THE SPECTRA AND AXIAL ROTATIONAL VELOCITIES OF THE COMPONENTS OF 116 VISUAL DOUBLE-STAR SYSTEMS

ARNE SLETTEBAK
Perkins Observatory, Ohio State and Ohio Wesleyan Universities
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ABSTRACT

Spectral types, luminosity classes, and axial rotational velocities were estimated for the components of 116 physical visual double-star systems. H-R diagrams for the systems with normal components are compatible with current theories of stellar evolution No significant differences between the mean rotational velocities for double-star components and single stars were found, either for main-sequence or for giant stars Absolute magnitudes for normal B-type components of double stars appear to be somewhat higher than determined in earlier calibrations. Absolute magnitudes for 9 metallic-line stars and 9 peculiar A-type stars are consistent with earlier determinations. Absolute magnitudes were derived for a number of additional peculiar stars of interest

I. INTRODUCTION

The first systematic study of the spectra of visual double stars was carried out by F. C. Leonard, who was interested in obtaining information about stellar evolution. Leonard (1923) wrote: "If the components of a double star had a common origin, a knowledge of the spectral relationships existing in different systems, presumably at various stages in the evolutional course, might be expected to disclose the general trend and the comparative rates of development of these stars."

During more recent years, a renewed interest in double-star spectra has arisen, stimulated by the new theories of stellar evolution. Observations of star clusters have proved to be of very great importance to stellar evolutionary ideas and focused attention on double stars, which can be regarded as tiny star clusters for this purpose. Following the colorimetric work of Johnson (1953) on 40 physical pairs, a number of investigators initiated spectroscopic and photometric studies of visual binary stars. Of particular importance are the papers of Struve and Franklin (1955), Bidelman (1958), Bakos and Oke (1957, 1959), Stephenson (1960), and, most recently, Berger (1962).

The spectroscopic observations on which this investigation is based were started in 1957, with the aim of concentrating more heavily on the double-star components of early type than had been done up to that time, with particular emphasis on axial rotation characteristics. An additional objective was to determine absolute magnitudes of peculiar components in double-star systems, knowing the absolute magnitude of the normal component and the Δm for the system.

II. OBSERVATIONS

The observing program was originally defined to include all double-star systems in which both components were brighter than magnitude 7.5, separated by at least 4 seconds of arc, declination greater than $-20°$, with Δm's listed in the catalogue of Wallenquist (1954). Although the majority of systems observed meet these criteria, a number of interesting systems are included that fall outside this definition. On the other hand, many systems that qualify were not observed, particularly those in which both components are of spectral type F5 or later. The result is an observing program which defies definition but consists essentially of the brighter, northern, wide pairs of early type. A total of 235 stars in 116 physical systems was observed.

Nearly all the spectrograms were taken with the two-prism spectrograph attached to the Perkins 69-inch telescope in Delaware, Ohio, during the years 1957–1959. This spectrograph with its Pα camera gives a dispersion of 28 A/mm at Hγ. The spectra were taken on Kodak 103a-O plates and widened to 1.5 mm on the plate whenever possible, in order to increase the accuracy of estimating the spectral types and axial rotational velocities. The slit width was held constant for all these observations. In addition, a few systems were photographed with the Yoder spectrograph attached to the Perkins 69-inch telescope at its new site near Flagstaff, Arizona, in collaboration with the Lowell Observatory in the spring of 1962. These spectra and those of the corresponding standard stars were taken on baked Kodak IIa-O plates with a dispersion of 20 A/mm.

III. SPECTRAL TYPES AND AXIAL ROTATIONAL VELOCITIES

The spectral types and luminosity classes for the double-star components were estimated with the help of a large number of standard-star spectra, taken with the same equipment. A total of 179 MK standards from the list by Johnson and Morgan (1953), including stars of all luminosity classes with spectral types between O9 and M2, was used. Every effort was made to disguise the identity of the stars being classified, so that a knowledge of the system with its observed Δm would not prejudice the classifications. This was not possible for a few of the brighter systems, however, and some observational bias may have crept into these classifications.

The axial rotational velocities were estimated visually by comparing absorption-line widths on spectrograms of double-star components with those of standard stars of measured rotational velocity, observed with the same equipment. Some 140 MK standard stars of spectral type O9–K0 for which rotational velocities had been measured earlier (Slettebak 1954, 1955, 1956; Slettebak and Howard 1955) were used as standards of rotational velocity. Since all plates were taken in the same way, using the same instrumentation, fairly reliable rotational velocities can be obtained by visual estimate if care is taken to obtain good density matches between spectrograms. The minimum value of $v \sin i$ that was just detectable on good-quality plates is near 25 km/sec.

The estimated spectral types and rotational velocities for the double-star components are listed in Table 1, which contains 116 systems that are probably physical. ADS numbers are listed in this table, except for a few systems with BDS numbers only, which are listed in parentheses. The Δm's in the table are from the list of Wallenquist (1954). A few systems that are not in Wallenquist's catalogue have Δm's, listed in parentheses, from other sources. Table 2 contains 12 pairs which were observed but which are almost certainly optical doubles. These are listed in the event that the spectral types and rotational velocities might prove useful at some later date and will not be discussed further in this paper.

IV. RESULTS AND DISCUSSION

a) *H-R Diagrams for Systems with Normal Components*

Figures 1 and 2 show the H-R diagrams for binaries with components which were both judged to have normal spectra. Systems in which one component is on the main sequence, while the other component was classified as above the main sequence, are shown in Figure 1. The main-sequence components are plotted on the Keenan (1963) main sequence, and the observed Δm's are applied to the more luminous components to locate them above the main sequence. The resulting diagram is similar to those published by Struve and Franklin (1955) and by Bidelman (1958), although the observational material is different, and again shows the tendency for the primaries to lie above the main sequence. As the aforementioned authors have pointed out, these results are compatible with the hypothesis that the locations of the primaries in the H-R diagram are the result of nuclear evolution, which proceeds more rapidly in the primaries than in the secondaries.

Systems in which both components were classified as main-sequence stars are shown in Figure 2. The two components are located symmetrically around the Keenan (1963)

Table 1

SPECTRAL TYPES AND AXIAL ROTATIONAL VELOCITIES FOR THE COMPONENTS OF 116 PHYSICAL DOUBLE STAR SYSTEMS

ADS or (BDS)	Design.	α(1950)	δ(1950)	m_v	Δm	Sep.	Sp. Type	v sin i (km/sec)	Ref.	Remarks
1 A	HR 9094	$0^h\ 0^m.0$	+65°49'	6.0	1.50	15"	K1 III	≤25	J,B	See notes.
B				7.5			A2V shell	250		
671 A	η Cas	0 46.1	+57 33	3.6	3.79	10"	G0V*	≤25		See notes.
B				7.4			K3p	≤25		
824 A	HR 283	0 57.2	+44 27	6.0	0.84	8"	B9.5V	300	L	Spectroscopic binary orbit.
B				6.8			A1V	250		
899 A	ψ^1 Psc	1 3.0	+21 13	5.6	0.24	30"	A0V	250	Be	
B				5.8			B9V	250		
996 A	ζ Psc	1 11.1	+ 7 19	5.6	0.96	24"	A7IV	250	Be	Spectroscopic binary orbit.
B				6.5			F7V	≤25		
1073 A	ø Cas	1 16.9	+57 58	5.3	2.04	134"	F0Ia*	≤25	Be	
C				7.3			B6Ib**	≤25		
1477 A	α UMi	1 48.8	+89 2	2.1v	6.78	18"	F8Ib-Cep.	≤25	L,Be	Spectrograph focus poor.
B				8.9			F2IV-V:	≤60:		
1507 A	γ Ari	1 50.8	+19 3	4.7	0.09	8"	A1p	50	L	Pec-A and sp. variable.
B				4.8			B9.5V	170		
1563 A	λ Ari	1 55.1	+23 20	4.8	2.54	37"	F2IV	100	Be	
B				7.3			G0V	≤25		
1630 A	γ And	2 0.8	+42 6	2.3	2.85	10"	K2II	≤25	L,S	See notes.
BC				5.1			B9.5V, 2sp.	70;70		
(1094) A	HD 12927	2 6.7	+79 27	6.5	(0.6)	56"	A5III	100:		See notes.
B	HD 12881			7.1			Am, 2sp.	≤25; ≤25		
1683 A	59 And	2 7.8	+38 48	6.1	0.61	17"	B9V	200	Be	
B				6.7			A1V	300		
1982 A	30 Ari	2 34.1	+24 26	6.6	0.73	39"	F4IV	30		Spectroscopic binary orbit.
B				7.3			F6V	30		
2270 A	HR 890	2 57.3	+52 9	5.4	1.43	12"	B7V	200	L,Be	
B				6.8			B9V	200		
'(1731) A	HD 21700	3 28.0	+27 34	7.1	(0.4)	44"	A1V	100		
B	HD 21685			7.5			A3V	250		

Table 1 (Cont.)

