Astron. Nachr., Bd. 301, H. 2 (1980)

Ten Colour Photometry of Twelve Ap-Stars

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With 12 figures (Received 1979 August 1)

Ten-colour photoelectric observations are presented for twelve Ap-stars. Improved ephemeris for seven of them is given. Phase relations between the light curves and line intensity variations are discussed. The problem of the electromagnetic flux conctancy of IOTA Cas is approached from a qualitative point of view.

Für 12 Ap-Sterne liegen photoelektrische Beobachtungen in 10 Farben vor. Für 7 von ihnen werden verbesserte Ephemeriden angegeben. Phasenbeziehungen zwischen den Lichtkurven und den Variationen der Linienintensitäten werden diskutiert. Das Problem der Veränderlichkeit von IOTA Cas wird qualitativ untersucht.

1. Introduction

Combination of a variable line and continuous blocking with the consequent backwarming caused by rotation of a star with non-uniform distribution of peculiar elements over the surface seems to be the main mechanism of light variations observed in Ap-stars. Such a hypothesis was first proposed by Peterson (1970) and Wolff and Wolff (1971).

The line blocking and backwarming mechanism requires line intensity variations of elements, which can produce a strong absorption in the ultraviolet. These variations must be in phase with light curves longward from the 'null wavelength region'. It was possible to find (already published) spectroscopic data for nine of the stars presented here. In eight of them the line intensity variations are in agreement with the blocking-backwarming mechanism, whereas only in the case of HD 119213 the observed phase relation is not.

2. Observations

All of the observations were obtained with the 35-cm telescope on the Shemakha Station of the Zentralinstitut fuer Astrophysik der AdW der DDR. The ten-colour system and equipment are described elsewhere (Schoeneich et al., 1976a). We give here only the effective wavelength for our filters:

U:	3450 Å	V:	5450 Å
P:	3740 Å	HR:	6150 Å
X:	4050 Å	S:	6550 Å
Y:	4660 Å	MR:	7200 Å
Z:	5160 Å	DR:	7650 Å

(In the summer season 1975 the Z-filter was out of order. The obtained results are therefore of very poor accuracy. Since the winter season 1976 a new filter has been used with somewhat different characteristics. In Tables 1—12 the magnitude differences ΔZ are given in the system which was applied for the measurements.)

The observations were taken in the following manner:

$$S(U-DR) - C(DR-U) - V(U-DR) - V(DR-U) - C(U-DR) - S(DR-U) \ldots ,$$

Table 1. Photometric data for HD 15089

Magnitude differences are in the sense (HD 15089—HD 12111)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2442700											
18. 1. 1976	96.194	87	− .086 .	− .065	− .059	− .047 .	− .023	− .013	− .017	− .010	+ .003	+ .007
19. 1. 1976	97.192	44	− .106	− .074	− .067	− .055	− .038	− .028 .	− .040	− .031 .	− .014	− .007
	2442800											
22. 1. 1976	.144	14	− .079	− .066	− .054	− .041	− .022	− .013	− .019 .	− .008	+ .003	+ .011
25. 1. 1976	3.137	86	− .082	− .060 .	− .060	− .047	− .022	− .013	− .024 .	− .019	+ .001	+ .013
26. 1. 1976	4.159	45	− .100	− .070	− .060	− .048	− .031	− .021	− .034	− .027 :	− .010	− .004 .
28. 1. 1976	6.144	59	− .098	− 074	− .063	− .059	− .031	− .018	− .037	− .022	− .013	− .006
29. 1. 1976	7.151	17	− .090	− .066	− .060 :	− .050 .	− .023	− .024	− .032	− .022	− .007	+ .003
21. 2. 1976	30.150	38	− .100	− .067	− .057	− .053	− .031 .	− .025	− .033	− .021	− .013	− .003

Table 2. Photometric data for HD 27309

Magnitude differences are in the sense (HD 27309—HD 27176)

