

PHOTOELECTRIC OBSERVATIONS OF VISUAL DOUBLE STARS*

HAROLD L. JOHNSON†

Yerkes and McDonald Observatory

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ABSTRACT

Photoelectric observations of the magnitudes and colors of both components of 40 visual double stars, all of which are likely to be physical pairs, have been made with the 82-inch telescope of the McDonald Observatory. It appears that many of the brighter components must be more luminous than main-sequence stars.

During the course of three-color photoelectric work on bright standard stars and stars in galactic clusters,¹ observations were made on each component of 40 visual double stars. In all cases, the two components were compared directly with each other; the stars were then tied in with the fundamental system.¹ The observations were made with the 82-inch telescope of the McDonald Observatory during the summer of 1951. The focal plane diaphragm had an angular diameter of 15", except for the stars separated by less than 15", for which a 7" diaphragm was used. It was found that 1 per cent of the starlight that went through the 15" diaphragm did not go through the 7" one, and the magnitudes have been corrected for this. Changing diaphragms had no effect on the colors.

The observed magnitudes and colors are listed in Table 1. The first column contains the number of the binary (all probably physical pairs) in Aitken's catalogue,² the second, the constellation name, if any, of the star; the third, fourth, and fifth, the measured values of V , $B - V$, and $U - B$, respectively, for the individual stars. The absolute magnitudes, M_v , given in the sixth column, are computed on the assumption that the fainter component of each double star is an ordinary main-sequence (single) star and that it fits on the standard main sequence previously defined.¹ In two cases, Nos. 11061 and 15571, the fainter component is known to be a double-line spectroscopic binary; accordingly, a correction of -0.75 mag. has been applied to the derived values of M_v for the brighter components. In one case, No. 9626, the fainter component is a visual double star (measured photoelectrically as one star) with a magnitude difference of 0.7, necessitating a correction of -0.4 to the absolute magnitude of the brighter component.

The seventh column of Table 1 gives the number of observations on each star; the eighth, the values of ϵ , defined in a previous paper.¹ The probable errors of the magnitudes and colors, in terms of ϵ , are listed in Table 2. The last column of Table 1 gives the spectral type by W. W. Morgan.

The color-absolute-magnitude diagram for the brighter components of the double stars is shown in Figure 1. The solid line represents the standard main sequence¹ to which the fainter components were fitted. Let us neglect, for the moment, the six stars in the upper right corner of the diagram. One notices immediately that many of the stars fall along the main-sequence line but that many others fall a considerable distance above the line. While some of these brighter components may themselves be double, with nearly equal components, we know that not many such cases are present, since spec-

* *Contributions from the McDonald Observatory, University of Texas*, No. 219.

† Now at Lowell Observatory, Flagstaff, Arizona.

¹ H. L. Johnson and W. W. Morgan, *Ap. J.*, **117**, 313, 1953.

² *New General Catalog of Double Stars* (Washington, D.C.: Carnegie Institution of Washington, 1932).

TABLE 1
MAGNITUDES AND COLORS OF THE COMPONENTS OF VISUAL DOUBLE STARS

ADS	Name*	<i>V</i>	<i>B</i> − <i>V</i>	<i>U</i> − <i>B</i>	<i>M_v</i> †	<i>n</i>	<i>ε</i>	Sp.
1.....	A	5.86	+1.09	+0.91	0.0	1	15	.....
	B	7.34	+0.08	+0.05	+1.5	2	11	.....
<i>No No.</i>	36 UMa A	4.82	+0.51	0.00	+4.3	2	10	F8 V
	B	8.69	+1.36	+1.26	+8.2	2	12	K7 V
8706.....	α CVn A	2.89	−0.12	−0.32	+0.1	2	9	Ap
	B	5.60	+0.34	−0.03	+2.8	2	9	F0 V
9173.....	κ Boo A	4.54	+0.20	+0.14	+1.0	3	8	.....
	B	6.69	+0.39	−0.04	+3.1	2	9	F2 V
9479.....	A	6.69	+1.19	+1.20	+2.0	2	10	.....
	B	10.18	+0.78	+0.36	+5.5	2	10	.....
9535.....	A	6.68	+0.68	+0.25	+4.4	2	8	.....
	B	7.53	+0.73	+0.33	+5.3	2	8	.....
9559.....	δ Boo A	3.50	+0.95	+0.69	+0.2	2	8	G8 III
	B	7.84	+0.59	+0.01	+4.5	2	8	G0 V
9580.....	A	7.13	+0.49	0.00	+3.7	2	8	.....
	B	8.07	+0.61	+0.12	+4.6	2	8	.....
9584.....	5 Ser A	5.06	+0.54	+0.06	+3.0	5	7	F8 IV−V
	B	10.11	+1.34	.....	+8.1	2	25	.....
9626.....	μ Boo A	4.30	+0.30	+0.08	+1.9	2	8	.....
	BC	6.50	+0.59	+0.13	+4.5	2	8	.....
9696.....	A	6.58	+0.67	+0.13	+4.9	2	12	.....
	B	7.31	+0.79	+0.37	+5.6	2	12	.....
9778.....	β Ser A	3.67	+0.07	+0.09	+0.2	4	6	A2 IV
	B	9.95	+0.99	+0.81	+6.5	2	8	.....
9910.....	A	7.46	+0.74	+0.29	+5.3	2	11	.....
	B	8.03	+0.84	+0.51	+5.9	2	11	.....
10386.....	A	8.87	+1.16	+1.08	+7.2	2	8	.....
	B	9.34	+1.26	+1.21	+7.7	2	8	.....
10628.....	ν ² Dra A	4.84	+0.28	+0.10	+2.5	2	9	Am
	ν ¹ Dra B	4.86	+0.25	+0.06	+2.5	2	9	Am
10638.....	A	7.41	+0.52	+0.09	+2.9	2	8	.....
	B	10.53	+0.88	+0.64	+6.0	2	8	.....
10715.....	A	6.36	+1.20	+1.18	+0.6	2	8	.....
	B	9.40	+0.45	−0.07	+3.6	2	8	.....
11061.....	41 Dra A	5.68	+0.50	−0.01	+2.9	2	11	.....
	40 Dra B	6.04	+0.51	−0.01	+4.0	2	11	.....
11089.....	100 Her A	5.90	+0.14	+0.08	+1.8	2	8	.....
	B	5.86	+0.12	+0.08	+1.8	2	8	.....

