SPECTRAL CLASSIFICATIONS FOR NEW OR UNCLASSIFIED EMISSION-LINE, CARBON AND S, LONG-PERIOD VARIABLE, AND DOUBLE STARS

J. J. NASSAU AND C. B. STEPHENSON
Warner and Swasey Observatory, Case Institute of Technology
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ABSTRACT

New spectroscopic data from objective-prism plates covering blue-ultraviolet and Hα spectral regions are presented for about sixty stars belonging to the categories defined in the paper title. Identification charts are given for two new long-period variables.

I. INTRODUCTION

In the course of a recently completed objective-prism survey for high-luminosity stars (Stock, Nassau, and Stephenson 1960), a number of other spectra of unusual interest were noted. The classification of the spectra falling within the categories mentioned in the title of this communication has now been completed, and the results are given here.

II. OBSERVATIONS

Almost all the plates used for the survey were taken with the 80–120-cm Schmidt telescope of the Hamburg Observatory. These plates were surveyed in Cleveland as part of the joint survey of the northern Milky Way being conducted by the Hamburg and Warner and Swasey Observatories. The region of the Milky Way surveyed in the present connection extends from $l^{II} = 45°$ to $l^{II} = 75°$ and to about $\pm 10°$ in galactic latitude.

Two spectral regions were included in the survey. The blue region comprises the interval Hβ-3300 A, with a dispersion of ~580 A/mm at Hγ. The red or Hα plates cover the interval roughly from λ 6100 to λ 6600, at a dispersion of ~1500 A/mm, and the survey area was not completely covered by these plates. The limiting photographic magnitude of the blue plates is 13.0–13.5. The limiting visual magnitude of the red plates is about 10–12, depending on the color of the stars. The roles of these two spectral regions in the detection and classification of the stars in the tables below are discussed in the introductory remarks to the tables.

Except for the new variable stars, it is felt that the positions given for new objects will probably suffice to identify the stars, e.g., on the *Palomar Sky Atlas*, particularly if colors are anticipated from the spectral types which are available in almost every case. However, we shall be glad to furnish identification charts to any observers requesting them.

Asterisks in the "Remarks" column of a table indicate additional notes at the end of the table.

III. EMISSION-LINE STARS

For the great majority of the stars given in Table 1, the emission features were detected on Hα plates. However, all but one of the spectral classifications given were secured from blue plates. Among them there are a number of stars of high luminosity which should have been included in our general catalogue for such stars, which is to be published elsewhere (Stock, Nassau, and Stephenson 1960). Their detection was made possble by a second examination of the spectra, which resulted from their Hα emission features. Only stars with strong Hα emission are included in Table 1. The table characterizes the Hα intensities as strong or weak by means of the letter "s" or "w" in the

TABLE 1

EMISSION-LINE STARS

No.	R.A. (1950)	Decl (1950)	m_{pg}	Spectrum	Nature of Emission	Remarks
1	$19^h\ 4^m13^s.8$	+21° 33′ 53″	10.4	B7 V	Hβ	21°3662*
2	13 47 3	+22 53 49	10 8	C::	s Hα	*
3	34 37 0	+33 39 51	10 1	B3:	. . . . .	*
4	41 19.7	+22 0 44	12 3	B6 V	w Hα	
5	48 29 8	+25 45 12	13 5:	. .	s Hα	
6	49 51 5	+27 11 52	13 4	OB:	w Hα	*
7	20 1 46 9	+29 34 58	12 2	OB:	w Hα	29°3874 s*
8	4 57 5	+35 20 34	13 5	. . .	w Hα	*
9	14 6 0	+34 37 10	11 4	OB−	w Hα	
10	18 27 3	+29 56 41	11 0	B6 V	w Hα	
11	21 5 20 9	+37 43 6	10 0	B9 V	. . . .	37°4182*

NOTES TO TABLE 1

Star 1. Hα is in absorption on an Hα plate taken on a different date from that of the blue plate.
Star 2. The spectral class is based on an Hα plate; the star is omitted from Table 2 because of the classification uncertainty.
Star 3. The spectral type is correct only if the star is a dwarf. Weak emission near λ 4470 and λ 4686.
Star 6. This spectrum may be composite.
Star 7. The star is just south of the BD star whose number is given here.
Star 8. Bad overlap.
Star 11. Emission at or near λ 4780:.