Datum	JD	Phase	ΔU	DP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2441700											
28. 1. 1973	11.224	03	−1.333 ⊙	—	− .853 ⊙	− .527	− .349 .	− .293 ⊙	− .174 ⊙	− .085	+ .034 ⊙	—
29. 1. 1973	12.261	69	−1.269 ⊙	−1.058 .	− .826 ⊙	− .506 .	− .323 .	− .266	− .137 :	− .043 ⊙	+ .073	+ .149
30. 1. 1973	13.203	29	−1.314 ⊙	−1.081 ⊙	− .832 ⊙	− .515 ⊙	—	− .280 ⊙	− .142 ⊙	− .047 ⊙	+ .074 ⊙	+ .132 ⊙
4. 2. 1973	18.229	50	−1.240 ⊙	−1.056 ⊙	− .835 ⊙	− .481 ⊙	− .326 ⊙	− .248 :	− .139 ⊙	− .031 ⊙	+ .096 ⊙	+ .134 ⊙
7. 2. 1973	21.223	41	−1.268 ⊙	−1.046 ⊙	− .831 ⊙	− .503 ⊙	− .325 ⊙	− .261 ⊙	− .124 ⊙	− .020 ⊙	+ .087 ⊙	+ .141 ⊙
10. 2. 1973	24.208	31	−1.299 ⊙	−1.080 ⊙	− .837 ⊙	− .512 ⊙	− .325 .	− .257 ⊙	− .131 :	− .047 ⊙	+ .065 ⊙	+ .123 ⊙
14. 2. 1973	28.268	90	−1.330 :	−1.125 ⊙	− .862 ⊙	−. 541 :	− .347 ⊙	− .287 ⊙	− .153 ⊙	− .079 :	+ .039 :	+ .121 ⊙
15. 2. 1973	29.191	48	−1.250 ⊙	−1.036 ⊙	− .817 ⊙	− .489 ⊙	− .315 ⊙	− .265	− .122	− .032 ⊙	+ .082 ⊙	+ .155 .
18. 2. 1973	32.200	40	—	−1.069 ⊙	− .808 ⊙	− .522 ⊙	− .324 ⊙	− .260 ⊙	− .124 ⊙	− .070 ⊙	+ .052 ⊙	+ .123 ⊙
	2442200											
26. 8. 1974	86.521	72	−1.285 ⊙	−1.074 .	− .829 ⊙	− .522 ⊙	− .323 ⊙	− .266 :	− .128 ⊙	− .050 ⊙	+ .059 ⊙	+ .143 .
6. 9. 1974	97.559	76	−1.300 .	−1.086 .	− .839 ⊙	− .537 .	− .333	− .269 ⊙	− .140 :	− .052 ⊙	+ .057	+ .124
8. 9. 1974	99.512	00	−1.354 ⊙	—	—	—	—	—	—	—	—	—
	2442300											
13. 9. 1974	4.527	20	−1.328 :	−1.115	− .843 .	− .547 :	− .342	− .286	− .153	− .076 .	+ .039	+ .108 .
14. 9. 1974	5.529	84	−1.323 :	−1.114	− .841 .	− .544	− .336 .	− .285 .	− .156	− .069	+ .043	+ .100 .
	2442700											
18. 1. 1976	96.238	61	−1.238 :	−1.043 :	− .818	− .508	− .337	− .253	− .109 .	− .033	+ 0.85 .	+ .156
	2442800											
22. 1. 1976	.244	16	−1.338	−1.114 :	− .850 ⊙	− .558 .	− .372 .	− .295	− .165 .	− .079	+ .030	+ .099 :
23. 1. 1976	1.255	81	−1.288 ⊙	−1.065 ⊙	− .852	− .544 :	− .360	− .291 ⊙	− .155 ⊙	− .075 ⊙	+ .043 ⊙	+ .126 ⊙
24. 1. 1976	2.229	43	−1.269 :	−1.059 ⊙	− .821 ⊙	− .519 ⊙	− .340 :	− .261 ⊙	− .112 :	− .035 ⊙	+ .079 ⊙	+ .156 :
25. 1. 1976	3.228	6	−1.332	−1.116	− .848	− .551	− .374	− .294	− .166	− .086 .	+ .027 .	+ .097
26. 1. 1976	4.245	71	−1.255 :	−1.050 ⊙	− .808 ⊙	− .517 .	− .334 ⊙	− .248 ⊙	− .124 .	− .042 .	+ .064	+ .135
27. 1. 1976	5.280	37	−1.289 .	−1.077 .	− .826	− .528 .	− .348	− .270	− .130	− .053 .	+ .059	+ .130
28. 1. 1976	6.215	97	−1.343	−1.118 .	− .851:	− .557 .	− .378	− .288 .	− .168	− .088 :	+ .026	+ .093 .
29. 1. 1976	7.242	62	−1.239 .	−1.038 .	− .812	− .507 .	− .328	− .251 .	− .120 ⊙	− .023 :	+ .089 :	+ .153
21. 2. 1976	30.229	27	−1.317 .	−1.100	− .845	− .548	− .362	− .285 .	− .152	− .064	+ .041	+ .113
22. 2. 1976	31.201	89	−1.341	−1.119	− .853	− .559	− .376	− .294	− .170	− .082	+ .030	+ .100

