	st-1	.021	80	
θ Lib	15 48.1	-16 26	4.34	G8 III-IV	+1.3	wk-1	.025	50	
ε CrB	15 53.5	+27 10	4.22	K3 III	+0.1		.015	28	
5 Her	15 56.3	+18 6	5.28	K0 III	+0.7	wk-1	.012	66	
ρ CrB	15 57.2	+33 37	5.43	G2 V	+4.6	wk-1	.068	64	
κ Her A	16 3.6	+17 19	5.34	G8 III	0.0	st-1	.0085	12	
HR 6016	16 4.6	- 3 12	5.41	K4 III	-0.1		.0079	18	
τ CrB	16 5.3	+36 45	4.94	K0 III-IV*	+1.4	wk-1	.020	77	
χ Sco	16 8.3	-11 35	5.50	K3 III	+0.1		.0082	14	
ε Oph	16 13.0	- 4 27	3.34	G8 III	0.0	wk-1	.022	33	
ξ CrB	16 18.2	+31 7	4.72	K0 III	+0.7	st-1	.016	41	
ψ Oph	16 18.3	-19 48	4.59	K0 III	+0.7	wk-1	.017	12	
ν^2 CrB	16 18.7	+33 56	5.28	K5 III	-0.2		.0080	40	
HR 6126	16 22.0	+69 20	5.44	K2 III	+0.9		.012	10	
η Dra	16 22.6	+61 44	2.89	G8 III*	+0.0	st-1	.026	7	
HR 6136	16 23.5	+ 0 53	5.47	K4 III p	-0.1		.0077	54	n
φ Oph	16 25.4	-16 24	4.40	G8 III	0.0	st-1	.013	24	
β Her	16 25.9	+21 42	2.81	G8 III*	0.0	st-1	.027	12	
HR 6152	16 26.2	+20 42	5.29	G8 p					r
29 Her	16 27.9	+11 42	4.92	K5 III	-0.2		.0094	89	
HR 6196	16 35.3	-17 33	5.04	G8 II	-2.5		.0050		
HR 6199	16 36.0	+56 13	5.44	K1 III	+0.8	st-1	.012	21	
η Her	16 39.5	+39 7	3.61	G8 III-IV	+1.3	st-1	.035	33	
18 Dra	16 40.2	+64 47	5.00	K1 p					l
43 Her	16 41.0	+ 8 46	5.38	K5 III	-0.2		.0076	18	
51 Her	16 47.6	+24 50	5.20	K2 II-III	-0.8		.0063	13	
23 Oph	16 49.3	- 6 0	5.35	K2 III	+0.9		.013	9	
HR 6287	16 50.6	+21 7	5.48	G8 III	+0.0	wk-1	.0079	43	

Table 4 (continued)