ADS or (BDS)	Design.	α(1950)	δ(1950)	m_v	Δm	Sep.	Sp. Type	v sin i (km/sec)	Ref.	Remarks
2582 A	HR 1065	$3^h28^m.3$	+27°24'	6.5	0.42	11"	A2V	100	L	
B				6.9			A3V	100		
2850 A	32 Eri	3 51.8	- 3 6	4.9	1.44	7"	G5III	≤25	L,S	
B				6.3			A1V	180		
2888 A	ε Per	3 54.5	+39 52	3.0	5.11	9"	B0.5V*	160	Be	
B				8.1			B8V:	300:		
2984 A	HR 1260	4 3.4	+62 12	7.0v	0.08	18"	B0III	275		See notes.
B				7.1			B0III	160:		
3085 A	HR 1322	4 12.8	+ 6 4	6.5	0.58	65"	G0V	≤25	S	Weak CaII K-line emission.
B				7.1			G8V	≤25		
3274 A	1 Cam	4 28.1	+53 48	5.9	1.02	10"	B0III*	275	Be	
B				6.9			B0V	≤25		
3317 A	88 Tau	4 32.9	+10 4	4.4	3.48	70"	Am	≤25		See notes.
B				7.9			F8V	≤25		
(2313)A	τ Tau	4 39.2	+22 52	4.3	2.95	63"	B3V	150	Be	Spectroscopic binary orbit.
B	+22°5715			7.3			A1V	100		
3409 A	55 Eri	4 41.2	- 8 53	6.7	0.13	9"	G8III	≤25	L,B	
B				6.8			F5III	60		
3597 A	HR 1610	4 57.8	+ 3 33	6.6	0.47	21"	B8V	350		
B				7.1			B9V	350		
3910 A	HR 1753	5 17.1	-18 34	6.2	(0.2)	39"	B5V	≤25		
B				6.4			A0 pec.?	80		See notes.
3962 A	23 Ori	5 20.2	+ 3 30	5.0	2.12	32"	B1V**	350	Be	
B				7.1			B3V:	300		
4068 A	118 Tau	5 26.2	+25 7	5.9	0.82	5"	B9V	150	L	
B				6.7			A0V	200		
4131 A	HR 1847	5 29.3	+17 1	6.1	0.40	10"	B7III	50		
B				6.5			B7IV	300		
4134 A	δ Ori	5 29.4	- 0 20	2.5	4.54	53"	O9.5II*	140	Be	Spectroscopic binary orbit.
C				7.0			B2V**	85		
4179 A	λ Ori	5 32.4	+ 9 54	3.7	1.98	4"	O8**	75	L	
B				5.7			B0V	125		

Table 1 (Cont.)

ADS or (BDS)		Design.	α(1950)	δ(1950)	m_v	Δm	Sep.	Sp. Type	v sin i (km/sec)	Ref.	Remarks
4182	A	HR 1887	$5^h32^m.6$	$-6°2'$	4.7	0.96	36"	B0.5V	≤25	Be	
	B				5.7			B1V**	≤25		
4186	A	θ^1 Ori	5 32.8	- 5 25	7.0	CA=1.55	CA=13"	B0.5V:	75:		See notes.
	B				8.0	CB=2.63	CB=17"	B1V::	200:		
	C				5.4	CD=1.48	CD=13"	O6**	120:		
	D				6.9			O9.5V:	50:		
4188	A	θ^2 Ori	5 32.9	- 5 27	5.2	1.34	52"	O9.5V**	165:		See notes.
	B				6.5			B0.5V	≤25		
4193	A	ι Ori	5 33.0	- 5 56	2.9	4.53	11"	O9III*	100	Be	Spectroscopic binary orbit.
	B				7.4			B3p	50		
4262	A	HR 1945	5 38.2	+29 28	6.8	0.64	26"	B7V	200	Be	
	B				7.4			B9.5V	120		
4749	A	HR 2174	6 6.4	+ 2 31	5.9	1.21	29"	A1V shell	250	Be	See notes.
	B				7.1			A0V	120		
4773	A	41 Aur	6 7.8	+48 44	6.1	0.83	8"	A2V	120	L,Be	
	B				6.9			A5V	120		
5012	A	8 Mon	6 21.1	+ 4 37	4.5	2.18	13"	A5III	125	L,Be	
	B				6.7			F5V	≤25		
6012	A	19 Lyn	7 18.8	+55 23	5.6	1.03	15"	B8IV	80	Be	Spectroscopic binary orbit.
	B				6.6			B9V	250		
6175	A	α Gem	7 31.4	+32 0	2.0	0.98	5"	A1V	≤25	L	See notes.
	B				3.0			Am	≤25		
6255	A	HR 2948	7 36.8	-26 41	4.5	0.16	10"	B6V	60		
	B				4.7			B7V	200		
6815	A	ϕ^2 Cnc	8 23.8	+27 6	6.3	0.04	5"	A5III	150	L	
	B				6.3			A3IV	120		
6988	A	ι Cnc	8 43.7	+28 57	4.2	2.57	31"	G8III	≤25	SF,B	
	B				6.8			A3V	200		
7093	A	17 Hya	8 53.0	- 7 47	6.7	(0.2)	4"	Am	≤25	L	See notes.
	B				6.9			Am	50		
7311	A	27 Hya	9 18.0	- 9 20	5.0	(1.9)	229"	G8III	≤25	B,S	See notes.
	B				6.9			F5V::	≤60		

Table 1 (Cont.)

ADS or (BDS)	Design.	α(1950)	δ(1950)	m_v	Δm	Sep.	Sp. Type	v sin i (km/sec)	Ref.	Remarks
7627 A	HR 3963	$10^h\ 1^m.7$	$-17^\circ 51'$	6.2	(0.8)	21"	A0III,IV:	≤ 25		
C				7.0			A1V	50		
7654 A	α Leo	10 5.7	+12 13	1.3	6.55	176"	B7V*	350		
B				7.9			K0Vb	≤ 25		See notes.
7705 A	HR 4021	10 13.9	+71 19	6.6	0.70	17"	Am	≤ 25	L,Be	See notes.
B				7.3			Am	≤ 25		
7979 A	54 Leo	10 52.9	+25 1	4.5	1.89	6"	A0V	180	L,Be	
B				6.4			A1V	250		
8347 A	65 UMa	11 52.5	+46 45	6.5	0.39	63"	A3V	150	Be	Close visual binary, 7.2:9.0.
D				6.9			A2p	≤ 25		Pec-A of 78 Vir Type.
8568 A	17 Com	12 26.4	+26 11	5.4	1.37	145"	A0p	≤ 25	Be	Pec-A of 78 Vir Type.
B				6.8			Am	≤ 25		See notes.
8600 A	24 Com	12 32.6	+18 39	5.2	1.63	20"	K2III	≤ 25	B	
B				6.8			Am, 2sp.	≤ 25;≤ 25		See notes.
8630 A	γ Vir	12 39.1	- 1 11	3.7	0.02	6"	F0V	≤ 25	L,SF	
B				3.7			F0V	≤ 25		
8657 A	HD 110886	12 42.7	- 3 37	6.8	0.75	16"	F0III:	200:	Be	See notes.
B				7.6			F0V::	120:		
8682 A	HR 4893	12 48.6	+83 41	5.3	0.53	22"	A2V shell	250	Be	See notes.
B				5.8			A0V + A2V	≤ 25;≤ 25		
8706 A	α CVn	12 53.7	+38 35	2.9	2.62	20"	A0p	≤ 25	L,J	See notes.
B				5.5			F0V	≤ 25		
8891 A	ζ UMa	13 21.9	+55 11	2.4	1.66	15"	A2V, 2sp.	≤ 25;≤ 25		
B				4.1			Am	50		See notes.
(6498)A	HR 5074	13 25.4	+65 0	6.7	0.39	69"	F2V	≤ 25		
B				7.1			F3V	≤ 30		
A	3 Cen	13 48.9	-32 45	4.7	1.49	8"	B5Vp	≤ 25		See notes.
B				6.2			B9V	150		
9173 A	κ Boo	14 11.7	+52 1	4.6	2.18	13"	A7IV	140	J,Be	
B				6.8			F2V	40		
9247 A	HR 5386	14 20.9	+ 8 40	5.1	1.67	6"	A0V	100	L	
BC				6.8			A9V	70		Close visual binary, 7.4:7.4