Table 3. Photometric data for HD 51418

Magnitude differences are in the sense (HD 51418—HD 50973)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2442400											
20. 1. 1975	33.328	14	+1.535	+1.697	+1.890	—	+1.783	+1.750 ⊙	+1.705	+1.703 ⊙	+1.721 ⊙	+1.724 ⊙
7. 2. 1975	51.332	45	+1.609 .	+1.735	+1.888	+1.861 :	+1.884 :	+1.863 ⊙	+1.844	+1.840 ⊙	+1.844 :	+1.841 ⊙
12. 2. 1975	56.30	37	+1.607	+1.720	+1.886	+1.858	+1.870	+1.857	+1.826	+1.811 .	+1.836	+1.827
14. 2. 1975	58.30	73	+1.554	+1.685	+1.866 .	+1.817 .	+1.832	+1.803	+1.764	+1.752	+1.774	+1.772
	2442700											
18. 1. 1976	96.333	90	+1.508 :	+1.662 .	+1.864 .	+1.741 .	+1.735	+1.712 .	+1.671	+1.660 .	+1.677	+1.691
	2442800											
22. 1. 1976	.304	63	+1.574 :	+1.703	+1.869 .	+1.838	+1.844 .	+1.840 .	+1.808 .	+1.803 .	+1.818 :	+1.818
25. 1. 1976	3.285	18	+1.558 .	+1.698 :	+1.879 ⊙	+1.796	+1.787 .	+1.770 .	+1.727 ⊙	+1.741 ⊙	+1.739 :	+1.760 ⊙
26. 1. 1976	4.315	36	+1.597 ⊙	+1.713 ⊙	+1.887 .	+1.844 ⊙	+1.833 ⊙	+1.840 ⊙	+1.801 ⊙	+1.778 ⊙	+1.820 ⊙	+1.830 ⊙
27. 1. 1976	5.319	55	+1.603 :	+1.718	+1.882	+1.855	+1.863 .	+1.858 .	+1.830	+1.821 .	+1.836	—
28. 1. 1976	6.267	72	+1.544	+1.691 .	+1.860 .	+1.814	+1.818 .	+1.813	+1.772 .	+1.760 :	+1.778	+1.777 .
29. 1. 1976	7.342	92	+1.501 .	+1.669	+1.868 ⊙	+1.732	+1.726 .	+1.702 .	+1.664	+1.654 :	+1.674	+1.668
30. 1. 1976	8.261	09	+1.516 :	+1.683 .	+1.883 .	+1.748 .	+1.743	+1.710	+1.672 .	+1.671 .	+1.679	+1.688 .
20. 2. 1976	29.234	95	+1.499	+1.669	—	+1.732	+1.719 .	+1.692 .	+1.652	+1.644 .	+1.654 .	+1.666 .
21. 2. 1976	30.278	14	+1.532 .	+1.695	+1.888	+1.770 .	+1.769 .	+1.747	+1.701 .	+1.698 .	+1.715 .	+1.723 .
22. 2. 1976	31.255	32	+1.595	+1.720	+1.885	+1.838	+1.850	+1.841 .	+1.810	+1.799 .	+1.812	+1.820 .
27. 2. 1976	36.242	24	+1.576 :	+1.703 ⊙	+1.877 ⊙	+1.809 :	+1.816 .	+1.802	+1.768	+1.763	+1.774	+1.777
4. 3. 1976	42.207	33	+1.596 .	+1.719 .	+1.882	+1.842	+1.848	+1.836 .	+1.813	+1.816	+1.826 :	+1.820 :

