

PECULIAR AND METALLIC-LINE A-TYPE STARS IN A GALACTIC ZONE*

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ABSTRACT

An objective-prism survey in a galactic zone, followed by slit spectrograms, has resulted in the segregation and classification of a number of new peculiar A-type, metallic-line, composite, and supergiant A-type stars.

I. INTRODUCTION

The survey for peculiar and metallic-line A-type stars described in this paper was carried out along a zone 12° wide centered on the galactic equator from galactic longitude 335° through zero to 201° . Existing 4° objective-prism plates taken with the Burrell Schmidt-type telescope of the Warner and Swasey Observatory were used for this purpose. An observing list of stars suspected to be peculiar or of the metallic-line type was prepared from this material (by Nassau) to be used for securing slit spectra with the 69-inch reflector of the Perkins Observatory (by Slettebak).

II. THE OBJECTIVE-PRISM SURVEY

The spectral plates were taken with Eastman IIa-O emulsion with an exposure of 2 minutes for each plate. This permitted the classification of A-type stars with magnitudes between 6.5 and 8.3, although some brighter and fainter stars were included.

The dispersion of the 4° objective prism is 280 Å/mm at $H\gamma$. The criteria for segregating suspected peculiar and metallic-line A-type stars were based upon the detection of the K line, Sr II 4077, the Si II blend 4128–4131, Cr II 4171, and the G band. The latter, in combination with the strength of the K line and Balmer lines, was very effective in the detection of the metallic-line stars. The spectral lines which characterize the peculiar A stars are weak at this dispersion, however, and liable to be missed in over-exposed spectra.

When the strength of the K line indicated that the star was of spectral class F0 or later, it was not included in the list. The survey therefore includes stars with spectral types between B8 and A7. Temperature classifications were based on the ratio of the intensities of the H and K lines.

If a star was classified as Ap or Am, an estimate of the Balmer line intensities was made. In more than half the cases these stars showed weaker hydrogen lines than normal A-type stars of the same subclass.

During the examination of the spectral plates some stars were segregated which showed other peculiarities, as, for example, stars with decidedly weak hydrogen and stars with composite spectra.

III. SLIT SPECTRA

Slit spectra of all the stars segregated in the objective-prism survey which were of visual magnitude 8.1 and brighter, plus a few fainter than this limit, were obtained

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with the Perkins 69-inch reflector. A small camera attached to the two-prism spectrograph was employed, giving a dispersion of 104 Å/mm at H γ . Eastman IIa-O and, to a lesser extent, 103a-O plates were used.

The slit spectrograms obtained are of good quality and permitted the classification of peculiar A-type, metallic-line, composite, and A-type stars of high luminosity. Because of vignetting in the camera, however, the region of the K line is underexposed when the blue region of the spectrum is exposed correctly. This is disadvantageous for the classification of A-type stars, in which the K line is a useful feature. The K-line types listed in the following tables are therefore, in general, those determined from the objective-prism spectra.

TABLE 1
PECULIAR A STARS

No.	HD	$\alpha(1900)$	$\delta(1900)$	m_v	Spectral Type	Peculiar Features	Prototype
1...	1009	0 ^h 9 ^m 4	+64° 0'	8.0	B8p	Mn	α And
2	5221	0 48.9	+63 50	8.6	A0p	Si	56 Ari
3	50461	6 48.3	- 7 39	7.7	A0p	Si, Sr, Cr	γ Ari S
4.....	59435	7 24 8	- 9 3	7.9	A5p	Sr, Cr, Si	73 Dra
5	170901	18 26.7	- 9 26	7.7	A0p	Si	56 Ari
6.....	170973	18 27.1	+ 3 35	6.34	A0p	Si, Sr, Cr	49 Cnc
7*.....	171263	18 28.7	+ 5 32	8.1	A0p	Si	56 Ari
8.	171782	18 31.6	+ 5 12	7.9	A0p	Si, Sr, Cr	α^2 CVn
9.	171914	18 32.2	+ 2 54	7.9	A0p	Si, Sr, Cr	α^2 CVn
10†....	191742	20 6.4	+42 15	7.80	A7p	Sr, Si, Cr	ϵ Cas
11.....	203819	21 19.5	+53 48	7.78	A0p	Cr, Si, Sr	45 Her
12.....	204037	21 20.8	+52 1	8 3	A0p	Si	56 Ari
13.....	213232	22 24.9	+58 2	7.9	A5p	Sr, Si, Cr	ϵ Cas
14.	218439	23 3.0	+60 18	7.61	A2p:	Sr, Cr, Si	κ Psc:
15.....	222853	23 39.1	+58 11	8.1	A2p	Sr, Cr, Si	κ Psc

* The Balmer lines are not so strong as in 56 Ari.