Table 1 (Cont.)

ADS or (BDS)	Design.	α(1950)	δ(1950)	m_V	Δm	Sep.	Sp. Type	v sin i (km/sec)	Ref.	Remarks
9258 A	HR 5397	$14^h22^m.7$	-19°45'	6.4	0.55	35"	A2V	80		
B				7.0			A4V	60		See notes.
9277 A	HR 5415	14 26.4	+28 31	7.0	0.49	25"	AOV	100		
B				7.5			AOV	80		
9338 A	π Boo	14 38.4	+16 38	4.9	0.92	6"	B9p	≤25	L	Pec-A of Mn type.
B				5.8			A5V	150		Could be mild Am star.
	9 α Lib	14 48.1	-15 50	2.9	(2.4)	231"	A3V	80		
	8 α Lib			5.3			F2V	≤25		
9474 A	HD 132910	14 58.1	+54 4	6.8	0.77	41"	FOIV	80	Be	
B				7.6			F2IV	≤30		
9494 A	44 Boo	15 2.1	+47 51	5.3	0.70	3"	G2V	≤30	L	See notes.
B				6.0v			G, 2sp.	Large		
9626 A	μ Boo	15 22.6	+37 31	4.5	2.27	108"	FOIV	90	J	
BC				6.8			G1V	≤25		Close visual binary, 7.2:7.8.
9701 A	δ Ser	15 32.4	+10 42	4.2	1.09	4"	FOIV	80	L	
B				5.3			FOIV-V	70		
9728 A	HR 5816	15 36.0	- 8 38	6.5	0.09	12"	F7V	≤25	L,SF	
B				6.6			F7V	≤25		
9737 A	ζ CrB	15 37.5	+36 48	5.1	0.95	6"	B6V, 2sp.	100:;100:	L,Be	
B				6.0			B7V	≤25		
9913 A	β Sco	16 2.5	-19 40	2.9	2.25	14"	BO.5V, 2sp.	85(br)	L	
C				5.1			B2V*	85		
9951 A	ν Sco	16 9.1	-19 21	4.3	2.28	41"	B2V	200		See notes.
C				6.6			B9Vp	70:		
9979 A	σ CrB	16 12.8	+33 59	5.8	1.01	5"	F8V, 2sp.	≤25;≤25	L	See notes.
B				6.8			G1V	≤30		
10129 A	17 Dra	16 35.0	+53 1	5.6	AB=1.03	AB= 4"	B9V	220		
B				6.6	AC=0.10	AC=91"	AOV	250		
C	16 Dra			5.7			B9.5V	75		
10149 A	37 Her	16 38.2	+ 4 19	5.7	1.08	70"	AOV	140	Be	
B	36 Her			6.8			A5V	80		Could be a mild Am star.
10526 A	ρ Her	17 22.0	+37 11	4.5	0.95	4"	AOp	80	L	Pec-A of Si type.
B				5.5			B9.5V	200		

Table 1 (Cont.)

ADS or (BDS)	Design.	α(1950)	δ(1950)	m_V	Δm	Sep.	Sp. Type	v sin i (km/sec)	Ref.	Remarks
10628 A	25ν^2 Dra	$17^h31^m.2$	+55°13'	4.9	0.03	62"	Am	60	J	See notes.
B	24ν^1 Dra			4.9			Am	≤25		
10635 A	53 Oph	17 32.2	+ 9 37	5.8	1.97	41"	A2V	≤25	Be	
B				7.8			F0IV	150		
10750 A	61 Oph	17 42.0	+ 2 36	6.3	0.40	21"	A0IV-V	90		
B				6.7			A0V	120		
10759 A	ψ Dra	17 42.8	+72 11	4.9	1.18	31"	F5IV	≤25	Be	
B				6.1			F8V	≤25		
10966 A	67 Oph	17 58.1	+ 2 56	3.9	4.30	55"	B5Ib*	≤25	Be	
C				8.2			B3V	150		
10993 A	95 Her	17 59.4	+21 36	5.1	0.13	6"	A1V	180	L,SF,S	
B				5.2			G5III	≤25		
11046 A	70 Oph	18 2.9	+ 2 31	4.3	1.79	6"	K0V*	≤25		See notes.
B				6.1			K4V	≤25		
11056 A	HR 6758	18 3.4	+12 0	7.0	0.46	7"	A5IV	250	L	
B				7.5			A8p	≤25		Pec-A of β CrB type.
11061 A	41 Dra	18 3.8	+80 0	5.8	0.38	20"	F7V	≤25	J	
B	40 Dra			6.2			F7V	≤25		Only one spectrum visible.
11089 A	100 Her	18 5.8	+26 5	5.9	0.04	14"	A3V	180	J	
B				6.0			A3V	180		
11336 A	39 Dra	18 23.2	+58 46	4.9	2.76	4"	A1V*	180:		Only one spectrum visible.
B				7.7			A5pec	80		Metallic lines weak.
11593 A	HR 7033	18 40.3	+34 42	6.1	1.64	25"	B3V	130	Be	Close visual binary.
B				7.7			B8V	150		
11635 A	ϵ^1 Lyr	18 42.7	+39 37	5.1	1.10	3"	A5V	200	L	
B				6.2			A7V	150		
11639 A	ζ Lyr	18 43.0	+37 33	4.3	1.38	44"	Am	≤25	J,SF,Be	See notes.
D				5.7			F0IV	250		
11667 A	5 Aql	18 43.9	- 1 1	5.9	1.59	13"	Am	≤25	L	See notes.
B				7.5			Am	≤25		
11745 A	β Lyr	18 48.2	+33 18	3.4-4.3	(4.4)	47"	var.	-		See notes.
B				7.8			B6V	120		

Table 1 (Cont.)