Table 4. Photometric data for HD 65339

Magnitude difference are in the sense (HD 65339—HD 65301)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2442000											
20. 1. 1975	433.38	18	+ .079 .	+ .067	− .073	+ .048	+ .186 .	+ .257	+ .349	+ .440 :	+ .518 .	+ .575 .
5. 2. 1975	449.37	17	+ .067 .	+ .075 .	− .069 :	+ .054	+ .191 .	+ .257 .	+ .345 .	+ .443	+ .511	+ .581
12. 2. 1975	456.35	04	+ .060	+ .062	− .074	+ .045 .	+ .189 .	+ .261 .	+ .344	+ .429	+ .512 .	+ .571
14. 2. 1975	458.35	29	+ .095	+ .073 .	− .071 .	+ .052	+ .185 .	+ .250	+ .351	+ .447 .	+ .520	+ .583 :
16. 2. 1975	460.33	54	+ .116 :	+ .079 :	—	+ .061 .	+ .202 .	+ .263 :	+ .359	+ .454 :	+ .525 :	+ .590
18. 1. 1976	796.39	40	—	+ .063 :	—	+ .052 .	+ .183	+ .261 :	+ .352 .	+ .453 .	+ .524 .	+ .591
22. 1. 1976	800.35	89	+ .063 .	+ .052	− .077 .	+ .043	+ .184	+ .266 .	+ .359	+ .450 :	+ .521	+ .585
25. 1. 1976	803.34	26	+ .088 .	+ .072 .	− .072 .	+ .051	+ .174	+ .257 .	+ .350	+ .446	+ .517	+ .575 .
27. 1. 1976	805.36	52	+ .103 .	+ .074 :	− .063 .	+ .059 .	+ .183	+ .258	+ .358	+ .448	+ .526	+ .586 .
29. 1. 1976	807.39	77	+ .077	+ .059	− .076 .	+ .055	+ .178 .	+ .256	+ .362 .	+ .458 .	+ .530	+ .585 .
30. 1. 1976	808.31	88	+ .063 .	+ .059 .	− .073 :	+ .046	+ .185 .	+ .265	+ .356	+ .451 .	+ .520 .	+ .585
21. 2. 1976	830.32	63	—	+ .068 :	− .065 :	+ .058 .	+ .187	+ .265	+ .361 .	+ .456	+ .528 .	+ .587
22. 2. 1976	831.30	75	+ .077	+ .059	− .074 :	+ .049 .	+ .181 .	+ .258	+ .361	+ .453	+ .526	+ .588
26. 2. 1976	835.31	25	+ .077 :	—	− .076 :	+ .042 .	+ .164 .	+ .250 .	+ .352 .	+ .441 .	+ .524	+ .584 .
27. 2. 1976	836.31	37	+ .092	+ .064 .	− .083 .	+ .045	+ .176	+ .255	+ .351	+ .454 .	+ .522 .	+ .583 .
2. 3. 1976	840.26	86	+ .056 .	+ .075 .	− .081 .	+ .051 .	+ .186 .	+ .264 :	+ .356 .	+ .455 :	+ .523	+ .590
3. 3. 1976	841.28	99	+ .045 :	+ .063 :	− .080 .	+ .039 .	+ .184 .	+ .257	+ .354	—	+ .513 :	+ .575 :

Table 5. Photometric data for HD 112185

Magnitude differences are in the sense (HD 112185 − HD 106591)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2442400											
19. 1. 1975	32.567	35	−1.631 .	−1.721	−1.679 .	−1.581 .	−1.545	−1.534	−1.507	−1.514	−1.474	−1.461 .
5. 2. 1975	49.495	67	−1.618 :	−1.712	−1.677	−1.580 .	−1.541 .	−1.531	−1.507	−1.508	−1.468 :	−1.464 .
11. 2. 1975	55.498	85	−1.644	−1.736	−1.690	—	−1.546 ⊙	—	−1.516	−1.515	−1.480 :	−1.468
12. 2. 1975	56.481	05	−1.651 :	−1.745 .	−1.689	−1.587	−1.551 .	−1.548 :	−1.529 .	−1.525 .	−1.483 :	−1.479 ⊙
14. 2. 1975	58.473	44	−1.632	−1.721 .	−1.682 :	−1.576	−1.544	−1.534 .	−1.510 :	−1.518 ⊙	−1.476 :	−1.472 :
16. 2. 1975	60.448	83	−1.646 .	−1.737 :	−1.687	−1.593	−1.552	−1.540	−1.524 .	−1.519 .	−1.488	−1.470 ⊙
19. 2. 1975	63.482	42	−1.629	−1.716 .	−1.671	−1.575 :	−1.543 :	—	—	−1.515 ⊙	—	—
12. 3. 1975	84.451	54	−1.629 :	−1.722 .	−1.681	−1.580 :	−1.541	−1.533 ⊙	−1.509 .	−1.503 .	−1.470 :	−1.455 .
	2442700											
18. 1. 1976	96.569	88	−1.656	−1.747	−1.701	−1.606	−1.558	−1.554	−1.539	−1.532	−1.496	−1.480 .
	2442800											
22. 1. 1976	.547	66	−1.629	−1.724	−1.696 .	−1.591	−1.546	−1.544	−1.523	−1.516 :	−1.484 ⊙	−1.470 ⊙
27. 1. 1976	5.533	64	−1.628 .	−1.722	−1.694	−1.594	−1.552	−1.543	−1.519	−1.513 :	−1.474 .	−1.458 .
28. 1. 1976	6.556	84	−1.648	−1.743 .	−1.694	−1.597	−1.556	−1.550	−1.533	−1.524	−1.492	−1.480 :
29. 1. 1976	7.530	03	−1.656 .	−1.752	−1.702	−1.610	−1.564	−1.554	−1.548 :	−1.542 .	−1.500	−1.485
30. 1. 1976	8.510	22	−1.631 .	−1.727	−1.687 .	−1.590	−1.549	−1.542	−1.517	−1.508	−1.480	−1.459 .
20. 2. 1976	29.457	34	—	—	−1.692 ⊙	−1.589 .	—	−1.539	−1.526 ⊙	−1.508 .	—	—
21. 2. 1976	30.467	54	−1.633 :	−1.724 .	−1.692	−1.592	−1.552	−1.541 .	−1.518	−1.511 :	−1.474	−1.467 ⊙
22. 2. 1976	31.448	73	−1.632	−1.729	−1.690	−1.598	−1.553	−1.544	−1.523 .	−1.514 .	−1.478	−1.464
26. 2. 1976	35.468	52	−1.630 .	−1.723 .	−1.689 .	−1.589 :	−1.552 .	−1.541	−1.519 :	−1.523 ⊙	−1.483 :	−1.471 ⊙
27. 2. 1976	36.462	72	−1.629	−1.722	−1.693	−1.592 .	−1.554	−1.547	−1.517	−1.513 .	−1.476	−1.467 :