* The designations "A" and "B" are Aitken's (*New General Catalog of Double Stars* [Washington, D.C.: Carnegie Institution of Washington, 1932]).

† Determined on the assumption that the fainter component is an ordinary main-sequence star.

TABLE 1—*Continued*

ADS	Name*	<i>V</i>	<i>B</i> − <i>V</i>	<i>U</i> − <i>B</i>	<i>M</i> _v †	<i>n</i>	ε	Sp.
11639.....	ζ Lyr	A	4.37	+0.18	+0.17	2	9	Am
		B	5.74	+0.28	+0.06	2	9	F0 IV
11853.....	θ Ser	A	4.59	+0.15	+0.09	2	10	.....
		B	4.99	+0.20	+0.07	2	10	.....
12169.....	.....	A	6.57	+0.65	+0.21	2	9	.....
		B	6.75	+0.64	+0.17	2	9	.....
12725.....	.....	A	8.17	+0.24	+0.14	2	10	.....
		B	9.49	+0.49	+0.05	2	10	.....
12815.....	16 Cyg	A	5.96	+0.64	+0.19	2	8	G2 V
		B	6.20	+0.66	+0.20	2	8	G5 V
12913.....	17 Cyg	A	4.99	+0.46	0.00	2	8	F5 V
		B	8.56	+1.04	+0.95	2	8	.....
13442.....	θ Sge	A	6.48	+0.38	−0.04	2	8	.....
		B	8.89	+0.76	+0.34	2	8	.....
13868.....	.....	A	6.70	+0.52	−0.02	2	9	.....
		B	7.50	+0.52	−0.02	2	9	.....
13870.....	.....	A	6.36	0.00	0.00	2	9	.....
		B	8.40	+0.08	+0.09	2	9	.....
13902.....	ο Cap	A	5.94	+0.08	+0.30	2	11	.....
		B	6.74	+0.22	+0.04	2	11	.....
14054.....	.....	A	7.98	+0.38	−0.02	2	10	.....
		B	9.11	+0.56	0.00	2	10	.....
14279.....	γ Del	A	4.27	+1.04	+0.97	3	7	.....
		B	5.14	+0.49	+0.08	3	7	.....
14636.....	61 Cyg	A	5.19	+1.19	+1.10	4	8	K5 V
		B	6.02	+1.38	+1.23	4	8	K7 V
14909.....	1 Peg	A	4.09	+1.10	+1.05	2	9	K1 III
		B	9.14	+0.86	+0.52	2	9	.....
15147.....	3 Peg	A	6.17	+0.03	+0.02	2	9	.....
		B	7.65	+0.37	−0.01	2	9	.....
15366.....	.....	A	6.45	+0.39	+0.05	2	9	.....
		B	10.53	+0.91	+0.57	1	15	.....
15571.....	.....	A	6.98	+0.52	−0.02	2	11	.....
		B	7.49	+0.70	+0.17	2	11	.....
15719.....	.....	A	5.50	+0.38	−0.04	2	10	.....
		B	8.62	+0.86	+0.49	2	10	.....
15828.....	.....	A	6.17	+0.28	+0.11	2	9	.....
		B	8.85	+0.60	+0.05	2	9	.....
16097.....	.....	A	7.63	+0.68	+0.17	2	11	.....
		B	9.71	+0.81	+0.42	2	11	.....
16611.....	.....	A	7.56	+0.56	−0.04	2	10	.....
		B	8.19	+0.69	+0.09	2	10	.....

trograms not showing double lines exist for most of these stars.³ Furthermore, some of these stars fall more than 0.75 mag. above the main sequence, a situation that requires *three* components of nearly equal brightness. It appears that many of the brighter components of these visual binaries must be more luminous than ordinary main-sequence stars; two of these, Nos. 9584 A and 9778 A, do in fact show higher luminosity effects in their spectra. An alternative explanation that might be advanced is the possibility that a

TABLE 2
PROBABLE ERRORS (MAG.)