ADS or (BDS)	Design.	α(1950)	δ(1950)	m_v	Δm	Sep.	Sp. Type	v sin i (km/sec)	Ref.	Remarks
11853 A	θ Ser	$18^h53^m.7$	$+4^\circ 8'$	4.5	0.37	22"	A5V	130	J	
B				4.9			A7V	220		
11870 A	HR 7199	18 55.2	+75 43	6.6	0.79	6"	A0V	100		
B				7.4			A2V	150		
12540 A	β Cyg	19 28.7	+27 51	3.2	2.14	35"	K3II:+B:	≤25(K)	L,B	See notes.
B				5.3			B8Ve	250		
12815 A	16 Cyg	19 40.6	+50 24	6.3	0.24	39"	G2V*	≤25	J	
B				6.5			G5V*	≤25		
12893 A	HR 7529	19 43.8	+35 58	6.5	0.50	15"	B9p	50		See notes.
B				7.0			B9.5V	250		
(9705) A	HD 188211	19 51.2	+20 13	7.2	0.20	42"	A1V	≤25		
B	HD 188212			7.4			Am	60		See notes.
13087 A	57 Aql	19 51.9	- 8 21	5.8	(0.7)	36"	B6V	350		
B				6.5			B8V	250		
13148 A	ψ Cyg	19 54.4	+52 18	4.9	2.53	3"	A3IV	300		
B				7.4			A7V	120		
13554 A	31 Cyg	20 12.0	+46 35	4.0	3.13	107"	K2II+B3V	≤25(K)	S	See notes.
C				7.1			B5V	≤25		
13902 A	o Cap	20 27.0	-18 45	6.1	0.78	22"	A2V	350	J	
B				6.9			A8V	150		
14279 A	γ Del	20 44.4	+15 57	4.5	0.93	10"	K2IV	≤25	L,J,SF,	
B				5.4			F8V	≤25	B,S	
14636 A	61 Cyg	21 4.7	+38 28	5.6	0.79	>26"	K5V*	≤25	J,SF	
B				6.4			K7V*	≤25		Ca II H and K emission.
14720 A	HR 8107	21 8.8	+47 29	6.4	0.82	135"	B5V	120		See notes.
C				7.2			M5III	≤25		
15032 A	β Cep	21 28.0	+70 20	3.3v	4.56	14"	B2III	≤25	Be	
B				7.9			A1V::	60:		Spectrum somewhat contaminated.
15147 A	3 Peg	21 35.2	+ 6 24	6.3	1.43	39"	A1V	100	J,Be	
B				7.7			F2V	30		
15405 A	HR 8357	21 50.3	+55 33	5.6	0.88	19"	B7V	120:		See notes.
B				6.5			A1p	60		

Table 1 (Cont.)

ADS or (BDS)	Design.	α(1950)	δ(1950)	m_v	Δm	Sep.	Sp. Type	v sin i (km/sec)	Ref.	Remarks
15434 A	HD 208392	$21^h52^m.4$	+62°22'	7.1	0.83	62"	B0.5V	300		See notes.
B				7.9			B1V	140		
15493 A	HD 208718	21 55.5	+ 5 42	7.1	0.45	11"	Am	60		See notes.
B				7.6			F2V	120		
15571 A	HR 8423	22 0.4	+82 38	7.1	0.47	14"	F7V	30	J	
B				7.6			G5V, 2sp.	-		v sin i estimate impossible.
15600 A	ξ Cep	22 2.2	+64 23	4.6	2.03	7"	Am	50		See notes.
B				6.6			F7V	≤25		
15987 A	δ Cep	22 27.3	+58 10	3.7-4.6	(2.5)	41"	Ceph	-	L,Be	
C				6.6			B8V	140		
16095 A	8 Lac	22 33.6	+39 23	5.8	0.73	22"	B1(V)e	350	Be	See notes.
B				6.5			B2V	50		

Notes to Table 1

Spectral types designated by an asterisk are MK types from the list of Johnson and Morgan (1953). Those designated by a double asterisk are from the list of Morgan, Code and Whitford (1955). All others are estimated by the writer, except as noted.

The Δm's are from the catalogue of Wallenquist (1954), except for those in parentheses.

References given in the 10th column are to the following authors:

B = Bidelman (1958).
Be = Berger (1962).
J = Johnson (1953).
L = Leonard (1923).
S = Stephenson (1960).
SF = Struve and Franklin (1955).

Notes on individual stars:

ADS 1 B. The over-all type is A2V, but the Balmer lines have sharp and deep absorption cores with wide Stark-broadened wings, the K-line is sharp with some wings, and the Fe II lines at 4233, 4351, and 4549 A are sharp, while all other lines show considerable rotational broadening. The spectrum is that of a shell star of rather late type (plate taken Sep., 1957).

ADS 671 B. The Ca II H- and K-lines show sharp emission cores. The absorption spectrum is peculiar and suggests that of a late-type, metal-poor dwarf. Ca I 4226 has a rather sharp core and broad wings, and the G-band also has a peculiar appearance. The chromium-iron ratio suggests a type near K3, according to P. C. Keenan.

ADS 1630. The spectral type for the primary is by P. C. Keenan, as quoted in the paper by Maestre and Wright (1960). The secondary consists of a close visual binary, the brighter component of which is a spectroscopic binary with two spectra visible. The latter are of approximately the same type (B9.5V) with approximately the same v sin i (70 km/sec).

BDS 1094. The primary has peculiar-looking absorption lines: rather sharp cores with diffuse wings. The secondary is a spectroscopic binary with two spectra visible. Abt (1961) has derived orbital elements. Both components of B are metallic-line stars with A3 K-lines, A7 Balmer lines, and F2 metallic lines, and both have apparently sharp lines on the Perkins plate.

ADS 2984. Morgan, Code and Whitford (1955) gave a combined type of BO II-III for the two components. The primary is SZ Cas, a 2.7 day eclipsing system. The absorption lines look somewhat different on two plates of the secondary taken a few days apart; this star might also be double.

ADS 3317 A. Spectroscopic binary orbit. Only one spectrum visible, which is that of a metallic-line star with A3 K-line, A5 Balmer lines, and A7 metallic lines.

ADS 3910 B. The metallic lines are somewhat weak for AO III. This could be a λ Bootis-type star. The system is probably physical, but there is some doubt.

ADS 4186. Nebular emission complicates the classification of all four components. B is a spectroscopic binary with orbit computed.

ADS 4188. Nebular emission complicates the classification of both components. A is a spectroscopic binary with orbit computed.

ADS 4193 B. Helium lines too weak for this type. Balmer lines also somewhat weak relative to main-sequence star of this type.

ADS 4749 A. A plate taken in February, 1958 shows a shell spectrum almost identical with that of ADS 1 B, though of slightly earlier type. Another plate taken in March, 1959 shows the shell spectrum considerably weakened, although the Fe II lines are still sharp and fairly prominent.

ADS 6175. Both components are spectroscopic binaries with orbits computed. B is a metallic-line star with A1 K-line, A3 Balmer lines, and A5 metallic lines.

ADS 7093. A is a metallic-line star with A3 K-line, A3 Balmer lines, and F2 metallic lines. B is also a metallic-line star, with A4 K-line, A5 Balmer lines, and FO metallic lines.

ADS 7311. The system is probably physical but there is some doubt.

ADS 7627 C. Sr II 4077 is rather strong for this type.

ADS 7654 B. The star may be on the lower edge of the main sequence, according to P. C. Keenan. The Balmer lines and Sr II 4077, 4216 are weak, and there is no trace of CN.

ADS 7705. Both components are metallic-line stars with very similar spectra on the Perkins plates: A9 K-line, A9 Balmer lines, and F5 metallic lines.

ADS 8568 B. A3 K-line, A5 Balmer lines, and F2 metallic lines.

ADS 8600 B. This is a spectroscopic binary with both components metallic-line stars. The composite type is: A5 K-line, A7 Balmer lines, and F2 metallic lines.

ADS 8657. The system is probably physical but there is some doubt.

ADS 8682. The primary shows a shell spectrum on plates taken in April and July in 1958 and in June, 1960 which is similar to that of ADS 1 B. Again the Balmer lines, K-line, and Fe II lines show sharp cores, while other lines are diffuse. The wings of the Balmer lines and K-line seem somewhat stronger in 1960 than in 1958. He I does not appear on any of the plates. A 103a-F plate taken in June, 1960 shows Hα as a strong absorption line. The secondary component shows two spectra of types near AOV and A2V, both with apparently sharp lines on the Perkins plates.

ADS 8706 A. Spectroscopic binary with orbit computed. Also peculiar-A star and spectrum variable.

ADS 8891 B. A2 K-line, A2 Balmer lines, and A7 metallic lines. Spectroscopic binary with orbit computed.

3 Cen A. The unusual spectrum of this star was first pointed out by Bidelman (1960). Later, Sargent and Jugaku (1961), showed the existence of He^3 in the spectrum.