Table 6. Photometric data for HD 119213

Magnitude differences are in the sense (HD 119213—HD 120874)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2442200											
30. 6. 1974	29.319	80	− .244 :	− .197 ⊙	− .154 ⊙	− .171 .	− .154 ⊙	− .163	− .164	− .159 ⊙	− .135 :	− .111 .
1. 7. 1974	30.296	20	− .260 .	—	− .144 :	− .169 .	− .160 :	− .159	− .172	− .157 ⊙	− .139 :	− .136 ⊙
9. 7. 1974	38.309	47	− .251 ⊙	− .157 ⊙	− .081 ⊙	− .153 .	− .161 :	—	—	− .175 ⊙	—	− .127 ⊙
21. 7. 1974	50.256	35	− .257 .	− .181 ⊙	− .103 :	− .153 .	− .159 .	− .160 ⊙	− .181 .	− .168 .	− .146 .	− .141 .
22. 7. 1974	51.272	76	− .253 :	− .200 .	− .138	− .170	− .154 .	− .157	− .163 .	− .147 .	− .140	− .117
25. 7. 1974	54.244	98	—	− .214	− .160 ⊙	− .183 .	− .157	− .156 .	− .174 :	− .159 ⊙	− .130:	− .124
15. 8. 1974	75.211	54	− .237 ⊙	− .173 :	− .075 :	− .143	− .156 .	− .164 :	− .171 :	− .168:	− .153:	− .146 ⊙
16. 8. 1974	76.210	94	− .245 ⊙	− .209 ⊙	− .158 ⊙	− .173 ⊙	− .155 .	− .162 ⊙	—	− .151⊙	− .137 ⊙	− .128 :
17. 8. 1974	77.206	35	− .233 ⊙	− .154 ⊙	− .091	− .137 .	− .140 ⊙	− .150	− .158 ⊙	− .140 ⊙	− .125 .	− .128 .
19. 8. 1974	79.202	16	− .258 :	− .204 :	− .151 .	− .171	− .156 :	− .156 :	− .158	− .144 :	− .128 :	− .122 :
	2442400											
14. 2. 1975	58.606	39	− .236 .	− .164 ⊙	− .082 ⊙	− .146 ⊙	− .155 ⊙	− .164 .	− .168 .	− .154 ⊙	− .124 ⊙	− .109 ⊙
	2442500											
30. 6. 1975	94.265	77	− .253	− .203 ⊙	− .140 ⊙	− .170 :	− .156 ⊙	− .157	− .165 .	− .159 ⊙	− .128	− .118 ⊙
3. 7. 1975	97.274	00	− .249 :	− .207 :	− .156 ⊙	− .175 :	− .145 :	− .148 ⊙	− .160 ⊙	− .156 ⊙	− .138	− .115 :
4. 7. 1975	98.264	40	− .233 .	− .161 .	− .081 .	− .147	− .162 ⊙	− .163 ⊙	− .171 .	− .169 .	− .153	.145 :
	2442600											
22. 7. 1975	16.251	74	− .240 ⊙	− .188 :	− .132 :	− .174	—	− .158 .	− .169	− .165 :	− .143	− .131 .
23. 7. 1975	17.241	15	− .273 :	− .195 .	− .147 .	− .180 :	− .149 .	− .153 .	− .162 .	− .146 .	− .131 :	− .113 :
24. 7. 1975	18.229	55	− .235 .	− .156 ⊙	− .076 .	− .149 .	− .145 ⊙	− .160 .	− .175 .	− .164 :	− .144 ⊙	− .149 :
25. 7. 1975	19.232	96	− .251 ⊙	− .205 .	− .154	− .173	− .165 ⊙	− .156 .	− .158 :	− .161 ⊙	− .131	− .123 :
26. 7. 1975	20.230	37	− .244 :	− .177 ⊙	− .092 .	− .151	− .161 ⊙	− .162 :	− .168	− .171 ⊙	− .154 :	− .138 .
29. 7. 1975	23.224	59	− .228 :	− .159 :	− .085 .	− .148	− .163 ⊙	− .164 :	− .168 .	− .165 .	− .153 :	− .135 ⊙
	2442800											
22. 1. 1976	.603	99	− .256 .	− .218 .	− .159	− .177	− .168	− .158	− .168	− .153	− .137	− .124 .
27. 1. 1976	5.598	03	− .255	− .214	− .162	− .180	− .164	− .152	− .171	− .162 .	− .138	− .126
30. 1. 1976	8.613	26	− .240 :	− .184 .	− .122	− .158	− .156	− .149	− .171	− .159 ⊙	—	− .124 .
16. 2. 1976	25.602	20	− .232 ⊙	− .193 :	− .138 :	− .169 .	− .157 :	− .147 :	− .160 .	− .136	− .125 :	− .110
20. 2. 1976	29.561	81	− .245 ⊙	− .192	− .145 .	− .171 .	− .155	− .151	− .171 :	− .154 ⊙	− .139 :	− .120 .
21. 2. 1976	30.561	22	− .263 ⊙	− .204	− .145 .	− .170	− .160 .	− .150 ⊙	− .161 .	− .150 .	− .138 .	− .118
22. 2. 1976	31.552	62	− .236 .	− .176	− .095	− .155	− .157	− .163	− .173	− .170	− .146	− .135
27. 2. 1976	36.571	67	− .246	− .188	− .116	− .158	− .160	− .159	− .167	− .154	− .145	− .131
	2442900											
9 6.1976	39.256	59	− .238	− .160	− .082 .	− .142	− .154	− .158 .	− .167 .	− .165 .	− .144 .	− .133