V	$B-V$	$U-B$
$\pm 0.002\epsilon$	$\pm 0.001\epsilon$	$\pm 0.0025\epsilon$

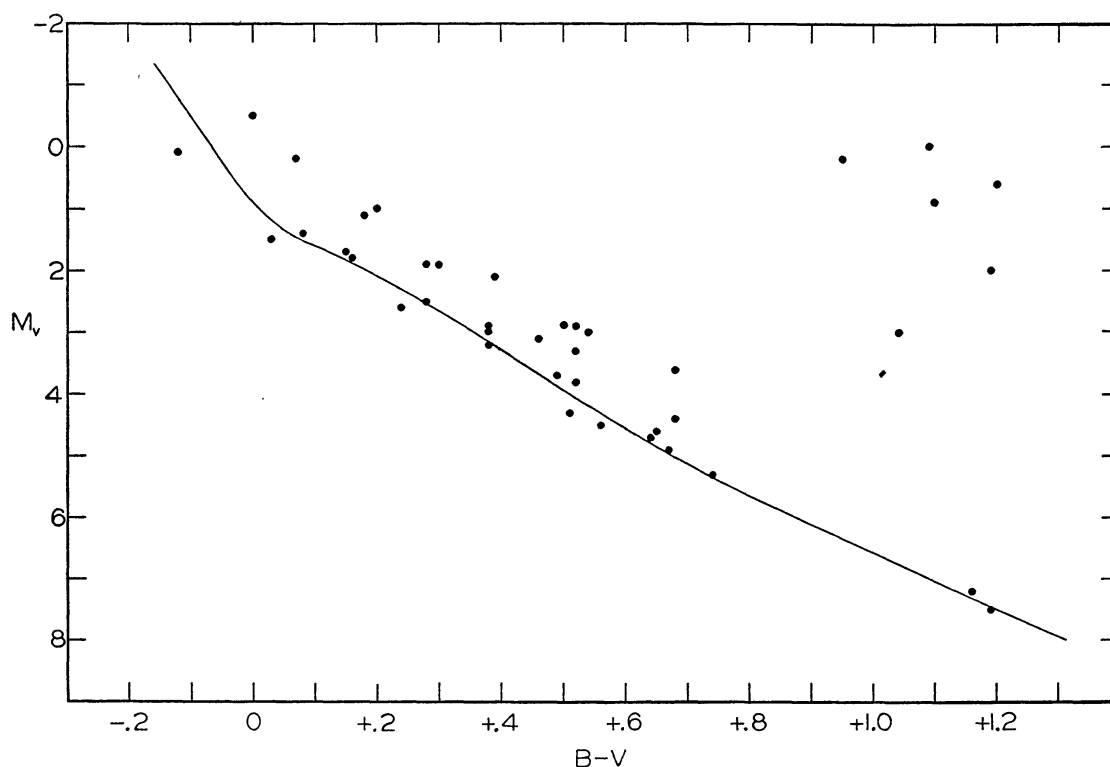


FIG. 1.—Color-absolute-magnitude diagram for the brighter components of the double stars

large number of the fainter components of these binaries are subdwarfs, but this is quite unlikely, in view of the low frequency of subdwarfs among the near-by stars.⁴

Let us now return to the six stars in the upper right corner of the diagram. Their position in the diagram suggests that the brightest ones must be ordinary yellow giants

³ Aitken's catalogue notes spectral types, radial velocities, or spectroscopic parallaxes for all but eight of these stars, but in no case does he indicate the existence of double lines in the spectra of any of the brighter components.

⁴ G. P. Kuiper, *Ap. J.*, 95, 201, 1942.

and two, Nos. 9559 A and 14909 A, are so classified by Morgan. The position of No. 14279 A, γ Del A, is more nearly that to be expected from a subgiant, unless the fainter component is itself a double (or multiple) star or, possibly, actually belongs 1 or 2 mag. above the main sequence.

Magnitudes and colors have been given for 40 visual double stars, all of which are likely to be physical pairs. On the assumption that the fainter component is an ordinary main-sequence star, these data permit determination of the absolute magnitudes of the brighter components, from which magnitudes we deduce that many of the brighter components must be more luminous than main-sequence stars.