BRIGHT-LINE STARS AMONG THE TAURUS DARK CLOUDS

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ABSTRACT

On objective-prism photographs of three areas of the Taurus dark clouds, 40 faint stars with $H\alpha$ emission were discovered. Slit spectrograms of 35 of these stars were examined for the purpose of finding spectral peculiarities which might be attributed to interaction between the stars and the surrounding clouds.

Except for two stars of type Be which are probably not involved in the clouds and one peculiar A4e star, the stars are main-sequence stars of late spectral type and low luminosity. The stars are concentrated in small regions in or near areas of great obscuration. If these stars are of normal luminosity and are at the distance of the clouds, their apparent magnitudes are generally too faint as a result of space absorption.

The spectra show many of the characteristics previously found in the T Tauri variables. The hydrogen and *Ca* II (H and K) bright lines are extremely strong in spectral types dGe–dM2.5e. Emission lines of *He* I, *Fe* I, *Fe* II, and [*S* II] decrease in intensity in later spectral types in the two Taurus areas but are practically absent in stars of the area in Orion.

Related stars.—A few stars with similar spectra, located in other regions of the sky are discussed for comparison with the Taurus stars.

Radial velocities.—The approximate radial velocities from emission and absorption lines were measured. The differences, emission *minus* absorption, seem to be greatest for the earlier types, which also show the strongest T Tauri characteristics.

The relationship of the T Tauri variables to the Milky Way obscuring clouds was previously noted.[1] The emission lines of hydrogen and calcium (H and K) appear in great intensity in such variables and are easily detected in low-dispersion spectra. For the purpose of identifying additional stars of this kind, objective-prism photographs on red-sensitive 103*a*-E emulsions were made with the 10-inch *f*5.2 refractor. The lens of this telescope is corrected for red light, making it particularly suitable for discovering stars with bright $H\alpha$. A yellow filter was used to exclude the blue and violet light, and, as a result, H and K do not appear.

Two regions about 15° square in Taurus and one in northern Orion were photographed by W. C. Miller (Table 1). The spectra were somewhat widened during exposure. The red continuous spectra of stars as faint as the fourteenth magnitude may be seen, and the bright $H\alpha$ line alone, of stars a magnitude or more fainter.

On these plates, previously unknown bright $H\alpha$ was detected in the spectra of 40 faint stars. In general, the distribution of the stars indicates a marked relationship to the lanes of dark nebulosity. The stars appear to be located on the peripheries rather than in the centers of the obscuring clouds.

Later, slit spectrograms of 35 of these stars were obtained at the 100-inch telescope in order to check the emission lines and to determine other spectral characteristics. A dispersion of 220 A/mm at $H\gamma$ was generally used, and usually only one spectrogram of each star was obtained. A preliminary report of the results was given in 1946.[2]

In Table 2 the stars with $H\alpha$ in emission are listed in order of right ascension, together with the measured radial velocities of the emission and absorption lines. The displacement of the bright lines relative to the absorption lines are in the eighth column. Figures 1–5 are enlarged identification charts, photographed on 103*a*-C red-sensitive plates at the 60-inch telescope by Dr. R. Minkowski.

[1] A. H. Joy, *Mt. W. Contr.*, No. 709; *Ap. J.*, **102**, 168, 1945.

[2] A. H. Joy, *Pub. A.S.P.*, **58**, 244, 1946.

THE STARS OF EARLY SPECTRAL TYPES

Two stars of the list, MHα 259-21, mag. 12, and 265-12, mag. 9.2, are Be stars with rapid decrement of the hydrogen emission lines. The continuous spectra extend into the ultraviolet region, and the K lines appear weak in absorption. In the first star, bright $H\alpha$ is strong, but the emission series ends with $H\gamma$; the ultraviolet absorption lines are weak. In the second star, $H\beta$ is barely visible in emission; the dark hydrogen lines from $H\gamma$ shortward are wide and strong. Both stars are outside the areas of dense obscuration and may not be greatly affected by interstellar absorption. If we disregard absorption effects, the difference of about 3 mag. in their apparent magnitudes indicates a considerable difference in distance, and both are probably well beyond the clouds.

Another star, MHα 265-13, MWC 497, is peculiar and may be affected by its apparent location in the densely obscured region just south of Barnard 122. The spectrum shows strong bright $H\alpha$ with a steep decrement of the hydrogen series shortward. Beyond $H\delta$ the Balmer series has strong deep absorption lines. If the star is at the distance of the clouds, its brightness must be dimmed by about 5 mag.; nevertheless, it is not greatly reddened. The presence of λ 4068 [*S* II] and λ 4233 *Fe* II in emission indicates that the

TABLE 1

OBJECTIVE-PRISM OBSERVATIONS

PLATE	CENTER α (1900)	CENTER δ (1900)	DATE	EXPOSURE (MIN.)	NO. OF BRIGHT $H\alpha$ STARS
MHα 257	$4^h 32^m$	$+16^\circ 22'$	1945 Nov. 3	240	5
259	4 32	26 22	1945 Dec. 1	270	26
265	5 30	12 0	1946 Jan. 26	180	9

star is probably involved in nebulosity. Forbidden iron lines are present on all four Mount Wilson plates, but in variable intensity. They are wider and stronger than those observed in the companion to α Scorpii by Wilson and Sanford.[3] According to Struve and Swings,[4] the *Fe* II lines in the companion to α Scorpii may have their origin in a "small nebulosity" surrounding the companion and are influenced in some way by the supergiant M-type primary star. Similar interactions may be at work between MHα 265-13 and the dark cloud in which it is probably imbedded.

The measures of the dark lines on four plates, dispersion 110 A/mm at $H\gamma$, indicate large and rapid variations in velocity, while the bright-line velocity is either constant or nearly so (Table 3). The peculiarities of the spectrum were independently discovered by G. H. Herbig (letter, January 19, 1948).

STARS WITH LATE-TYPE SPECTRA

The spectroscopic data of the stars of late type are in Table 4. Intensity estimates of some of the important emission lines were made. The computed total absorption for each star is in the last column. These values are the differences between the apparent magnitude, corrected for a distance modulus of 5.0 mag., and the main-sequence absolute magnitudes of the Russell diagram. The absorption may be due to material of the clouds in the line of sight or to envelopes immediately surrounding the stars. The negative values indicate that the estimated apparent magnitudes are too bright, the modulus too large, or the estimated spectral type in error. The magnitude estimates are rough approxima-

[3] *Pub. A.S.P.*, **49**, 221, 1937.