Table 7. Photometric data for HD 140160

Magnitude differences are in the sense (HD 140160—HD 141187)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2442900											
21. 6. 1976	51.313	15	− .422	− .467	− .457 .	− .428	− .400 .	− .382 .	− .374 .	− .351	− .324 :	− .311 .
22. 6. 1976	52.302	77	− .429	− .466	− .468	− .438	− .407	− .388	− .371	− .350	− .319	− .306
24. 6. 1976	54.276	00	− .437 .	− .462	− .463 .	− .437	− .403	− .384	− .364	− .344	− .327	− .304 :
29. 6. 1976	59.295	15	− .420 :	− .459 :	− .454 .	− .429 .	− .404 .	− .394	− .375 :	− .353 :	− .320 :	− .308 :
30. 6. 1976	60.302	78	− .433	− .470 .	− .467 .	− .438	− .411	− .395	− .372	− .354	− .321	− .306
5. 7. 1976	65.258	88	− .428 .	− .464 ⊙	− .467	− .433	− .404	− .387	− .377	− .360	− .328	− .308
6. 7. 1976	66.288	53	− .425 ⊙	− .458	− .460 .	− .428	− .393	− .380	− .357	− .345 :	− .315	− .298 .
7. 7. 1976	67.238	12	− .428 .	− .459 .	− .464	− .435 ⊙	− .401	− .383	− .373:	− .354 ⊙	− .329	− .316 ⊙
9. 7. 1976	69.275	40	− .411 .	− .439	− .441	− .414	− .382	− .369 .	− .352	− .344	− .304 .	− .288
10. 7. 1976	70.264	02	− .433 .	− .458 :	− .461	− .432	− .403	− .387	− .379	− .353 :	− .322	− .313 .
11. 7. 1976	71.329	69	− .423 .	− .460 .	− .460 :	− .439 .	− .399 ⊙	− .392	− .365 :	− .344 .	− .316	− .303 ⊙
12. 7. 1976	72.246	26	− .411	− .446	− .446	− .426	− .389	− .375	− .361	− .338 .	− .312 .	− .307 .
14. 7. 1976	74.247	52	− .423 .	− .448	− .453 .	− .420	− .390 .	− .374 .	− .363	− .324 .	− .314	− .296
16. 7. 1976	76.296	80	− .421 .	− .454	− .463 .	− .433	− .400 .	− .390 .	− .374	− .352	− .322	− .307
21. 7. 1976	81.290	93	− .425 .	− .473 ⊙	− .454 ⊙	− .440 ⊙	− .410 .	− .394	− .384 ⊙	—	− .345 ⊙	− .291 ⊙
23. 7. 1976	83.242	15	− .421 :	− .458 :	− .458	− .425	− .397	− .378	− .369	− .351	− .323	− .305
26. 7. 1976	86.243	04	− .436 :	− .469 :	− .469 :	− .435	− .400 .	− .394 .	− .375	− .366 :	− .334 .	− .308
27. 7. 1976	87.287	69	− .424	− .453	− .471	− .433	− .394	− .382	− .365	− .344	− .317	− .299
31. 7. 1976	91.243	17	− .435	− .457	− .460	− .434 .	− .400	− .382	− .369	− .345 .	− .321	− .303 .