† The Sr II lines are stronger than in ϵ Cas.

IV. DESCRIPTION OF THE TABLES

Table 1: Peculiar A Stars

Fifteen new peculiar A stars are listed in Table 1, ranging in type from B8p to A7p. The best way to describe the spectra of these stars seemed to be in terms of well-known peculiar A stars. The column headed "Prototype" therefore lists the bright peculiar A stars which most nearly resemble the tabulated star. All the prototype stars are listed in Deutsch's catalogue (1947), with the exception of HR 5313 and κ Piscium. The spectral types listed in Table 1 are also taken from the prototype star and are due either to Deutsch or to Morgan.

Although there is no difficulty in recognizing peculiar A stars of the silicon, strontium, and chromium types with the dispersion employed, at least two types of peculiar A stars are on the threshold of detectability—the manganese stars and the ϵ Ursae Majoris stars. Only one of the former is listed in Table 1 and none of the latter. A number of stars were suspected of being of the ϵ Ursae Majoris type, but the similarity between these and early A-type subgiants, on the one hand, and metallic-line stars of early type, on the other, made certain identification impossible with the dispersion employed.

In addition to the fifteen stars listed in Table 1, eight stars which had been previously recognized as peculiar A-type stars were rediscovered. Of these, the following were noted as peculiar in the *Henry Draper Catalogue* also and are listed here with their

TABLE 2
METALLIC-LINE STARS

No.	HD	$\alpha(1900)$	$\delta(1900)$	m_v	K-Line Type	Metallic- Line Type
1.....	861	0 ^h 7 ^m 9	+61° 29'	6.59	A2	F2
2.....	13929	2 10.5	+57 34	8.0	A5	F0
3.....	21584	3 23.9	+50 9	7.32	A2	F0
4.....	24141	3 45.6	+57 40	5.79	A5	F0
5.....	32428	4 58.1	+32 11	6.43	A5	F0
6.....	34492	5 12.7	+41 6	8.1	A3	F0
7.....	36360	5 26.1	+36 15	7.08	A5	F2
8.....	40602	5 54.8	+ 8 57	8.1	A5	F2
9.....	42954	6 8.6	+17 57	5.74	A5	F0
10.....	46283	6 27.4	- 7 20	7.18	A3	F0
11.....	46825	6 30.4	+13 47	7.03	A3	F0
12.....	47072	6 31.7	+ 5 36	7.5	A7	F2
13.....	50462	6 48.3	-12 2	7.04	A5	F0
14.....	51106	6 50.9	- 1 27	7.6	A3	F0
15.....	165830	18 2.8	-10 34	8.1	A3	F0
16.....	166960	18 7.9	- 4 3	6.57	A5	F2
17.....	171388	18 29.5	+ 3 4	7.50	A5	F0
18.....	174916	18 47.9	- 4 51	7.50	A2	F2
19.....	175922	18 52.6	+13 14	6.94	A5	F0
20.....	176942	18 57.5	+10 50	7.5	A5	F2
21*.....	177983	19 1.8	+15 42	7.24	A5	F2
22.....	179892	19 9.2	+ 7 20	7.6	A3	F0
23.....	180638	19 12.2	+28 7	8.1	A3	A7
24.....	181099	19 14.0	+16 31	7.18	A2	F2
25.....	183262	19 23.6	+17 38	6.87	A5	F2
26.....	184360	19 29.0	+20 12	7.20	A2	F0
27.....	184537	19 29.9	+25 51	6.92	A2	F2
28.....	187751	19 46.5	+19 47	7.25	A5	F0
29.....	189085	19 53.2	+35 16	8.17	A0	F2
30.....	189574	19 55.6	+38 36	7.6	A3	F0
31†.....	190275	19 59.1	+37 32	7.16	A3	F0
32.....	190401	19 59.7	+41 11	6.91	A7	F2
33.....	190468	20 0.0	+34 35	8.6	A0	F2
34.....	191158	20 3.4	+36 33	6.88	A3	A7
35.....	192536	20 10.3	+38 51	6.97	A5	F2
36.....	193292	20 14.4	+31 48	7.24	A5	F2
37.....	193637	20 16.2	+33 37	8.6	A7	F2
38.....	193857	20 17.4	+30 16	6.76	A3	F2
39.....	199290	20 51.2	+48 33	8.1	A5	F0
40.....	199311	20 51.3	+45 51	6.66	A0	A7
41.....	199627	20 53.4	+45 56	8.6	A5	F0
42.....	200739	21 0.2	+50 25	8.02	A2	F0
43.....	201033	21 2.0	+55 11	7.71	A7	F2
44.....	201870	21 7.3	+45 42	8.3	B9	F2
45.....	202236	21 9.4	+53 29	8.1	A1	F0
46.....	215606	22 41.3	+56 37	7.9	A3	A7
47.....	222514	23 36.2	+57 17	7.22	A2	F0
48.....	225137	23 58.7	+56 50	8.0	A3	F2