[4] *Ap. J.*, **92**, 317, 1940.

TABLE 2

OBSERVATIONS OF STARS WITH $H\alpha$ EMISSION

STAR	α (1950)	δ (1950)	EST. (m_v)	DATE OF SLIT SPEC.	RADIAL VELOCITY			NOTES
					Bright (Km/Sec)	Absorption (Km/Sec)	Br.−Abs. (Km/Sec)	
MHα 259-3	$4^h 11^m.3$	+28° 3′	13.5	1946 Feb. 19	....	....	....	
259-22	4 11.8	+26 41	14	Jan. 23	+31	−19	+50	
259-23	4 11.8	+26 39	14.5	Jan. 23	+19	+6	+13	
259-4	4 11.9	+28 5	15.5	....	....	....	....	
259-5	4 14.4	+28 13	14	Jan. 19	−19	−48	+29	
259-6s	4 15.4	+28 9	14	Jan. 19	−47	+28	−75	1
259-6n	4 15.4	+28 10	15	1948 Jan. 1	+56	+44	+12	
259-7	4 16.2	+29 0	12	1945 Dec. 12	−29	−39	+10	2
259-8	4 18.8	+27 48	13	Dec. 13	− 3	−13	+10	
259-11	4 24.0	+25 35	12	Dec. 29	−32	+53	−85	3
259-10	4 24.1	+25 57	11.5	Dec. 29	+ 1	....	....	4
259-9sf	4 26.6	+26 28	13.5	Dec. 30	+37	+37	0	5
259-9npr	4 26.6	+26 28	13.5	Dec. 30	− 3	+35	−38	6
259-12	4 27.7	+25 57	13	1946 Feb. 19	....	....	....	
257-3	4 28.6	+17 31	12	....	....	....	....	
259-16	4 28.8	+24 19	15	....	....	....	....	
257-2	4 29.6	+17 26	12.5	Mar. 12	+26	+12	+14	7
259-13	4 30.6	+25 15	13.5	Feb. 20	−54	+16	−70	3
259-20	4 30.9	+22 45	13	Jan. 24	+ 5	+47	−42	6,15
257-6	4 30.9	+18 4	13	Feb. 7	−14	−18	+ 4	3
259-17	4 31.9	+24 24	14	Feb. 6	+13	+34	+21	15
259-18	4 32.4	+24 9	12.5	1945 Dec. 30	− 8	+19	−27	
259-14	4 34.3	+27 4	12	1946 Jan. 22	....	....	....	
259-15	4 35.4	+26 6	14	Sept. 20	−19	+14	−33	6
259-19	4 39.5	+25 10	14	Feb. 20	−91	....	....	
259-24	4 39.9	+25 15	15	1948 Jan. 2	+ 1	+15	−14	
257-7	4 44.0	+16 53	13.5	1946 Oct. 16	+ 1	0	− 1	
257-8	4 44.2	+16 52	13.5	Oct. 16	− 3	....	....	3
259-2	4 44.7	+29 20	12.5	Jan. 22	−61	+13	−74	8
259-1	4 52.0	+30 18	12	....	+ 6	+24	−19	9
259-21	4 53.8	+27 38	12	Jan. 23	−28	−23	− 5	10
265-2	5 26.3	+11 49	9.2	Feb. 6	−11	....	....	
265-3	5 26.6	+11 49	11.5	Feb. 6	+31	+36	− 5	
265-5	5 26.8	+12 53	14.5	Feb. 21	−22	....	....	11
265-6	5 27.3	+12 12	13	Feb. 21	−23	−31	+ 8	
265-7	5 27.4	+12 8	14	....	....	....	....	
265-9	5 28.0	+12 8	14.5	Oct. 17	+40	+40	0	
265-16	5 28.6	+12 9	14	....	−25	+31	−56	12
265-13	5 28.6	+12 8	11.5	....	+21	+56	−35	13
265-12	5 28.6	+10 59	9.2	....	....	+37	....	14

NOTES TO TABLE 2

1. Spectrum veiled by continuous emission, extending into the ultraviolet. Balmer series extends to H14. This star is described by Struve and Swings, *Pub. A.S.P.*, **60**, 61, 1948, under the heading "An Unusual Stellar Species." They emphasize the shortward intensity of the continuous spectrum and the hydrogen series.
2. BP Tauri, 11.7–12.8 pg. mag. Spectrum heavily veiled by continuous emission. Balmer series to H17.
3. Spectrum veiled by continuous emission.
4. Barnard No. 100, Pl. 5, *Atlas of Selected Objects in the Milky Way*, "a very minute bright nebula." Many emission lines of ionized and neutral atoms. Spectrum partially veiled by overlying continuous spectrum. Found independently by G. H. Herbig at the Lick Observatory (letter, Jan. 19, 1948).
5. Double star, separation 16″±. Good absorption-line spectrum.
6. Spectrum heavily veiled by continuous emission. Balmer series to H19.
7. Spectrum partially veiled by continuous radiation. Balmer series to H19.

NOTES TO TABLE 2—*Continued*

8. Following star of double, separation 4″, nearly equal components. Wide emission lines. The preceding star of the pair, dF0, has no bright lines; possibly an optical companion.
9. Two spectrograms, December 29, 1945, and February 13, 1947. On the second plate, taken independently by R. Minkowski, the bright lines were about twice as strong as on the first plate. The mean velocities are given.
10. B3e. $H\beta$ and $H\gamma$ are bright.
11. Preceding star of two, separation 20″±, equal magnitudes.
12. Star just preceding Barnard 122, Chart 6, *Atlas of Selected Objects in the Milky Way*. Two plates, January 15 and January 27, 1943.
13. A4ep. MWC 497. Star south of Barnard 122. Four plates (see Table 3).
14. B9e. *HD Ext.* 244524; B9; BD+10°803.
15. A letter (October 17, 1949) from G. H. Herbig identifies 259–20 with CI Tau and 259–17 with AA Tau.

tions, largely based on the strength of the spectra on the objective-prism plates and on the apparent brightness on the slit of the spectrograph at the time of observation. The large scattering in the values of the absorption indicates that the stars are differently affected by their environment or that they are differently situated with reference to the obscuring material as seen from the earth. The presence of selective absorption at short wave lengths cannot be readily evaluated because of the unmeasured effect in many stars of an unknown hot source which produces an overlying continuous spectrum, strong in the violet region.