ADS 9258 B. Close visual binary, 7.6:8.8. This could also be a mild Am star.

ADS 9494. Perkins spectrograms available only for the primary. The secondary is a W U Ma-type binary, which has been studied spectroscopically by Popper (1943).

ADS 9951. Both components are close visual binaries: A is a 4.4:6.4 pair while C has 6.8:7.8 components. The spectrum of C has the Si II 4128-4130 lines too strong for the assigned type of B9V.

ADS 9979 A. Both spectra are similar and of about the same strength. This component also shows double Ca II H and K emission.

ADS 10628. A has A3 K-line, A7 Balmer lines and F2 metallic lines, while B has A4 K-line, A7 Balmer lines, and F0 metallic lines. v^2 is a spectroscopic binary with orbit computed.

ADS 11046 A. Spectroscopic binary with orbit computed. Single weak and narrow emission components of Ca II H and K are visible.

ADS 11639 A. A4 K-line, A7 Balmer lines, and F0 metallic lines. Also spectroscopic binary with orbit computed.

ADS 11667. The primary has A2 K-line, A2 Balmer lines, and F0 metallic lines, while the secondary has A5 K-line, A7 Balmer lines, and F2 metallic lines.

ADS 11745 A. The spectrum is complicated by emission: spectral types ranging from B6 I, II to B8 Ia were obtained from three Perkins plates.

ADS 12540 A. Spectral type by W. W. Morgan, as quoted in Stebbins and Kron (1956). No rotational velocity estimate for the B-type component possible.

ADS 12893. The system is probably physical but there is some doubt. The primary appears to be a peculiar A-star of the silicon type, but the spectral type is close to B9 IV.

BDS 9705 B. A7 K-line, A7 Balmer lines, F2 metallic lines.

ADS 13554 A. Spectral type by Bidelman (1951). No rotational velocity estimate for the B-type component possible.

ADS 14720. This may not be a physical system. The spectral type of the secondary is due to P. C. Keenan.

ADS 15405. Only one spectrum visible on Perkins plate of primary. The secondary is a peculiar A-star of the θ Aurigae type, with strong Si II and Sr II lines.

ADS 15434. The system is probably physical but there is some doubt.

ADS 15493 A. A3 K-line, A5 Balmer lines, and F2 metallic lines.

ADS 15600 A. A3 K-line, F0 Balmer lines, and F5 metallic lines.

ADS 16095. Spectral types by Morgan in the list of Johnson and Morgan (1953).

Table 2

SPECTRAL TYPES AND AXIAL ROTATIONAL VELOCITIES FOR 12 OPTICAL PAIRS

ADS or (BDS)	Design.	α(1950)	δ(1950)	m_V	Sp. Type	v sin i (km/sec)	Remarks
639 A	HD 4372	$0^h43^m.7$	$+30^\circ40'$	7.4	K1IV	≤ 25	
B				7.5	K2III	≤ 25	
1534 A	56 And	1 53.2	+37 1	5.8	K2III	≤ 25	
B				6.1	K5III	≤ 25	
2735 A	HD 23245	3 41.6	+27 45	6.7	F2V	60	
B				6.8	G2V	≤ 25	
3615 A	β Cam	4 59.0	+60 22	4.2	G0Ib*	≤ 25	
B				7.6	F0IV	100	
(2480) A	11 Cam	5 1.8	+58 54	5.3	B3(V:)e	125	
B	12 Cam			6.4	K0III	≤ 25	
8659 A	HD 110932	12 42.9	+14 39	6.8	B8V	90	
B				7.4	F6V	≤ 25	
9933 A	κ Her	16 5.8	+17 11	5.3	G5III	≤ 25	
B				6.5	K2II	≤ 25	
11035 A	HD 165502	18 2.0	+56 25	7.1	F0V	60	
B				7.5	A3V	120	
12007 A	15 Aql	19 2.3	- 4 6	5.5	K1III	≤ 25	Type by P. C. Keenan.
B				7.1	K4III	≤ 25	Type by P. C. Keenan.
	48 Cyg	20 35.5	+31 24	6.3	B9Vp	80	Si II strong.
	HR 7887			6.4	F0V	150	
14702 A	γ Equ	21 7.9	+ 9 56	4.8	F0p	≤ 25	Sr II, Eu II strong.
D	6 Equ			6.0	A2V	60	
	HD 208947	21 55.9	+65 55	6.3	B2V	250	
	HD 208971			6.7	M2III	≤ 25	Type by P. C. Keenan.

main sequence, using the observed Δm to separate them in absolute magnitude. Figure 3 shows those systems in which both components were classified as normal stars above the main sequence, again using the observed Δm's to separate the components in absolute magnitude. The figures are essentially self-explanatory and show the distribution of spectral types selected for investigation.

b) Axial Rotation in Double-Star Components with Normal Spectra

Average values of $v \sin i$ for double-star components of various spectral types and luminosity classes are listed in Table 3. For comparison purposes, the corresponding val-

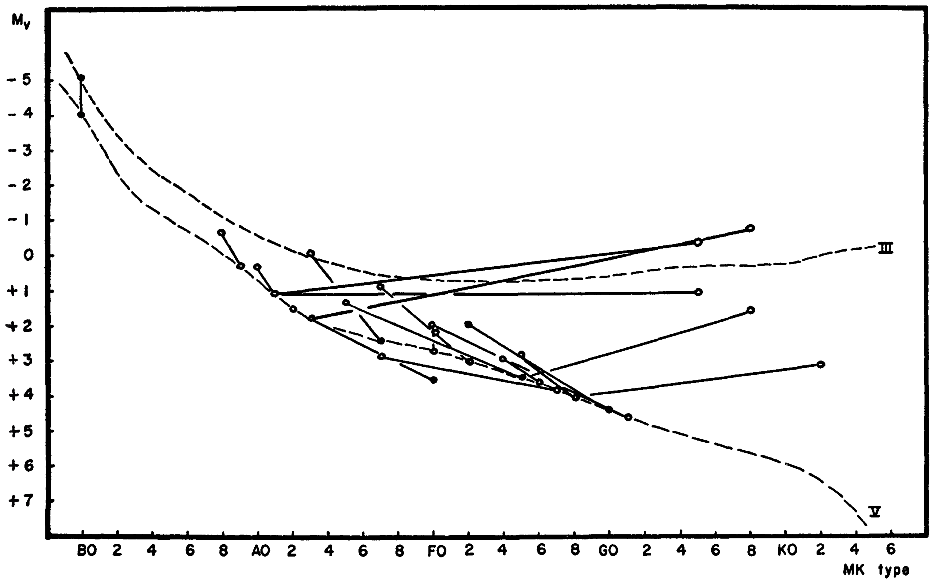

FIG. 1.—H-R diagram for binaries with normal spectra for both components, one being judged to be on the main sequence and the other above the main sequence.

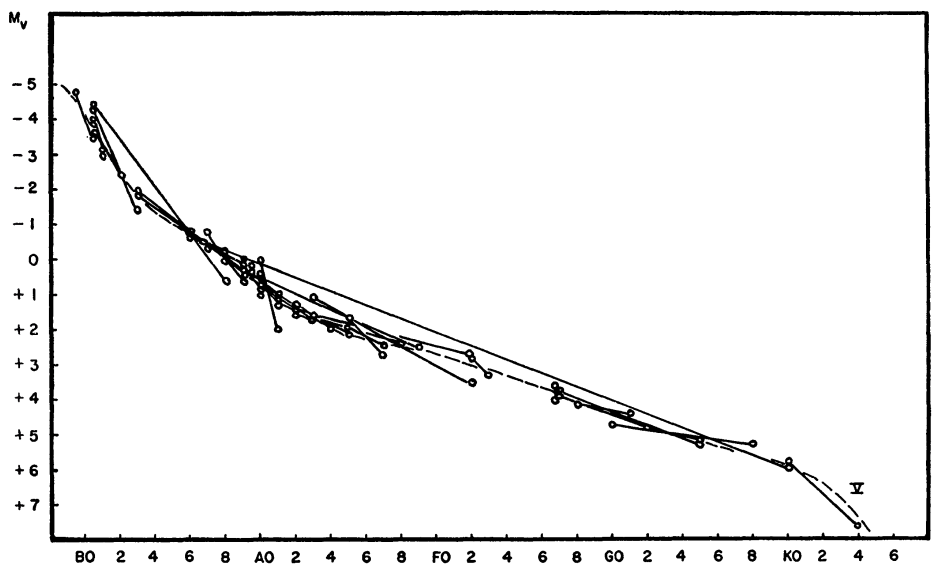

FIG. 2 —H-R diagram for binaries in which both components were classified as normal main-sequence stars.

ues for single stars are also listed. The comparison is expressed in graphical form in Figure 4. The average values for single stars were obtained from the writer's earlier papers on stellar axial rotation by removing visual binaries and spectroscopic binaries with computed orbits or two spectra visible from the statistical discussion.