TABLE 2

CARBON AND S-TYPE STARS

No.	R.A (1950)	Decl (1950)	m_v	Spectrum	Remarks
1	$18^h34^m12^s.6$	+16° 55′ 39″	10 8	R	
2	41 18 6	+17 36 8	10 8	N	
3	19 11 38 1	+30 5 24	11 0	S:	
4	20 51 6	+27 2 3	11 0	S	
5	22 39 3	+30 33 10	. . . .	R	Var?*
6	30 42.1	+28 31 49	. . . . .	R	Var?*
7	31 12.7	+16 23 54	10 1	R	
8	35 45.5	+32 14 54	11 0	S	
9	35 49 6	+30 40 44	11 0	S	*
10	40 56 0	+16 39 38	10 6	N	
11	41 21.9	+19 10 54	10 4	R	
12	46 28.4	+15 0 27	10.9	R	
13	49 4 0	+14 52 30	. . .	N	OW Aql
14	56 36 9	+22 2 4	10 6	N	
15	20 1 12.3	+16 57 2	9.9	R	
16	23 42 1	+25 7 20	10.0	S	
17	59 21.1	+36 13 58	10 0	S	*
18	21 3 4.7	+35 27 56	10.0	S	
19	8 33 8	+33 9 48	10.7	N	
20	10 45.3	+39 16 18	10 2	R	

NOTES TO TABLE 2

Star 5. This star was classified as C by Nassau and Blanco (1957).
Star 6. This star was classified as C by Nassau and Blanco (1957).
Star 9. The classification of this star is based on an Hα plate taken June 13, 1956. An infrared plate taken August 28, 1954, shows the star as M6.
Star 17. There is some evidence that Hγ and Hβ are in emission.

TABLE 3

SPECTRA OF VISUAL DOUBLE STARS

ADS	R A (1950)	Decl. (1950)	m_{pg}	Spectrum	Remarks
11999 ..	$19^h01^m47^s3$	+14° 42′ 30″	9 4 9.4	F3 V F3 V	
12216. . .	12 37 6	+28 48 32	9.5 9.5	F4 V F4 V	
12444 .	24 12 6	+18 32 34	11 1 10.2	F6 V F4 V	*
12448 .	24 31 5	+25 23 43	9 4 9 4	A2 V A2 V	
12630 ..	32 48 0	+35 11 17	9.9 10 7	F4 V F4 V	
13228 .. .	57 40 7	+11 02 50	9 5 9 5	F2 V F2 V	
. .	20 01 28 6	+14 27 29	10 4 10 4	G0 V G0 V	Burnham Gen. Cat. No. 9859
13699	17 25.4	+36 25 41	10 5 10 3	G8 III–IV G8 III–IV	
14569 .	21 00 24 5	+37 27 36	9 2 9 2	K0 V K0 V	

NOTE TO TABLE 3

12444. Aitken's component B is definitely the brighter star on our plate.

TABLE 4

LONG-PERIOD VARIABLES

No.	R A (1950)	Decl (1950)	m_{pg}	Spectrum	Date	Remarks
1 ..	$18^h44^m24^s6$	+21° 43′ 21″	13 2	M6e	25–7–58	BS Her
2 .	52 44 2:	+27 15 12:	13 5	M2:e	25–7–57	BE Lyr
3.	19 34 23 3	+34 17 5	13 4	M6e	1–8–57	FS Cyg
4	41 25 6	+22 37 42	12 0	M5e	15–5–56	CN Vul
5	46 1 4	+11 23 59	12 7	M5e	24–9–57	RY Aql
6	48 35 1	+13 5 30	12 7	M3e	24–9–57	SX Aql
7 .	51 1.5	+29 30 59	12 9	M2e	13–5–56	EV Cyg
8	54 48 0:	+36 56 0:	13.5	M2e	6–7–59	
9 . .	58 39 9	+10 51 27	12 5	M4e	24–9–57	V432 Aql
10 .	20 2 18 9	+11 36 45	12.5	M4e	24–9–57	V436 Aql
11.	11 52 1	+17 31 47	12.5	M5e	31–7–57	CO Sge
12 .	24 1 7	+20 17 6	13 5	M5e	1–8–57	
13	46 57 8	+31 39 47	12 2	M6e	1–8–57	AM Cyg