For intercomparison the stars of the three areas are grouped together. The stars of Plate 259, numbering 22, may be separated into three subdivisions, depending on the spectral type and the presence of certain emission lines. Since only one observation of each star has been made, it may be necessary to revise the classification of some stars if later spectrograms show large changes in the spectra.

Plate 259, group a, the T Tauri stars.—The spectra of the stars of Plate 259, group *a* (Table 4) are like those of the T Tauri variables at certain phases, and there can be little doubt that they are similar in nature, although reports of changes in light are, thus far, lacking. They may be classed as G type; absorption lines are too few to justify a more accurate estimate of type. The emission lines are numerous. H and K (*Ca* II) are stronger than $H\delta$ and are among the strongest bright calcium lines observed in any stars. The line λ 4063 *Fe* I and many lines of *Fe* II are prominent in all four stars. In two stars, λ 4068 [*S* II] appears in low intensity. The Balmer lines are strong and extend with slow decrement shortward to $H18$ or $H19$. The absence of absorption lines is due both to emission within the lines and to a veiling of the spectrum by an overlying continuous radiation such as occurs in many of the T Tauri variables and perhaps in the dwarf Me stars of low luminosity.[5] While none of these four stars has the extreme peculiarities of RU Lupi or SZ Tauri, all so closely resemble certain of the T Tauri variables that it seems quite probable that they also vary in light.

Consideration of the apparent magnitudes and luminosities of the stars of this group indicates either (1) that they are far beyond the Taurus clouds, (2) that they are definitely underluminous for G-type stars of the main sequence, or (3) that their apparent brightness is diminished 1–4 mag. by obscuration. The apparent concentration of the stars in the Taurus dark lanes and their peculiar spectra indicate beyond doubt that they are associated with the clouds. The impact of the particles of the clouds produces the bright lines and the hot veiling continuous spectrum. Observations of color are needed, but the spectra seem to show that the radiation received is not particularly weakened in the ultraviolet region, even though obscuration of several magnitudes may be present. This same conclusion was reached by Struve and Swings[6] in regard to the MHα 259-6 in B10.

[5] Joy and Humason, *Pub. A.S.P.*, **61**, 133, 1949.

[6] *Pub. A.S.P.*, **60**, 61, 1948.