There appear to be no significant differences in the mean rotational velocities for double-star components and single stars. Both classes of stars show the same general dependence of axial rotation on spectral type, including the greater rotation in F-type giant stars as against main-sequence stars of corresponding type.

Struve and Franklin (1955) state a general rule for the double-star components that they investigated: the rotation, unless it is zero in both components, is larger in the one of earlier type. The stars included in this study do not strictly obey such a rule, although,

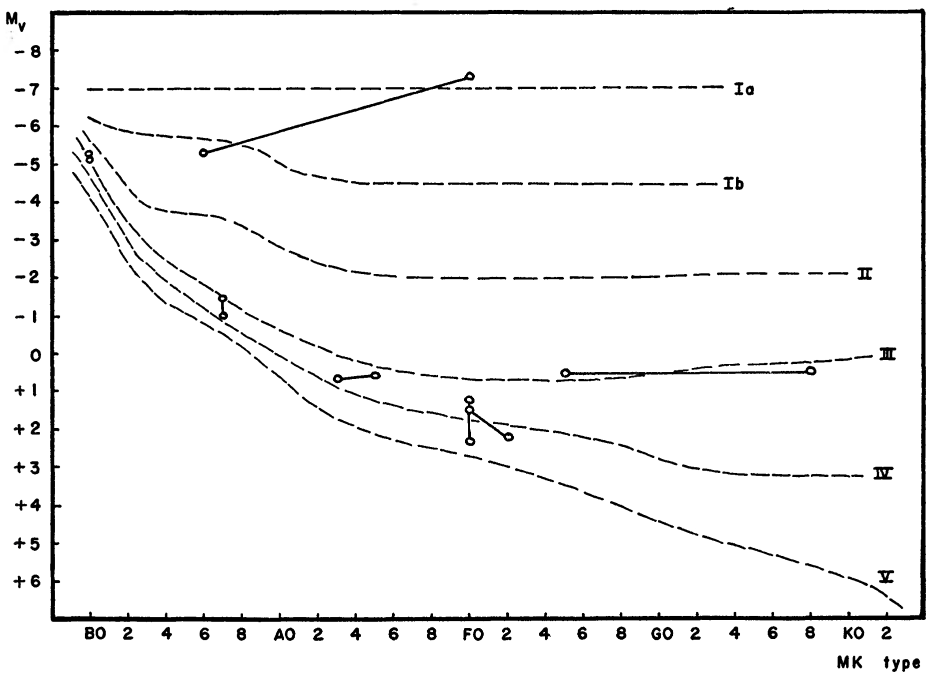

FIG. 3.—H-R diagram for binaries in which both components were classified as normal stars, above the main sequence.

statistically, their rotational velocities show the same trend across the H-R diagram as do single stars. The difference between the present results and those of Struve and Franklin probably lies largely in the selection of stars. Struve and Franklin considered primarily stars of type F0 and later, where axial rotation is falling off very rapidly with spectral type, as shown in Figure 4, while this investigation includes large numbers of A- and B-type stars as well. The rule of Struve and Franklin, then, may hold for the stars of late A and F type but does not appear to be valid across the entire H-R diagram.

c) Absolute Magnitudes of Double-Star Components

One of the original objectives in undertaking this spectroscopic study of double-star components was to derive absolute magnitudes for certain peculiar stars of special interest. At the same time, it was hoped that an independent calibration of the Morgan-Keenan luminosity classes might be achieved for some classes of normal stars. The results of such analyses of the data in Table 1 have been somewhat disappointing, in that the uncertainties in the derived absolute magnitudes are considerable. Although some of this uncertainty can be attributed to the Δm's, relatively few of which were determined pho-

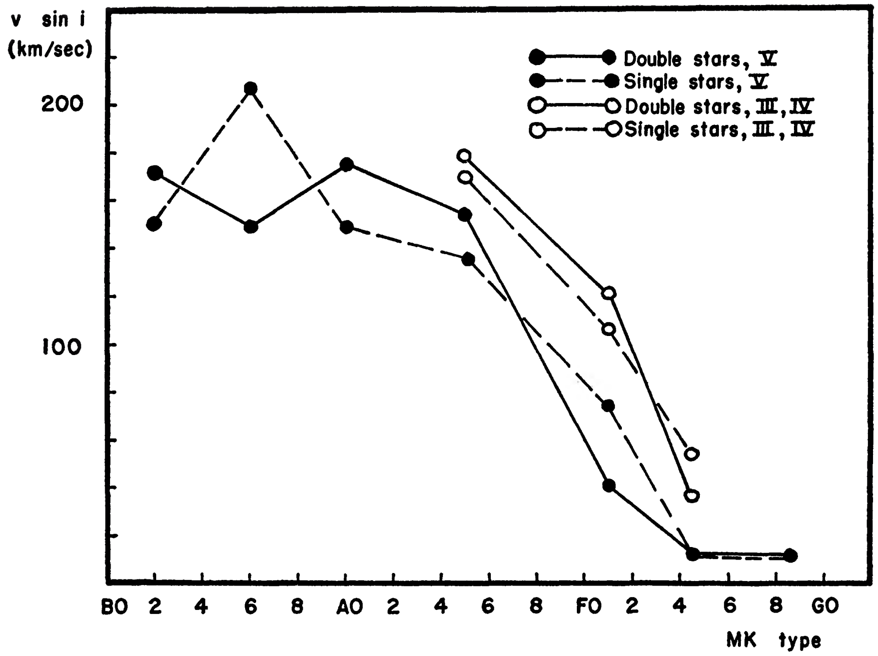

FIG 4 —Comparison of axial rotational velocities of double-star components with those of single stars of corresponding type.

TABLE 3

COMPARISON OF AXIAL ROTATIONAL VELOCITIES OF DOUBLE-STAR COMPONENTS WITH THOSE OF SINGLE STARS OF CORRESPONDING TYPE

SPECTRAL TYPE		DOUBLE-STAR COMPONENTS		SINGLE STARS	
		⟨v sin i⟩ (km/sec)	No of Stars	⟨v sin i⟩ (km/sec)	No of Stars
B1–3	V	172	10	150	54
	III, IV			96	17
B5–7	V	149	11	208	30
	III, IV	133	3	128	28
B8–2	V	175	45	147	70
	III, IV			77	20
A3-7	V	154	15	136	32
	III, IV	179	8	170	20
F0–2	V	41	9	74	12
	III, IV	121	8	106	22
F3–6	V	≤ 25	4	≤ 25	8
	III, IV	36	2	54	10
F7–G0	V	≤ 25	8	≤ 25	16
	III, IV	.		44	4

toelectrically, the largest part is probably due to the spectral classification. A large number of A-type stars are included in Table 1, for example, and luminosity classes of A-type stars near the main sequence are very difficult to estimate. An error of up to a magnitude is entirely possible in the luminosity classification of one of the components, and the full error is then thrown into the absolute magnitude derived for the other component. The following results are presented in the hope that they may have some intrinsic interest, even though uncertainties exist.

The visual absolute magnitude calibration by Keenan (1963) was used throughout for the normal components. Unless otherwise noted, values of Δm were taken from the Wallenquist (1954) catalogue whenever possible. Whenever appropriate, corrections for multiplicity of the components were made.