Name	α (1900)	δ	m	Spectral Type	M	Group	π sp	Speed (Km/Sec)
54 Her	$16^h51^m.0$	+18°36'	5.56	K4 III	-0.1		0".0074	72
κ Oph	16 52.9	+ 9 32	3.42	K2 III*	+0.9		.031	63
30 Oph	16 55.8	- 4 4	5.00	K4 III	-0.1		.0096	34
ε UMi	16 56.2	+82 12	4.40	G5 III	+0.0	st-1	.013	18
HR 6388	17 6.3	+40 54	5.12	K3 III	+0.1		.0099	41
41 Oph	17 11.5	- 0 20	4.82	K2 III	+0.9		.016	18
HR 6433	17 13.9	+10 58	5.28	K4 II-III	-1.0		.0053	94
σ Oph	17 21.6	+ 4 14	4.44	K3 II	-2.6		.0039	
HR 6516	17 25.3	- 0 59	5.34	G8 IV-V	+4.6		.071	60
λ Her	17 26.7	+26 11	4.48	K4 III	-0.1		.012	15
27 Dra	17 32.4	+68 12	5.21	KO III	+0.7	wk-1	.0125	72
β Oph	17 38.5	+ 4 37	2.94	K2 III*	+0.9		.039	28
μ Her	17 42.6	+27 47	3.48	G5 IV	+3.2	wk-1	.088	43
87 Her	17 44.8	+25 39	5.34	K2 III	+0.9		.013	13
90 Her	17 50.1	+40 1	5.12	K3 III	+0.1		.0099	28
ξ Dra	17 51.8	+56 53	3.90	K2 III*	+0.9		.025	23
ν Oph	17 53.5	- 9 46	3.50	KO III	+0.7	st-1	.028	29
ξ Her	17 53.9	+29 16	3.82	KO III	+0.7	st-1	.024	26
γ Dra	17 54.3	+51 30	2.42	K5 III*	-0.2		.030	14
93 Her	17 55.6	+16 46	4.71	KO II-III	-0.8	4150	.0090	5
70 Oph	18 0.4	+ 2 31	4.28	KO V*	+6.0		.220	24
71 Oph	18 2.5	+ 8 43	4.73	G8 III-IV	+1.3	st-1	.021	21
HR 6791	18 4.5	+43 27	5.11	KO p				n
36 Dra	18 13.3	+64 22	5.03	F5 V	+3.3	wk-1	.045	41
105 Her	18 15.1	+24 24	5.49	K4 II	-2.6		.0024	
74 Oph	18 15.9	+ 3 20	4.92	G8 III	0.0	st-1	.010	27
η Ser	18 16.1	- 2 55	3.42	G8 IV	+3.5	wk-1	.105	42
κ Lyr	18 16.4	+36 1	4.34	K2 III	+0.9		.020	8
ζ Sct	18 18.2	- 8 59	4.83	KO III	+0.7	wk-1	.015	29
HR 6885	18 18.4	+17 46	5.48	K3 III	+0.1		.0083	44
109 Her	18 19.4	+21 43	3.92	K2 III	+0.9		.025	67
χ Dra	18 22.9	+72 41	3.69	F6 V*	+3.6	st-1	.096	62
60 Ser	18 24.5	- 2 3	5.44	KO III	+0.7	4150	.011	45
42 Dra	18 25.7	+65 30	4.99	K2 III	+0.9		.015	62
HR 6970	18 29.5	-11 3	5.25	G8 III	0.0	st-1	.0088	34
α Sct	18 29.8	- 8 19	4.06	K3 III	+0.1		.016	96
HR 6983	18 31.7	+52 16	5.42	KO III	+0.7	st-1	.0115	7
ε Sct	18 38.0	- 8 22	5.09	G8 II	-2.6		.0029	
HR 7064	18 42.1	+26 33	4.92	K3 III	+0.1		.011	13
HR 7117	18 48.3	+73 58	5.33	KO II-III	-0.8	wk-1	.0076	57
o Dra	18 49.7	+59 16	4.78	KO II-III	-0.8	wk-CN	.0076	53
HR 7137	18 50.8	+50 35	4.97	G8 III	0.0	st-1	.010	32
η Sct	18 51.7	- 5 58	5.04	K2 III	+0.9		.015	81
HR 7162	18 53.3	+32 46	5.21	GO V	+4.3	wk-1	.066	34
ε Aql	18 55.1	+14 56	4.21	K2 III	+0.9		.022	34
υ Dra	18 55.6	+71 10	4.91	KO III	+0.7	wk-1	.014	15
HR 7181	18 55.7	+26 5	5.28	K2 III	+0.9		.013	28
λ Lyr	18 56.2	+32 0	5.11	K3 II	-2.6		.0029	
12 Aql	18 56.3	- 5 53	4.15	K1 III	+0.8	wk-1	.021	30
53 Dra	19 9.8	+56 41	5.24	G8 III	0.0	4150	.0089	25
43 Sgr	19 11.8	-19 8	5.03	G8 II	-2.6		.0030	
54 Dra	19 12.1	+57 32	5.26	K2 III	+0.9		.013	35
δ Dra	19 12.5	+67 29	3.24	G9 III	+0.3	wk-1	.026	17
23 Aql	19 13.5	+ 0 54	5.32	K2 II-III	-0.8		.0060	
κ Cyg	19 14.8	+53 11	3.98	KO III*	+0.7	st-1	.022	28
26 Aql	19 15.2	- 5 36	5.10	G8 III-IV	+1.3	wk-1	.017	35
τ Dra	19 17.5	+73 10	4.63	K3 III	+0.1		.0125	66
31 Aql	19 20.2	+11 44	5.23	G8 IV	+3.5	4150	.045	130
4 Vul	19 21.1	+19 36	5.31	KO III	+0.7	wk-1	.012	43
μ Aql	19 29.2	+ 7 10	4.65	K3 III	+0.1		.012	95