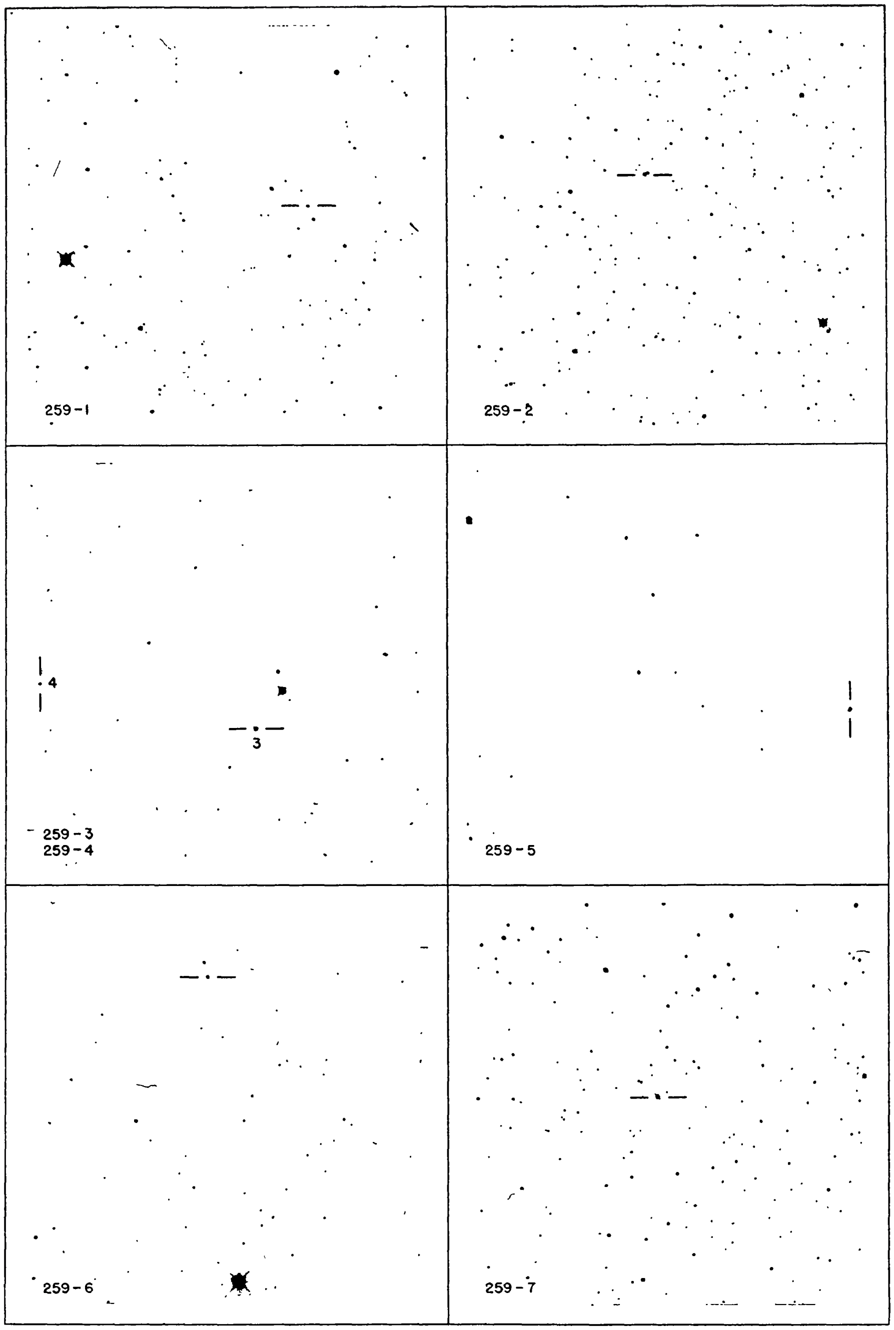

FIG. 1.—Charts of bright $H\alpha$ stars. Scale 1 cm = 3′

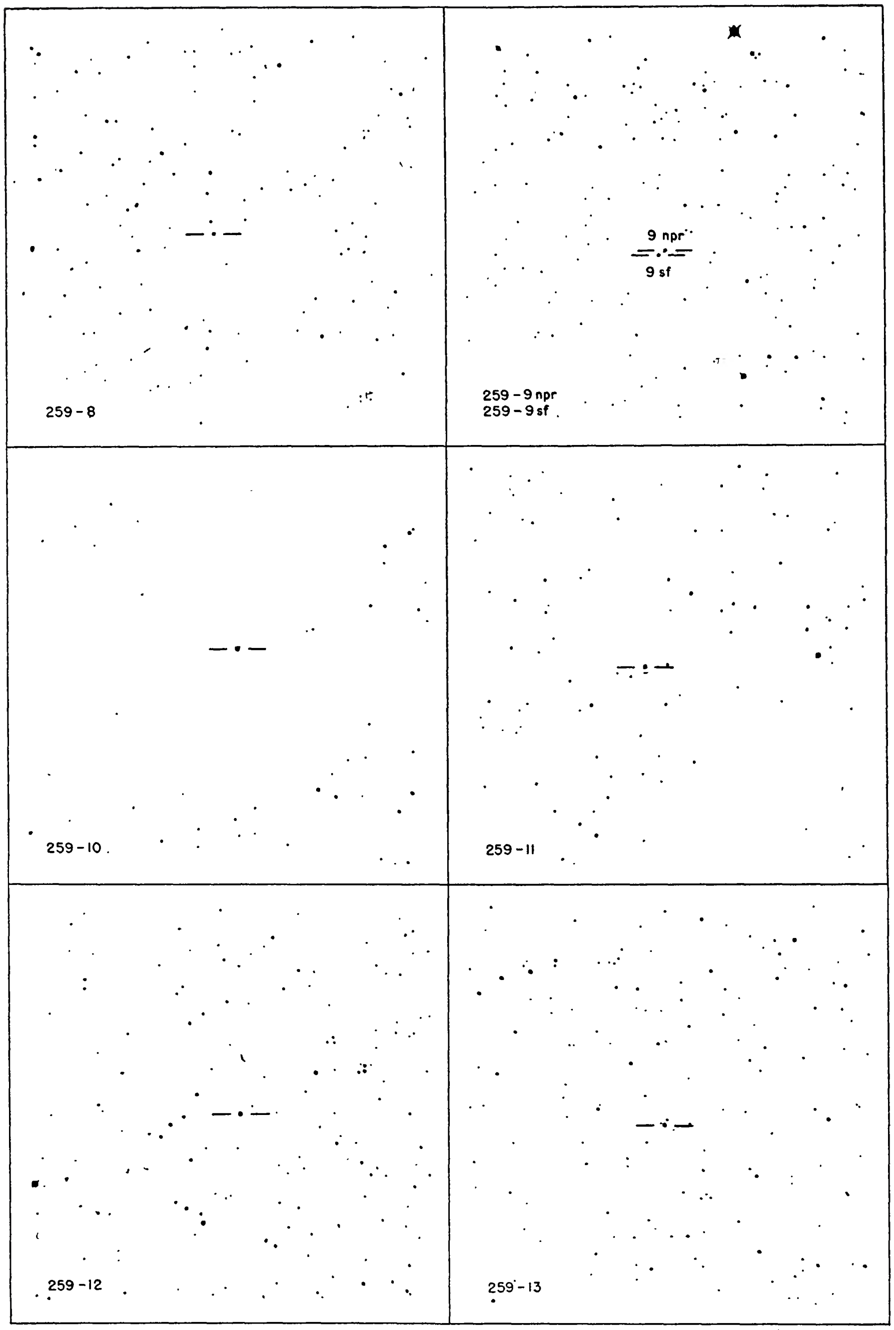

FIG. 2.—Charts of bright $H\alpha$ stars. Scale 1 cm = 3′

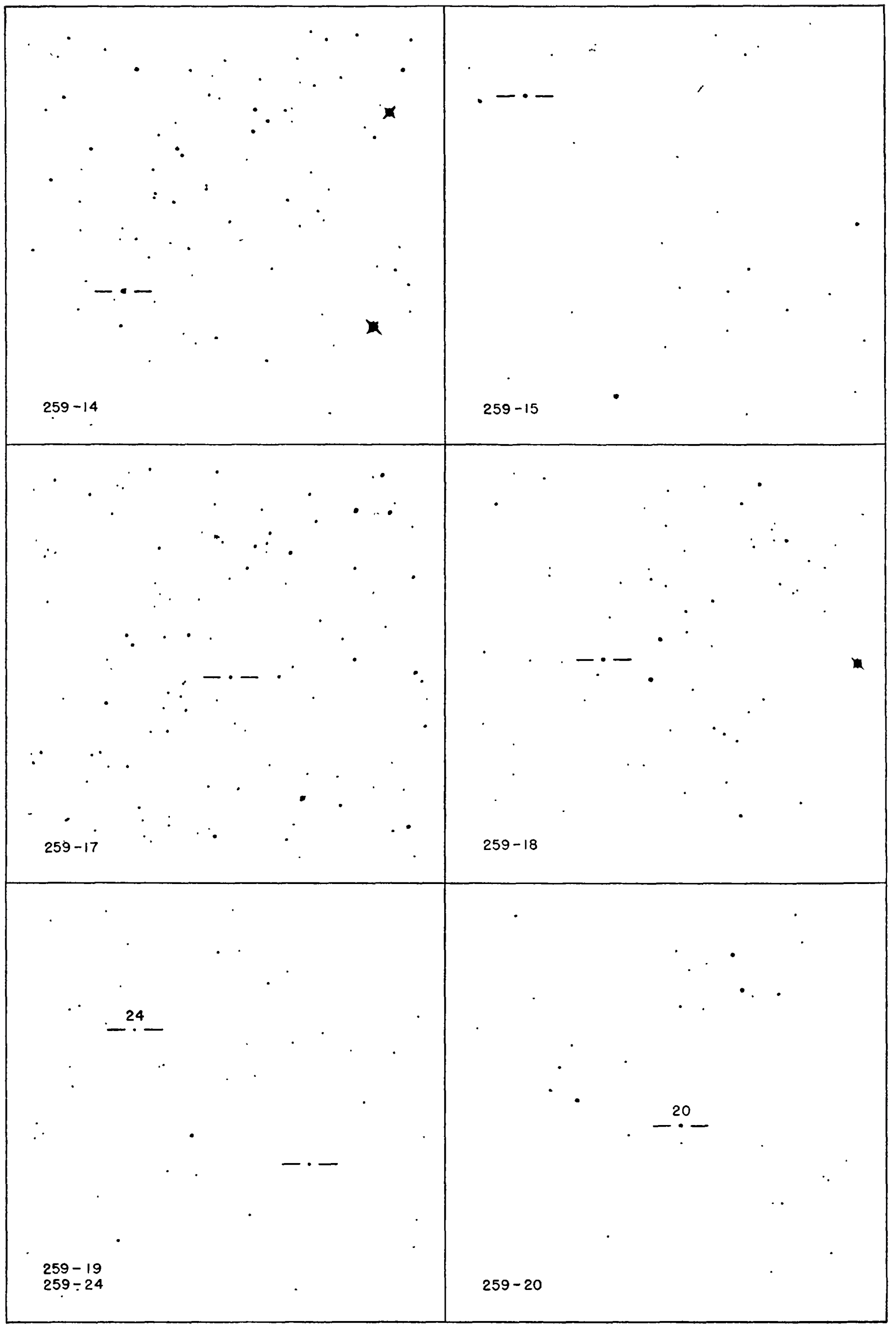

FIG. 3.—Charts of bright $H\alpha$ stars. Scale 1 cm=3′

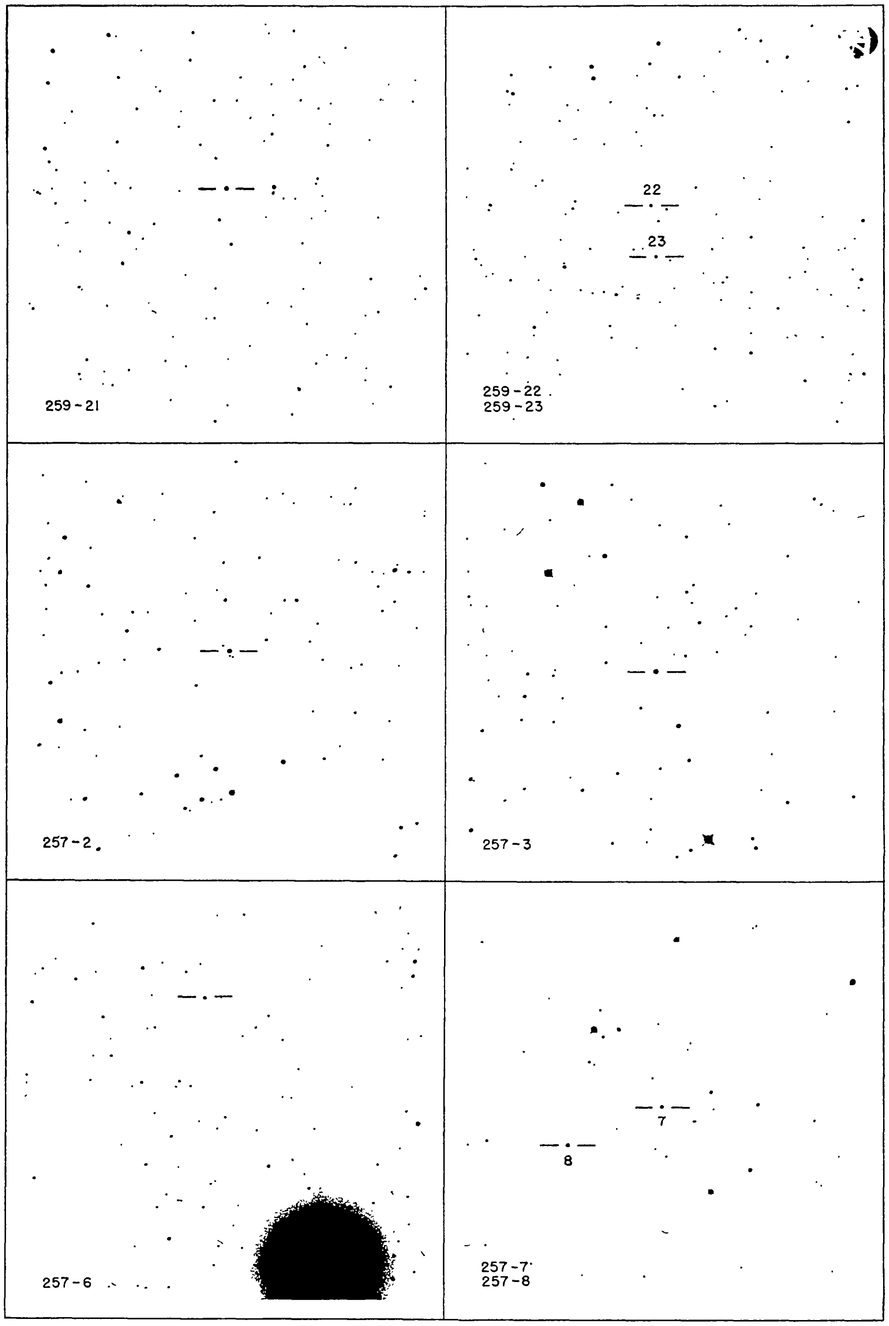

FIG. 4.—Charts of bright $H\alpha$ stars. Scale 1 cm = 3′

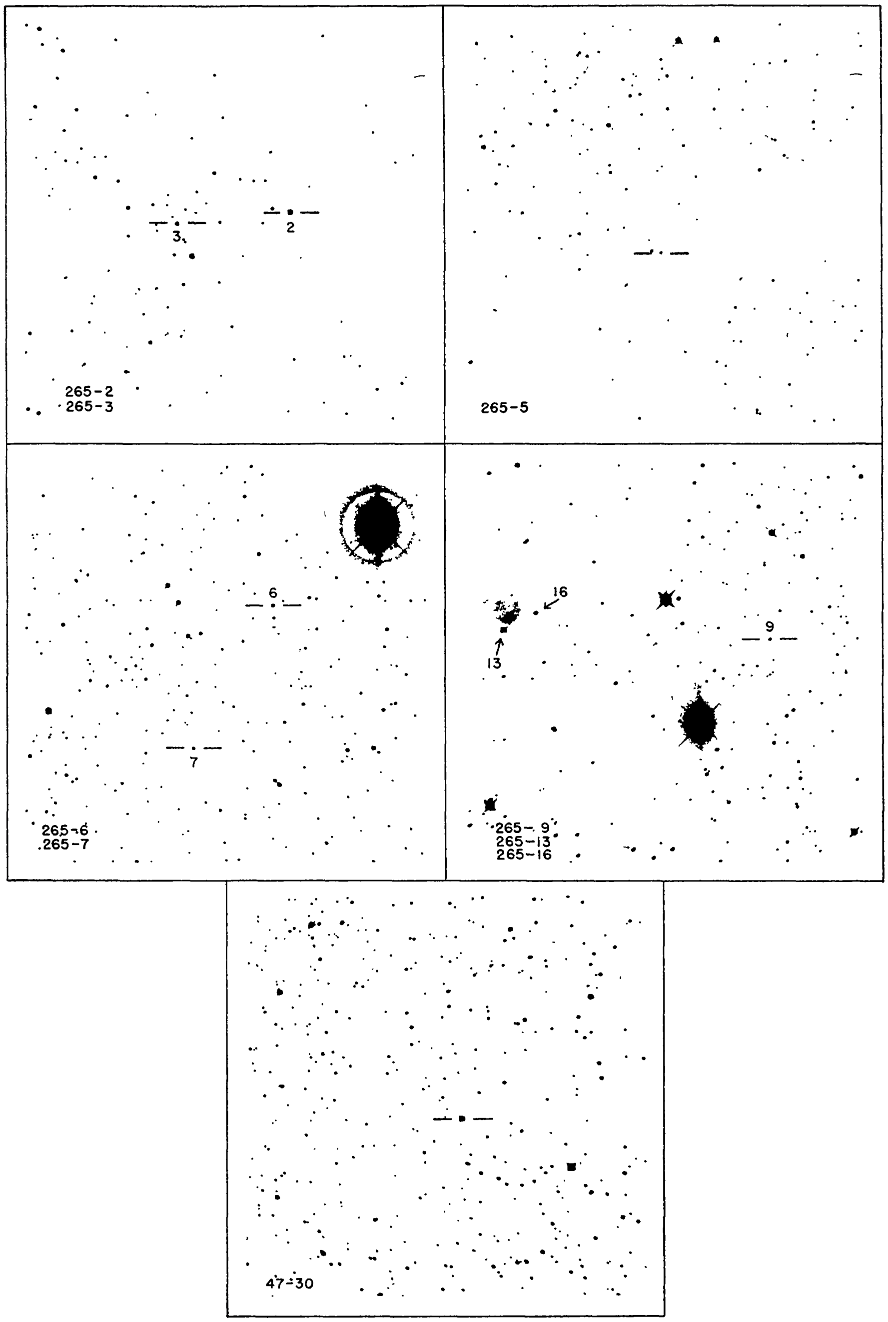

FIG. 5.—Charts of bright $H\alpha$ stars. Scale 1 cm = 3′