Normal main-sequence stars of early type.—The method of Lundmark and Luyten (1923), rediscussed by Luyten in 1957, was applied to the systems in Table 1 in which

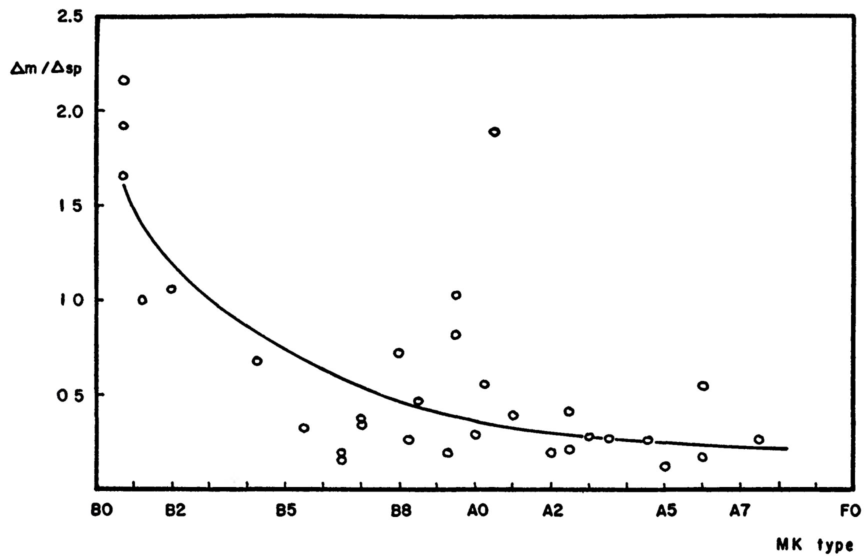

FIG. 5.—The difference in magnitude per tenth of a whole spectral class along the main sequence, as a function of spectral type, for 31 systems.

both components were estimated to be normal main-sequence stars. Values of $\Delta m/\Delta sp$, the difference in magnitude per tenth of a whole spectral class along the main sequence, are plotted against spectral type in Figure 5 for 31 systems. Despite the large scatter, a curve was drawn through the points and visual absolute magnitudes computed for main-sequence stars of types B2–A7, using the Keenan (1963) value of $M_v = +0.6$ for A0 V stars. The results are tabulated in Table 4. Individual values are not too meaningful, particularly for the earliest types, but it is interesting to note that, while the calibration from double-star components agrees fairly well for the A- and late B-type stars, the early and middle B-type stars are more luminous than indicated in the Keenan calibration.

Metallic-line stars.—Nine of the systems in Table 1 were found to consist of a metallic-line star plus a star with normal spectrum, four systems contain pairs of metallic-line stars, and one system consists of a metallic-line star with a companion peculiar A-type star. The afore-mentioned nine systems are listed in Table 5, with the visual absolute magnitudes derived for the metallic-line star components.

The range of visual absolute magnitudes in Table 5 is large, and there is no apparent correlation between M_v and the K-line types, Balmer-line types, metallic-line types, or "metallicity" for individual stars. The average visual absolute magnitude for the nine stars is $+1.7$ for a mean Balmer-line type of A6, which falls approximately in the middle of previous determinations by a number of authors. The paper by the Jascheks (1959) summarizes the earlier work. It is interesting to note that the present determination would place the metallic-line stars, on the average, about ½ mag. above the main sequence for their Balmer-line types, but there is considerable variation, as shown in Figure 6. Because the Balmer lines come to a rather flat maximum in intensity in the A-type stars, visual estimates of the Balmer-line types for metallic-line stars are not of high precision. Rather large differences exist, for example, between the Balmer-line types in the present paper and those of Roman, Morgan, and Eggen (1948) for some of the stars in common. In view of the correlation between Balmer-line type and $B - V$ colors for the metallic-line stars (Jascheks 1959; Slettebak, Bahner, and Stock 1961), the latter would be preferable in locating these stars accurately on the H-R diagram.

The Jascheks (1959) have suggested that the "metallicity" (the difference between the metallic-line type and the Balmer-line type of an object) is very probably a luminosity effect and that this point can be checked in double stars in which both components are metallic-line stars. In the four such systems in Table 1, the brighter component does

TABLE 4

VISUAL ABSOLUTE MAGNITUDES OF MAIN-SEQUENCE DOUBLE-STAR COMPONENTS OF SPECTRAL TYPES B2–A7

Spectral Type	M_v from Double-Star Components	M_v Keenan (1963)
B2 V	−4 9	−2 5
B3	−3 8	−1 7
B5	−2 1	−1 1
B7	−0 8	−0 6
B8	−0 3	−0 2
B9	+0 2	+0 2
A0	+0 6	+0 6
A1	+1 0	+1 2
A2	+1 3	+1 4
A3	+1 6	+1 7
A5	+2 1	+2 1

TABLE 5

VISUAL ABSOLUTE MAGNITUDES OF METALLIC-LINE STARS WITH NORMAL COMPANIONS IN DOUBLE-STAR SYSTEMS

ADS or (BDS)	K-Line Type	Balmer-Line Type	Metallic-Line Type	M_v
(1094) B	A3	A7	F2	+1 6
3317 A	A3	A3	A7	+0 5
6175 B	A1	A3	A5	+2 2
8600 B	A5	A7	F2	+2 3
8891 B	A2	A2	A7	+2 3
11639 A	A4	A7	F0	+0 3
(9705) B	A7	A7	F2	+1 4
15493 A	A3	A4	F2	+2 5
15600 A	A3	F0	F5	+1 8
Mean	A3	A6	F0	+1 7

indeed have metallicity greater than, or equal to, that of the fainter component in each case. The Balmer-line types suffer from the uncertainty already mentioned, however, and one could better test the Jascheks' suggestion if $B - V$ photoelectric colors were available for these objects.

For the metallic-line stars with normal companions, Table 1 shows that the Am star may be either the secondary or the primary and that it may be earlier or later than its companion. The normal companion stars include A- and F-type stars, and even a K2 giant star, but no B-type stars, suggesting that metallic-line stars are probably not extremely young objects from the evolutionary point of view.

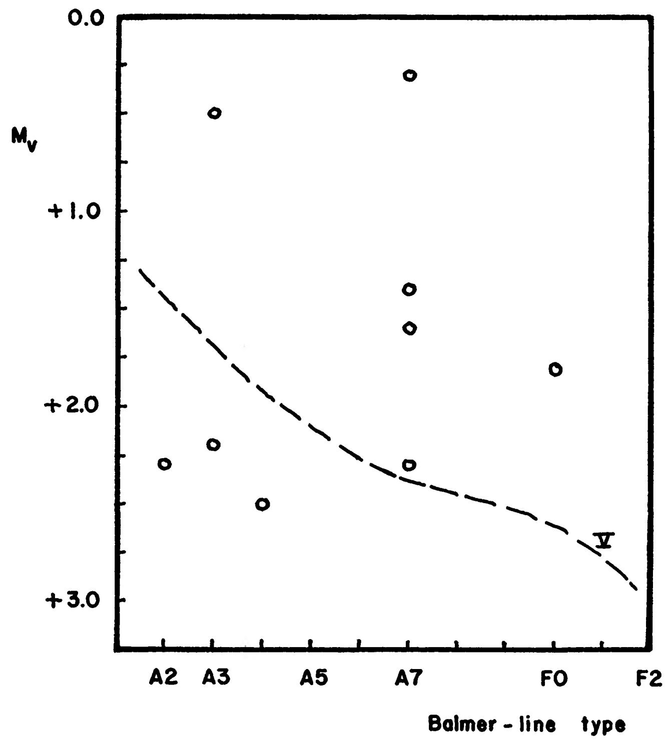

FIG. 6.—Visual absolute magnitudes of metallic-line stars, plotted against their Balmer-line types

Peculiar A-type stars.—Nine systems which are made up of a peculiar A-type star with a normal companion are listed in Table 6. A tenth system contains a peculiar A-type star with a metallic-line star companion. Visual absolute magnitudes for the peculiar components in Table 6 were again derived from the spectroscopic absolute magnitudes of their normal companions plus the observed Δm's for the systems. These are listed in Table 6 and plotted in Figure 7 against the corresponding spectral types. Four kinds of peculiar A-type stars are represented: silicon stars, a manganese star, a strontium star, and a β CrB-type star. Only the silicon stars are present in sufficient number to yield a meaningful absolute magnitude for the group. The mean M_v for six silicon stars of mean type A0p is 0.0, which would locate these stars about $\frac{1}{2}$ mag. above the main sequence for their mean type. This result is in general agreement with earlier results (Eggen 1957).