Table 4 (continued)

Name	α (1900)	δ	m	Spectral Type	M	Group	π sp	Speed (Km/Sec)
37 Aql	19h29m.6	-10°47'	5.24	G8 III	0.0	4150	0".0089	20
σ Dra	19 32.6	+69 29	4.78	K0 V*	+6.0		.175	74
ε Sge	19 32.8	+16 14	5.67	G8 III	0.0	st-1	.0074	22
HR 7468	19 33.5	+44 28	5.16	K0 III	+0.7	wk-1	.013	60
54 Sgr	19 35.0	-16 31	5.45	K2 III	+0.9		.012	50
φ Cyg	19 35.4	+29 55	4.79	G8 III-IV	+1.3	st-1	.020	27
β Sge	19 36.6	+17 15	4.45	G8 II	-2.6		.0039	
10 Vul	19 39.6	+25 32	5.45	G8 III	0.0	wk-1	.0080	17
56 Sgr	19 40.5	-20 0	5.06	K1 III	+0.8	wk-1	.014	62
15 Cyg	19 40.7	+37 7	5.02	G8 III	0.0	st-1	.0099	33
o Aql	19 46.2	+10 10	5.22	F8 V	+3.9	st-1	.054	22
20 Cyg	19 48.1	+52 44	5.17	K3 III	+0.1		.0096	39
ε Dra	19 48.5	+70 1	3.99	G8 III*	0.0	wk-1	.016	43
ξ Aql	19 49.4	+ 8 12	4.86	K0 III	+0.7	wk-1	.015	38
β Aql	19 50.4	+ 6 9	3.90	G8 IV*	+3.5	wk-1	.083	31
η Cyg	19 52.6	+34 49	4.03	K0 III	+0.7	wk-1	.021	18
HR 7633	19 54.0	+58 35	5.13	K5 II-III	-1.0		.0060	32
γ Sge	19 54.3	+19 13	3.71	K5 III	-0.2		.017	22
26 Cyg	19 58.5	+49 50	5.28	K1 II-III	-0.8	4150	.0061	21
η Sge	20 0.7	+19 42	5.26	K2 III	+0.9		.013	41
ρ Dra	20 2.4	+67 55	4.66	K3 III	+0.1		.012	11
66 Dra	20 4.0	+61 42	5.57	K3 III	+0.1		.0081	79
23 Vul	20 11.6	+27 30	4.73	K3 III	+0.1		.012	30
24 Vul	20 12.5	+24 22	5.45	G8 III	0.0	wk-1	.0080	34
α² Cap	20 12.5	-12 51	3.77	G9 III	+0.3	wk-1	.021	18
HR 7759	20 13.4	+40 3	5.50	K4 II	-2.6		.0024	
σ Cap	20 13.6	-19 26	5.46	K3 II	-2.6		.0024	
HR 7794	20 18.2	+ 5 1	5.41	G8 III-IV	+1.3	wk-1	.015	18
39 Cyg	20 19.9	+31 52	4.60	K3 III	+0.1		.0125	8