* Uncertain. Mg II 4481 is weak.

† Uncertain. Mg II 4481 is weak. Miss Walther gives the type as A5p and remarks that the spectrum peculiarities are very unusual.

prototype stars in parentheses, as determined from the Perkins plates: HD 18078 (78 Vir), HD 44738 (HR 5313), and HD 216533 (73 Dra). The following stars are contained in Miss Walther's list (1949): HD 197374 (α 2 CVn), HD 200177 (73 Dra), HD 200311 (45 Her), and HD 221568 (γ Ari S). M. Jaschek and C. Jaschek (1958) list HD 171586 (ι Cas).

Table 2: *Metallic-Line Stars*

Forty-eight new metallic-line stars are listed in Table 2 with their K-line and metallic-line types. As has been mentioned previously, the classification of these stars was complicated by the difficulty in using the K-line criterion with the Perkins spectrograms. In particular, stars in which the K-line and metallic-line types were estimated to be

TABLE 3
COMPOSITE SPECTRA

No.	HD	α (1900)	δ (1900)	m_v
1.....	962	0 ^h 8 ^m 9	+60° 10'	7.76
2.....	34807	5 15.0	+39 28	7.38
3.....	171347	18 29.3	-17 4	6.97
4.....	172806	18 37.1	+ 3 56	8.0
5.....	208253	21 49.9	+53 32	6.64
6.....	216572	22 48.9	+60 22	7.56

TABLE 4
SUPERGIANT A-TYPE STARS

No.	HD	α (1900)	δ (1900)	m_v	Sp.
1.....	3777	0 ^h 35 ^m 4	+56° 36'	8.0	A4 II
2.....	194357	20 20.1	+36 43	6.67	A0 II
3.....	199312	20 51.3	+44 45	8.5	A0 Ib:
4.....	209218	21 56.6	+54 33	7.9	A0 II
5.....	213050	22 23.7	+50 59	7.28	A0 II
6.....	215286	22 39.0	+57 54	8.0	A2 Ib
7.....	220819	23 21.8	+60 32	6.68	A5 II
8.....	223767	23 47.4	+61 19	7.31	A5 I

different but fairly close were not included in Table 2 because of the uncertainty of the K-line types.

Table 2 contains no representatives of the α Geminorum (fainter) type of metallic-line star, in which the K-line type is A0-A1 and the metallic-line type is near A5. This is because these stars are difficult to distinguish from early A-type subgiants and from the ϵ Ursae Majoris peculiar A-type stars with the spectrograms employed. Several stars were suspected to be of this type, but the classifications were judged to be too uncertain to justify their inclusion in Table 2.

Four additional metallic-line stars were found and classified in this survey but are not included in Table 2 because they had been discovered previously by other investigators. HD 19342 (A7-F2), HD 190537 (A3-F0), and HD 200407 (A5-F2) are in Miss Walther's list (1949), and HD 34384 (A5-F0) is in Zirin's list (1951). The types in parentheses in the preceding sentence are our K-line and metallic-line types, respectively.

Table 3: Composite Spectra

Table 3 lists six stars which are not known to be close visual binaries and which have not previously been classified as composites. All systems show an A-type K line plus the G band characteristic of a later-type star. Most systems also show the Balmer decrement characteristic of composite spectra.

In addition, the following stars, which were previously recognized as composites or are close visual binaries, were observed and found to show composite spectra: HD 21224, 39847, 169985-6, 174348, 174485, and 201271.

Table 4: Supergiant A-Type Stars

Eight A-type stars which were estimated to be of luminosity class II or more luminous are listed in Table 4.

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