Just as for the metallic-line stars, Table 1 shows that peculiar A-type components of double-star systems may be the primaries or the secondaries and may be earlier or later in type than their companions. They keep about the same company as do the metallic-line stars (with a possible slight preference for companions of earlier type) and probably represent about the same phase of evolution. Indeed, the system 17 Comae contains a peculiar A-type star together with a metallic-line star, and each is a fine example of its type.

Additional stars of interest.—A number of systems in Table 1 include stars which are peculiar or of special interest for one reason or another. These systems are listed in Table 7 together with the visual absolute magnitudes of the components of interest, determined as described in preceding sections. A brief discussion of some of these stars follows:

1. *Shell stars:* The three shell stars (ADS 1B, 4749A, and 8682A) have a mean visual absolute magnitude of +0.2, which would place them about 1 mag. above the main

TABLE 6

VISUAL ABSOLUTE MAGNITUDES OF PECULIAR A-TYPE STARS WITH NORMAL COMPANIONS IN DOUBLE-STAR SYSTEMS

ADS	Spectral Type	Peculiarity	M_v
1507 A	A1p	Silicon-chromium	+0 3
8347 B	A2p	Strontium-chromium	+2 1
8706 A	A0p	Silicon-chromium	0 0
9338 A	B9p	Manganese	+1 2
9951 C	B9Vp	Silicon	−0 2
10526 A	A0p	Silicon	−0 5
11056 B	A8p	β CrB type	+1 7
12893 A	B9p	Silicon	−0 1
15405 B	A1p	Silicon-strontium	+0 3

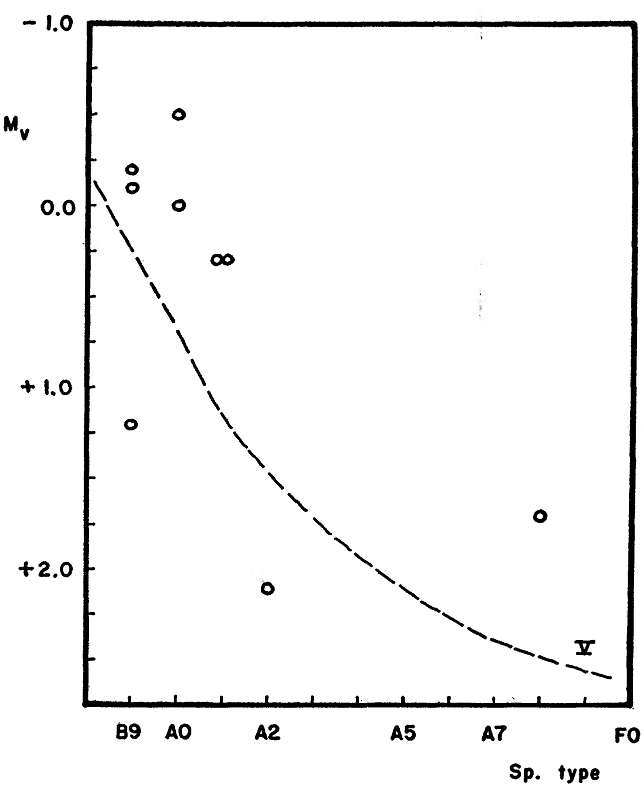

FIG. 7.—Visual absolute magnitudes of peculiar A-type stars, plotted against their spectral types

sequence for their mean spectral type. There is the possibility that the underlying stars are earlier than the spectral types in Table 7 would indicate, but they cannot be as early as B9, since He I lines are not visible in the spectra of any of these stars and the shells are not optically thick. It seems probable that these objects are indeed located somewhat above the main sequence. The rotational velocity is large for all three objects ($v \sin i =$ 250 km/sec), as would be expected for shell stars, but not so large as that of some non-shell stars of corresponding type.

2. *Cepheids:* Two classical cepheid variable stars are listed in Table 7. Although the visual absolute magnitude derived for δ Cephei is approximately consistent with its period, α Ursa Minoris is too luminous. A portion, but not all, of the discrepancy may arise from the fact that the spectrogram of the companion star was not of the highest quality.

TABLE 7

VISUAL ABSOLUTE MAGNITUDES OF SOME COMPONENT STARS OF SPECIAL INTEREST IN DOUBLE-STAR SYSTEMS

ADS	Name	Spectral Type or Peculiarity	M_v
1 B		A2 V shell	+1 5
4749 A		A1 V shell	−0 6
8682 A		A2 V shell	−0 3
1477 A	α UMi A	Cepheid	−4 3
15987 A	δ Cep A	Cepheid	−2 7
1073 A	φ Cas A	F0 I*a*	−7 7
1630 A	γ And A	K2 II	−3 5
4134 A	δ Ori A	O9.5 II	−6 3
10966 A	67 Oph A	B5 I*b*	−6 0
4179 A	λ Ori A	O8	−6 1
4186 C	θ^1 Ori C	O6	−6 0
671 B	η Cas B	K3p	+8 2
11336 B	39 Dra B	A5p	+4 0
9494 B	44 Boo B	W UMa type	+5 9 and +6 5
11745 A	β Lyr A	Variable spectrum (B6 I, IIp–B8 Iap)	−4 7
12540 A	β Cyg A	Composite spectrum (K3 II: + B:)	−2 3
13554 A	31 Cyg A	Composite spectrum (K2 II + B3 V)	−4 2
15032 A	β Cep A	Variable star (B2 III)	−3 4
	3 Cen A	Peculiar spectrum (B5 Vp)	−1 3

3. *Supergiant and luminous giant stars:* The four supergiant and luminous giant stars listed in Table 7 are all somewhat more luminous than the Keenan (1963) calibration would indicate is average for the type.

4. *Stars earlier than O9:* An O6 (θ^1 Ori C) and an O8 (λ Ori) star are included. The photometric data of Sharpless (1952) for the θ^1 Ori system was used to derive the visual absolute magnitude of θ^1 Ori C.

5. *Stars below the main sequence:* Two stars, η Cas B and 39 Dra B, appear to be located below the main sequence for the spectral types which best describe their spectra, by about 1 and 2 mag., respectively. The spectra are peculiar, with the metallic lines weak in both cases.

6. *Miscellaneous:* Table 7 also lists visual absolute magnitudes for the following peculiar components of binary systems:

ADS 9494 B = 44 Boo B. The luminosity ratio for the components of B of 0.6 by

Popper (1943) was used to derive the individual visual absolute magnitudes for this W UMa-type system.

ADS 11745 A = β Lyr A. The photometric data by Abt, Jeffers, Gibson, and Sandage (1962) were used to derive the visual absolute magnitude of this star. The spectral type of B6 V for component B leads to a value of M_v for component A that is somewhat brighter than that found by these investigators.

ADS 12540 A = β Cyg A. The visual absolute magnitude derived suggests that the K-type component of this composite may not be quite so luminous as class II.

ADS 13554 A = 31 Cyg A. The absolute magnitude determination is consistent with the estimated spectral type for this system.

ADS 15032 A = β Cep A. The value $M_v = -3.4$ derived for this β CMa-type variable is consistent with its spectral type of B2 III.

3 Cen A. The absolute magnitude found for this very peculiar object (see notes to Table 1) is consistent with the B5 V classification, which best describes its spectrum.

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