69 Aql	20 24.4	- 3 13	5.11	K2 III	+0.9		.014	18
70 Aql	20 31.5	- 2 54	5.22	K5 II	-2.6		.0027	
71 Aql	20 33.2	- 1 27	4.51	G8 III	0.0	st-1	.0125	8
κ Del	20 34.3	+ 9 44	5.23	G5 IV	+3.2		.039	48
1 Aqr	20 34.3	+ 0 8	5.39	K1 III	+0.3	wk-1	.012	42
30 Vul	20 40.6	+24 55	5.13	K2 III	+0.9		.014	76
52 Cyg	20 41.5	+30 21	4.34	K0 III	+0.7	wk-1	.019	22
ε Cyg	20 42.0	+33 36	2.64	K0 III*	+0.7	st-1	.041	49
HR 7956	20 43.2	+34 0	5.20	K3 III	+0.1		.0095	13
η Cep	20 43.3	+61 27	3.59	K0 III-IV	+1.4	wk CN	.036	124
31 Vul	20 47.9	+26 43	4.76	G8 III	0.0	st-1	.011	47
32 Vul	20 50.3	+27 41	5.24	K4 III	-0.1		.0085	26
17 Del	20 50.9	+13 20	5.39	K0 III	+0.7	wk-1	.0115	7
63 Cyg	21 3.2	+47 15	4.88	K4 II	-2.6		.0032	
ν Aqr	21 4.2	-11 47	4.52	G8 III	0.0	st-1	.0125	25
ι Cap	21 16.7	-17 16	4.30	G8 III	0.0	st-1	.014	25
1 Peg	21 17.5	+19 23	4.24	K1 III	+0.8	wk-1	.021	66
71 Cyg	21 25.3	+46 6	5.34	K0 III	+0.7	wk-1	.012	41
ρ Cyg	21 30.2	+45 9	4.22	G8 III	0.0	wk CN	.014	41
72 Cyg	21 30.7	+38 5	4.98	K1 III	+0.3	4150	.015	67
25 Aqr	21 34.5	+ 1 48	5.33	K0 III	+0.7	wk-1	.012	40
42 Cap	21 36.1	-14 30	5.23	G2 IV	+2.9	st-1	.033	46
κ Cap	21 37.1	-19 19	4.82	G8 III	0.0	wk-1	.011	51
46 Cap	21 39.7	- 9 32	5.28	G8 II-III	-1.0	4150	.0055	7
11 Cep	21 40.5	+70 51	4.85	K0 III	+0.7	wk-1	.015	44
12 Peg	21 41.5	+22 29	5.45	K0 Ib	-4.5			
HR 8324	21 41.9	+71 52	5.40	K1 III	+0.8	4150	.012	43
16 Cep	21 57.8	+72 42	5.15	F5 V	+3.3	st-1	.043	33
ν Peg	22 0.6	+ 4 34	4.90	K4 III	-0.1		.010	70
HR 8424	22 2.0	+44 32	5.32	K5 III	-0.2		.0078	17
20 Cep	22 2.0	+62 18	5.39	K4 III	-0.1		.0080	33