Table 8. Photometric data for HD 170000

Magnitude differences are in the sense (HD 170000 − HD 170153)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
2442200												
30. 6. 1974	29.402	00	− .211 .	− .175 :	− .157	+ .244	+ .483	+ .627 ⊙	+ .879 .	+1.039 :	+1.195 .	+1.313 :
1. 7. 1974	30.407	59	− .157	− .132	− .127	+ .282	+ .517 .	+ .648 .	+ .903	+1.065	+1.217 .	+1.332
9. 7. 1974	38.408	25	− .169	− .144	− .145 .	+ .271	+ .501	+ .639 .	+ .899 .	+1.051 .	+1.210 .	+1.329 .
10. 7. 1974	39.387	82	− .187	− .151	− .140	+ .268	+ .506	+ .641	+ .894	+1.052	+1.206	+1.320
17. 7. 1974	46.378	89	− .198	− .167	− .146	+ .271 .	+ .505 .	+ .639 .	+ .893	+1.050	+1.200	+1.319
21. 7. 1974	50.323	19	− .178 :	− .155 .	− .153 .	+ .258	+ .499 .	+ .635 :	+ .891 .	+1.053 :	+1.211	+1.321
23. 7. 1974	52.383	39	− .153 .	− .128	− .124	+ .287 .	+ .519	+ .653	+ .915	+1.064 .	+1.220	+1.339
25. 7. 1974	54.314	51	—	—	—	+ .295	+ .519	+ .653 :	+ .914 .	+1.060 :	+1.217	+1.341 ⊙
26. 7. 1974	55.317	10	− .195 :	− .166 :	− .162 :	+ .255 .	+ .499 .	+ .637 .	+ .885	+1.050 .	+1.206	+1.315
1. 8. 1974	61.308	59	− .167 :	− .135 .	− .135 .	+ .285 :	+ .521 ⊙	+ .651 ⊙	+ .905 :	+1.062 .	+1.215	+1.329 .
3. 8. 1974	63.287	74	− .188 ⊙	− .163 ⊙	− .147 :	+ .272 .	+ .503 :	+ .639 :	—	+1.049 :	+1.211 :	+1.324 .
16. 8. 1974	76.248	29	− .163 .	− .132 ⊙	− .128 :	+ .278 :	+ .508	+ .648 ⊙	+ .902 .	+1.056 .	+1.219	+1.331 :
18. 8. 1974	78.254	46	− .156	− .118 .	− .123	+ .290	+ .517	+ .659 .	+ .914	+1.070 .	+1.227 .	+1.337 .
19. 8. 1974	79.267	05	− .207 ⊙	− .174	− .162	+ .257	+ .495 .	+ .629 .	+ .886 :	+1.042 .	+1.199 .	+1.313
2442300												
20. 9. 1974	11.270	70	− .180	− .146	− .136 :	+ .274	+ .510	+ .647	+ .903	+1.054	+1.209 .	+1.322
2442500												
29. 6. 1975	93.304	01	− .206	− .172 .	− .157	+ .261	+ .492 ⊙	+ .629	+ .891	+1.039 .	+1.196	+1.314
30. 6. 1975	94.343	61	− .167	− .131	− .136 .	+ .284 :	+ .528 ⊙	+ .651 .	+ .902	+1.064 ⊙	+1.217	+1.338 :
3. 7. 1975	97.331	35	− .141 ⊙	− .117 .	− .115 ⊙	+ .295 .	+ .530 ⊙	+ .654	+ .909 :	+1.062	+1.224 .	+1.332 .
4. 7. 1975	98.318	93	− .198	− .165 :	− .146	+ .273 .	+ .509 .	+ .642	+ .901	+1.050	+1.213 .	+1.328 .
2442600												