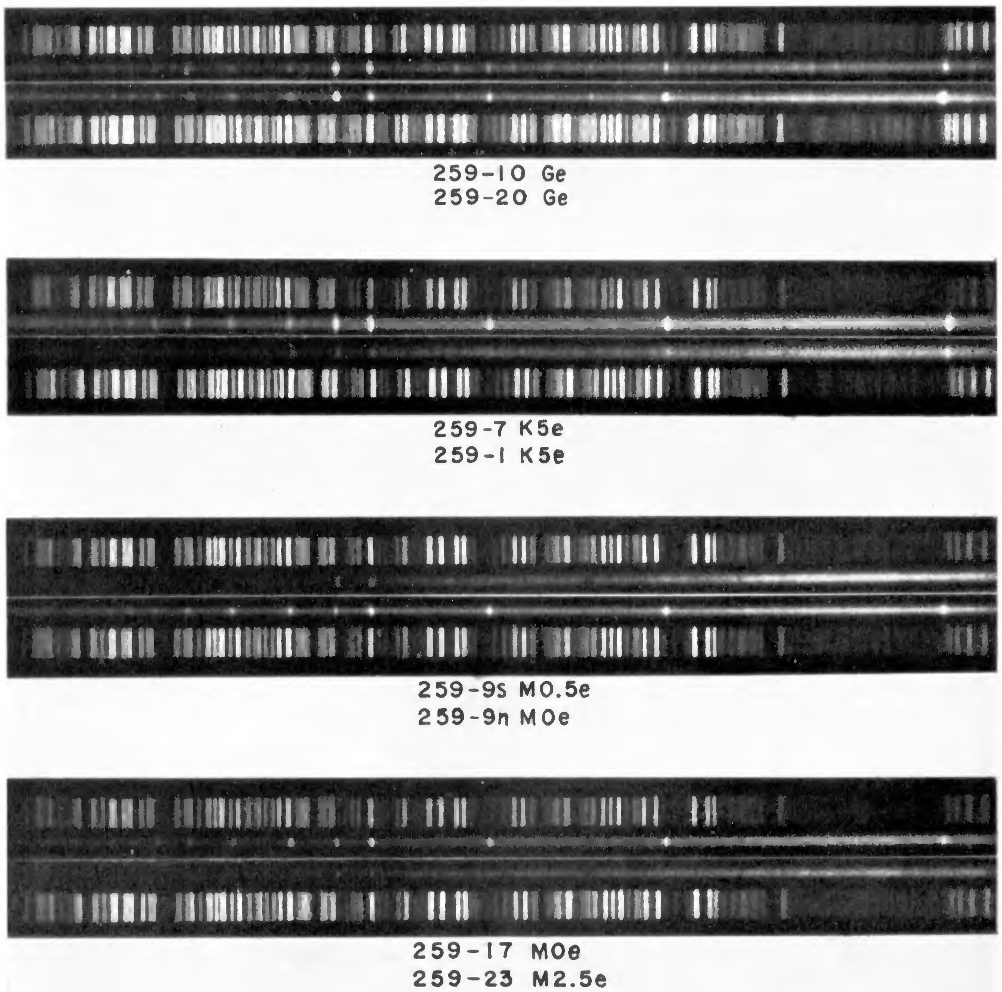

FIG. 6.—Spectra of bright-line stars in the Taurus clouds

Plate 259, group b, late-type stars with weak Fe II, Fe I, or [S II].—In this group, which contains stars of distinctly later type than group *a*, the *Ca* II and $H\delta$ bright lines are strong, but the lines of *He* I, *Fe* II, *Fe* I, and [*S* II] are less prominent. Some spectra are overcast with a heavy continuum. One star, MHα 259-7, is the known variable, BP Tauri, 11.7–13.1 pg. A suspected period of 0.18 day indicates that the light-changes are sometimes rapid. The constancy of the light of other members of the group may well be questioned. The negative values for the absorption effect in the last column of Table 4 indicate that the data are defective for the last two stars of the group. If they are foreground stars, the peculiarities of their spectra need explanation. If they are in the Taurus clouds at a distance of 100 parsecs, either too bright apparent or too faint absolute magnitudes have been used in determining the absorption effect.