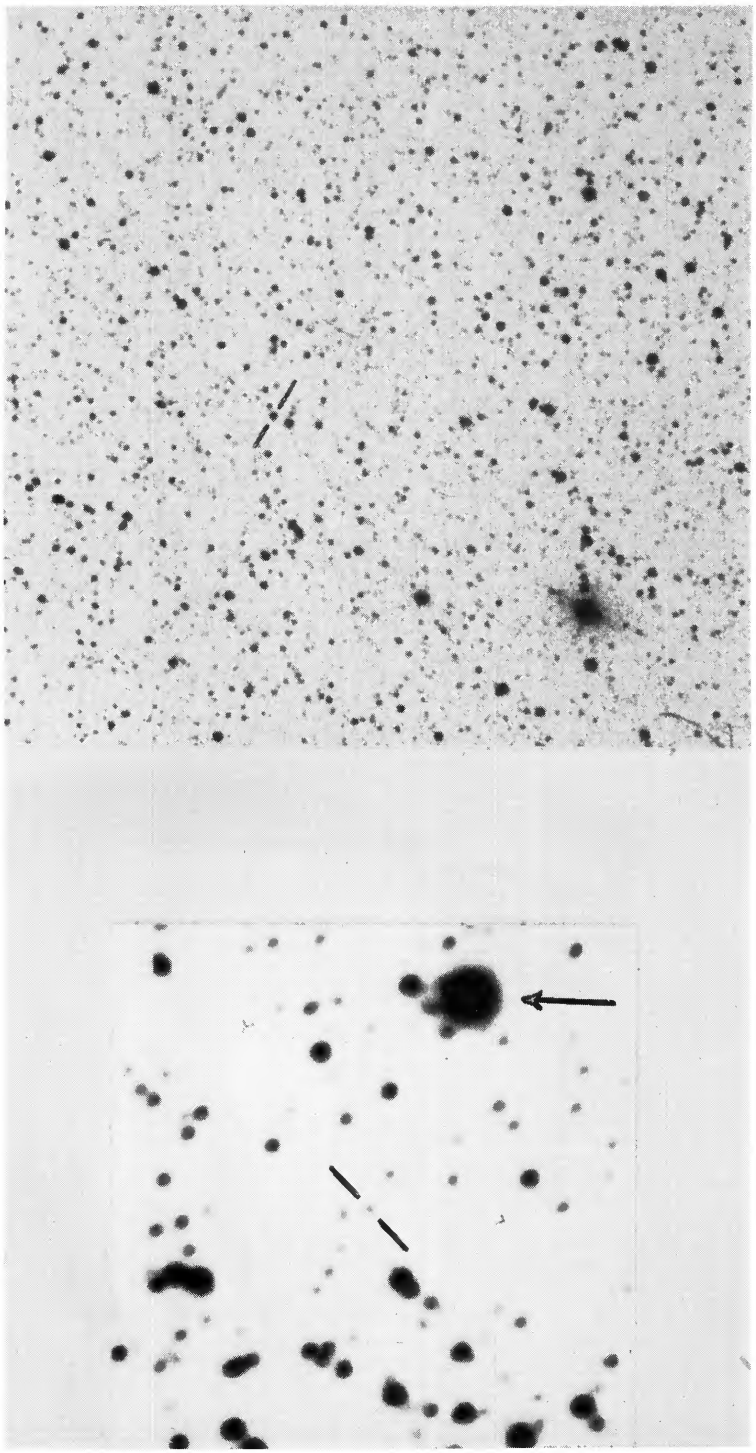

FIG. 1.—*Above:* Variable star No. 8, Table 4. North is up, east to the left. Size of field is 16′ × 16′, and the very bright star in the southwest quadrant is HR 7606 (blue plate). *Below:* Variable star No. 12, Table 4 (reproduced from the Lick Sky Atlas). North is up, east to the left. The field is about 15′ × 15′, and to aid identification the arrow indicates BD+20°4561.

next-to-last column, but all "weak" cases are definite. Some 60 additional stars with really weak or merely suspected emission observed in this survey were omitted. The photographic magnitudes given in the table are approximate, and they are given only to assist in the identification of the stars. The catalogue numbers given in the "Remarks" column are BD numbers.

IV. CARBON AND S-TYPE STARS

Table 2 gives the spectral classes of the new carbon and S-type stars found in the region of our survey. The carbon stars were classified as R and N by means of the C_2 and CN bands in the blue spectral region. The S stars were identified from Hα plates by means of the ZrO band at 6474 A, which appears strong in nearly all spectra. The indicated visual magnitudes are approximate and are given to assist in the identification of the stars.

V. DOUBLE STARS

In surveying our blue plates for OB stars, visual double-star spectra were often noted and classified. These data, for pairs whose individual components were clearly resolved, are collected in Table 3. The errors of the luminosity classes are not expected to be greater than about $1\frac{1}{2}$ luminosity classes for the A stars and 2 classes for the F stars—i.e., the stars called A dwarfs might be as luminous as luminosity class III–IV, and the F dwarfs could be as bright as luminosity class III. For the later types the uncertainty is about 1 luminosity class. Moreover, the foregoing discussion of uncertainties applies specifically to the stars in the table. Despite these limitations in classification precision, it is felt that these types may have some utility, in view of the relative scarcity of published classifications of individual components of double stars, which scarcity is rather marked for the dwarf systems such as appear to comprise the bulk of the table.

The table lists the components in the order A, B, according to published nomenclature. The magnitudes are photographic and have probable errors of several tenths of a magnitude.

VI. LONG-PERIOD VARIABLES

The objects given in Table 4 are all M stars showing Hδ in emission stronger than Hγ. They are either known Mira-type variables or are assumed to be Mira stars on the basis of their spectra. The *Variable Star Catalogue* (2d ed.) gives spectral classes for three of them, without mentioning emission characteristics, and the rest were given without any spectral classes. The photographic magnitudes assigned to them for the indicated dates are approximate. Two are new variables and identification charts are provided for them in Figure 1.

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