Table 4 (continued)

Name	α (1900)	δ	m	Spectral Type	M	Group	π sp	Speed (Km/Sec)
24 Cep	22^h 7^m.9	+71°51'	4.99	G8 III	0.0	st-1	0".010	5
HR 8472	22 8.2	+56 21	5.42	F8 V	+3.9	st-1	.050	14
HR 8475	22 8.4	+34 7	5.42	K2 III	+0.9		.0125	16
HR 8485	22 9.3	+39 13	4.64	K3 III	+0.1		.012	7
1 Lac	22 11.6	+37 15	4.22	K3 II-III	-0.8		.0090	6
θ Aqr	22 11.6	- 8 17	4.32	G8 III-IV	+1.3	st-1	.025	12
β Lac	22 19.3	+51 44	4.58	G9 III	+0.3	wk-1	.014	67
35 Peg	22 22.8	+ 4 12	4.93	K0 III	+0.7	wk-1	.015	110
κ Aqr	22 32.6	- 4 45	5.33	K2 III	+0.9		.013	53
11 Lac	22 36.1	+43 45	4.64	K3 III	+0.1		.0125	23
66 Aqr	22 38.2	-19 21	4.38	K4 III	-0.1		.010	38
13 Lac	22 39.6	+41 18	5.24	K0 III	+0.7	wk-1	.012	30
λ Peg	22 41.7	+23 22	4.14	G8 II-III	-1.0	st-1	.0093	16
μ Peg	22 45.2	+24 4	3.67	K0 III	+0.7	st-1	.026	26
ι Cep	22 46.1	+65 40	3.68	K1 III	+0.8	st-1	.027	35
HR 8702	22 47.9	+82 37	4.97	K3 III	+0.1		.0105	29
HR 8748	22 55.2	+83 49	4.96	K4 III	-0.1		.0097	37
HR 8779	22 59.7	+66 40	5.50	K3 III	+0.1		.0082	8
3 And	22 59.7	+49 30	4.91	K0 III	+0.7	wk-1	.014	76
56 Peg	23 2.2	+24 56	4.98	K0 IIp*				n
ψ¹ Aqr	23 10.7	- 9 38	4.48	K0 III	+0.7	wk-1	.018	86
γ Psc	23 12.0	+ 2 44	3.85	G8 III*	0.0	wk CN	.017	197
94 Aqr	23 13.9	-14 0	5.27	G5 IV	+3.2		.038	24
o Cep	23 14.5	+67 34	4.90	K0 III	+0.7	wk-1	.0145	11
11 And	23 14.8	+48 5	5.42	K0 III	+0.7	wk-1	.011	35
7 Psc	23 15.3	+ 4 50	5.18	K2 III	+0.9		.014	46
66 Peg	23 18.0	+11 46	5.28	K3 III	+0.1		.0091	2
θ Psc	23 22.9	+ 5 50	4.45	K1 III	+0.8	4150	.019	48
70 Peg	23 24.1	+12 13	4.67	G8 III	0.0	wk-1	.012	25
14 And	23 26.4	+38 41	5.34	K0 III	+0.7	wk CN	.012	114
72 Peg	23 29.0	+30 46	5.21	K4 III	-0.1		.0087	23
λ And	23 32.7	+45 55	4.00	G8 III-IV	+1.3	wk CN	.029	80
γ Cep	23 35.2	+77 4	3.42	K1 IV*	+2.9	4150	.105	39
HR 8987	23 37.3	-16 0	5.44	K4 III	-0.1		.0078	8
78 Peg	23 39.0	+28 48	4.98	K0 III	+0.7	wk-1	.014	10
ψ And	23 41.1	+45 52	5.09	G5 Ib	-4.5			
τ Cas	23 42.2	+58 6	5.09	K1 III	+0.8	wk-1	.014	26
27 Psc	23 53.6	- 4 7	5.07	G9 III	+0.3	st-1	.0115	40
3 Cet	23 59.4	-11 4	5.16	K3 Ib	-4.5			

* These stars have been classified by Dr. W. W. Morgan and have been used as standards in this study.

μ Cas — This star shows spectroscopic evidence of being fainter than other G5 V stars, such as κ Cet. The large trigonometric parallax supports this conclusion.

ι Ari — The hydrogen lines and λ 4290 are strong enough to indicate a class II star, but the CN is barely strong enough for class III, and the Sr II line is not much stronger than this would require.

φ Aur — CN is very strong, but Sr II is only slightly stronger than in class III stars, and the hydrogen lines are quite weak.

τ UMa — A metallic-line star. See Roman, Morgan, and Eggen, Ap. J., 107, 107, 1948.

37 Com — The hydrogen lines are strong, but the strontium line indicates that the star is no brighter than class II, and the CN indicates an even lower luminosity. CH is very weak. The remainder of the spectrum shows no evidence that it is composite.

16 Ser — Sr II is very strong, but CN is only moderate in intensity, and the hydrogen lines are weak.

HR 6136 — CN is too strong for a star later than K2 or K3, but the Ca I line, λ 4226, is as strong as it is at K5 III.

HR 6152 — The hydrogen lines and Sr II indicate that this is a class II star, but CN is very weak or absent. CH is probably too strong for class II.

18 Dra — CN and CH are weak. Otherwise, the star appears to be a normal giant.

HR 6791 — CN and Sr II are weak. The hydrogen lines are strong enough to indicate a fairly high luminosity.

56 Peg — The hydrogen lines are too weak for the strength of Sr II and CN.