In this group the continuous spectrum shows little selective absorption in the shorter wave lengths and the Balmer series extends to $H14$ or in some stars as far as $H19$.

Plate 259, group c, stars with bright H, Ca II, and He I only.—Most of the stars of this group have titanium bands, and the H and K emission is generally weaker than that of $H\delta$. Bright *He* I appears in five stars. In the absence of bright lines of other elements and

TABLE 3

VELOCITY MEASURES OF MHα 265-13

Plate	Date	G.M.T.	Velocity		Em. Int
			Em.	Abs.	
E 749	1943 Jan. 14	19^h45^m	+17	+ 56	Wk
E 753	1943 Jan. 15	17 50	+28	+101	Wk
C 7704	1943 Mar. 16	16 50	+13	+ 58	M
E 1503	1945 Sept. 13	0 5	+24	+ 39	Str

the presence of titanium oxide bands, these stars resemble (1) the faint dMe stars having large proper motions and (2) the companions of several T Tauri variables. Except for one star MHα 259-24, which is located in dense obscuration, the stars of this group show little dimming due to obscuration. Some of them may be on the nearer side of the heavy obscuring clouds. In the three groups of Plate 259 a rather loose relationship between spectral type, magnitude, and the intensity of the emission lines of *Ca* II, *Fe* II, and [*S* II] is indicated. Other correlations involving the darkness of the obscuring area surrounding the star, the absorption effects, the continuous emission veil superposed on the spectra, and the strength of the hydrogen and helium emission lines are uncertain, partly because of insufficient observational material.

The large absorption effects, amounting to several magnitudes, found for the stars of group *a*, show quite definitely that the stars which have the most intense T Tauri features are most deeply involved in the dark nebulosity. For group *b* the effects are less but of a similar nature. In group *c*, except for the presence of hydrogen and calcium emission in moderate strength, the results of contact with the dark clouds are noticeable for a few stars only. The lower temperatures evidently are not favorable for the production of T Tauri effects. Other stars which might be members of this group would be too faint to be observed if their brightness is reduced by obscuration. If the stars are variable, the computed absorption effect will change, depending on the estimated apparent magnitude.

Stars of Plate 257.—The bright-line stars found on Plate 257 resemble those of Plate 259, group *b*, which are about 10° farther north.

Stars of Plate 265.—The bright-line stars in this area are distinctly different from

TABLE 4

INTENSITY OF EMISSION LINES AND OBSCURATION

STAR	EST. m_v	SPECT.	*Ca* II H,K	$H\delta$	*He* I 4471	*Fe* II 4233	*Fe* I 4063	[*S* II] 4068	COMPUTED ABSORPTION (Mag.)
				Plate 259, Group *a*, T Tauri-like Stars					
259-10	11.5	Ge	50	20	1	3	10	1	1.5
20	13	Ge	50	40	3	5	4	...	3.0
13	13.5	Ge	50	30	4	4	5	...	3.5
15	14	Ge	50	35	2	2	3	2	4.0
				Plate 259, Group *b*, Faint *Fe* II, *Fe* I, or [*S* II]					
259-2	12.5	dK4e	30	25	1	...	...	...	0.9
7	12	dK5e	50	35	3	1	...	...	0.0
3	13.5	dK5e	25	6	1	2	...	5	1.5
6s	14	dK6e	25	40	4	1	...	2	1.5
18	12.5	dK6e	25	50	5	...	...	2	0.0
11	12	dM0e	40	50	3	1	...	...	(−1.0)
8	13	dM1e	50	25	1	1	4	...	(−0.8)
				Plate 259, Group *c*, *H*, *Ca* II, and *He* I, Only					
259-24	15	dK5e	20	40	2	...	...	...	3.0
1	12	dK5e	20	30	...	...	...	...	0.0
9npr	13.5	dM0e	20	40	4	...	...	...	0.5
17	14	dM0e	25	40	2	...	...	...	1.0
19	14	dM0e	30	30	...	...	...	...	1.0
12	13	dM0e	10	30	...	...	...	...	0.0
9sf	13.5	dM0.5e	15	1	...	...	...	...	0.1
22	14	dM1.5e	15	40	1	...	...	...	0.1
5	14	dM2e	10	20	2	...	...	...	(−0.4)
6n	15	dM2e	20	1	...	...	...	...	0.6
23	14.5	dM2.5e	20	0	...	...	...	...	(−0.5)
				Plate 257					
257-6	13	dK5e	15	40	...	1	...	...	1.0
8	13.5	dK5e	40	30	1	2	...	...	1.5
2	12.5	dK6e	50	30	...	2	...	...	0.0
7	13.5	dM0e	15	40	1	...	...	2	0.5
				Plate 265					
265-16	14	dK0e	40	10	...	...	...	...	3.3
2	9.2	dK3e	10	...	...	...	...	...	(−2.0)
3	11.5	dK3e	40	12	...	1	...	...	0.3
6	13	dK3e	10	...	...	...	...	...	1.8
9	14.5	dK4e	10	1	...	...	...	1	2.9
5	14.5	dM0e	40	20	...	...	...	...	1.5

those of the other groups. Their spectral types are mostly early K, a spectral class not found among the bright $H\alpha$ stars of the other two plates. Strong *Ca* II emission appears in three stars, but the hydrogen emission is weak in all stars of the group. Bright lines of other elements are weak or absent. The star MHα 265-2, which has weak bright lines ($H\alpha$, $H\beta$, H, and K), is probably a foreground star. The others show evidence of a loss of brightness and a weakening of the violet continuous spectrum due to selective absorption. The nine stars of this plate are concentrated in an area about 1° square.

Close visual binaries are few among the stars of Table 2, although many of the T Tauri variables are double stars with companions of comparable luminosity. The double star, MHα 259-9 is somewhat comparable with UZ Tauri. At the time of observation the two components were nearly equal in brightness, separation about 16″, position angle 315°±. Although both show faint titanium bands, the spectrum of the north-preceding star was heavily veiled with a strong continuous spectrum extending far into the ultraviolet, and the Balmer lines were strong in emission to H14. The south-following component, however, showed no veiling. Its hydrogen bright lines were extremely weak, and H and K were only moderately strong. We must conclude that, if the causes of the veiling and of the emission lines are external, they must be quite local to produce such marked effects in one star and not in the other. The stars should be observed for changes in brightness and spectrum.

The components of MHα 259-6, separation 30″, have been discussed by Struve and Swings.[6]

RELATED STARS

Although no emission at $H\alpha$ appeared in their objective-prism spectra, slit spectrograms were obtained of two stars in the heavily obscured area near B10. The first, BD+28°637, 9.5, dK5, is without doubt a foreground star. H and K appear in emission in considerable strength. No evidence of contact with the cloud is present. The radial velocity from one plate is +37 km/sec. The second star is Hubble No. 4,[7] IC 359?, a star with a nebulous fringe, situated in a lane of dense obscuration near B10. The spectrum of this star shows some selective absorption in the violet, but no peculiarities which might be attributed to contact with cloud particles. The spectrum is dK3, with rather weak bright H and K. The radial velocity from one plate is −17 km/sec. If the star is at the distance of the cloud, a total absorption of 1.2 mag. is indicated.

In the dark lanes of the Cepheus-Cassiopeia region of the Milky Way, Dr. R. Minkowski discovered on objective-prism plates a star whose spectrum resembles in some respects the bright $H\alpha$ stars of the Taurus clouds. The star is MHα 47–30; $\alpha = 22^{h}54^{m}.5$, $\delta = +58°27'$, 1950; mag. 11.5; dK3e. The intensities of bright *Ca* II and $H\delta$ vary somewhat but are about 40 and 15, respectively. *Fe* II and *He* I are bright. The absorption lines are indistinct, owing to partial veiling of the spectrum. The radial velocity varies from 0 to −45 km/sec on four plates.

The star BD−6°1253, $\alpha = 5^{h}34^{m}.0$, $\delta = -6°44'$, 1950, near the Orion nebula has been reported by Herbig[8] and by Morgan and Sharpless[9] to have T Tauri characteristics. It is imbedded in the bright nebula NGC 1999. The hydrogen lines showed wide absorption wings corresponding to A-type lines, with fairly strong emission components superposed. Emission lines of ionized and neutral elements, such as are found in the T Tauri variables, were found in great numbers. Herbig found evidence of variability in light. On spectrograms taken at Mount Wilson, January 24, 1946, and January 4, 1948, the appearance of the spectrum varied greatly. On the first plate the bright lines were numerous, as on the Lick and Yerkes plates. The line λ 4063 *Fe* I showed faintly in emission and the *Ca* II lines were strong. The radial velocity from the bright lines was +15 km/sec.

[7] E. P. Hubble, *Mt. W. Contr.*, No. 241; *Ap. J.*, **56**, 181, 1922.

[8] *Pub. A.S.P.*, **58**, 163, 1946.

[9] *Ap. J.*, **103**, 249, 1946.

On the second plate the lines were wide and diffuse. The calcium and hydrogen lines were weak as compared with those of *Fe* II. The spectrum resembled that of RW Aur on November 2, 1941 (Pl. XIV*a*, *Mt. W. Contr.*, No. 709; *Ap. J.*, **102**, 168, 1945). The broad absorption lines of hydrogen may originate in a different source from that of the bright lines, and its continuous spectrum may cause the blurring of the late-type lines of the star.

Several of the bright-line stars observed by Struve and Rudkjøbing[10] at the McDonald Observatory are doubtless related to the Taurus-cloud stars. They were found to be dwarfs with late spectral types. Emission lines of *H* and *Ca* II were strong, and in some stars *Fe* II appeared in moderate strength.

THE RADIAL VELOCITIES

On account of the large uncertainties inherent in the measurement of spectrograms having a dispersion of 220 A/mm, the radial velocities of the sixth and seventh columns of Table 2 can be considered little more than first approximations. These results are merely suggestive of the direction to be followed in further investigations. For most of the stars, only one plate was available, but variation in velocity should not be surprising. No evidence of group motion or of large peculiar motions was found.

TABLE 5

MEAN VELOCITIES

Plate	Vel. Bright (Km/Sec)	Vel. Absorption (Km/Sec)
257	+ 2 (30)	− 2 (19)
259	−11 (169)	+13 (100)
265	−10 (29)	+12 (33)

The mean velocities for the three regions, with the total number of lines measured, are in Table 5. No certain difference in velocity between the different regions is evident. In the mean, the negative displacements of the bright lines, which correspond to expansion of the emitting strata, decrease with advancing spectral type. The mean differences (bright *minus* dark) in velocities for G, K, and M types are −48, −20, and −3 km/sec, respectively.

DISCUSSION

The location of the bright-line stars in the Taurus clouds and the peculiarities of their spectra indicate that these stars are closely related to the T Tauri variables. Both groups are affected by their contact with the particles of the clouds. The nature of the interaction between the stars and the clouds requires more detailed study and more adequate observations. The relationship between the spectral type or temperature and the presence of the T Tauri spectral peculiarities is doubtless a leading key to the problem.

The overlying continuous spectrum resulting from sudden flares in dwarf stars, such as these bright-line stars of the Taurus clouds, the T Tauri variables, and the faint M4e–M6e dwarfs of large proper motion, presents a distinctly new problem of stellar atmospheres which requires further investigation. The intensity distribution of light in different wave lengths is greatly altered by the flare, and the intense emission of the calcium lines and the higher members of the Balmer series of hydrogen may be sufficient to affect color measurements.

[10] *A.J.*, **54**, 51, 1948.

Selective absorption in shorter wave lengths seems to depend to some extent on the area of the sky involved, but this preliminary survey does not provide sufficient data to justify definite conclusions.

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