6. 7. 1975	00.272	07	− .196	− .168	− .159	+ .253 ⊙	+ .502 .	+ .632	+ .888	+1.037 .	+1.206	+1.321
8. 7. 1975	02.324	26	− .156 .	− .138	− .134 .	+ .276	+ .518	+ .651 .	+ .910	+1.054 .	+1.218	+1.341 :
18. 7. 1975	12.300	08	− .194 .	− .172 .	− .156	+ .258	+ .504 ⊙	+ .628	+ .889	+1.039 .	+1.205 .	+1.318
21. 7. 1975	15.302	82	− .189 ⊙	− .160 :	− .142	+ .267	+ .535 :	+ .634	+ .901	+1.047 .	+1.207	+1.321 :
22. 7. 1975	16.305	41	− .146	− .126	− .120	+ .290	+ .519 ⊙	+ .656	+ .919 .	+1.070 .	+1.228	+1.348 :
24. 7. 1975	18.277	56	− .153 :	− .129 ⊙	− .131	+ .286 .	+ .517 ⊙	+ .653 ⊙	+ .913 .	+1.062 .	+1.215 :	+1.329 .
24. 7. 1975	18.393	63	− .162 ⊙	− .140 :	− .135 .	+ .285 :	+ .510 ⊙	+ .650 :	+ .902 .	+1.058	+1.219 .	+1.334
26. 7. 1975	20.320	75	− .176	− .147 .	− .139	+ .276	+ .521 :	+ .644 .	+ .897	+1.046	+1.213	+1.325 :
27. 7. 1975	21.255	29	− .165 .	− .135	− .139	+ .279	+ .510 ⊙	+ .648	+ .908 .	+1.053	+1.218	+1.328 .
28. 7. 1975	22.283	89	− .195	− .165	− .146 .	+ .272	+ .496	+ .637 .	+ .893 :	+1.047 .	+1.205	+1.319 :
2. 8. 1975	27.244	78	− .189 .	− .159 ⊙	− .167 ⊙	+ .271 :	+ .506 ⊙	+ .641 ⊙	+ .895 .	+1.047 :	+1.214 .	+1.333 :
3. 8. 1975	28.239	36	− .146 ⊙	− .123 ⊙	− .121 ⊙	+ .297 ⊙	+ .538 ⊙	+ .650 :	+ .915 ⊙	+1.058 ⊙	+1.219 ⊙	+1.341 ⊙
4. 8. 1975	29.237	94	− .214 :	− .178 .	− .150 :	+ .250 .	+ .506 ⊙	+ .633	+ .886	+1.048 ⊙	+1.214 ⊙	+1.320 .
5. 8. 1975	30.235	52	− .152	− .132	− .126 :	+ .292 ⊙	+ .515 ⊙	+ .651 ⊙	+ .914	+1.057 :	+1.218	+1.331 .
6. 8. 1975	31.240	11	− .201 :	− .180 :	− .166 .	+ .258	+ .482 ⊙	+ .622 .	+ .890	+1.043 ⊙	+1.206	+1.323 .
9. 8. 1975	34.235	85	− .197	− .163	− .143 .	+ .271	+ .519 .	+ .635	+ .897 .	+1.051	+1.207	+1.322 .
10. 8. 1975	35.234	44	− .155 ⊙	− .132 .	− .123 .	+ .294	+ .525 .	+ .658	+ .922 ⊙	+1.062 :	+1.225 :	+1.339 .
14. 8. 1975	39.227	76	− .182	− .157	− .141	+ .274 .	+ .513 ⊙	+ .644	+ .896	+1.048	+1.213	+1.329
20. 8. 1975	45.223	26	− .168	− .144 .	− .145 .	+ .275 .	+ .515 .	+ .641	+ .897	+1.056	+1.218 .	+1.335

Table 9. Photometric data for HD 173650

Magnitude differences are in the sense (HD 173650—HD 174261)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2441400											
27. 6. 1972	96.394	00	− .017 ⊙	− .345 ⊙	− .552 :	− .623 ⊙	− .592 ⊙	− .616 ⊙	− .643 ⊙	− .610 ⊙	—	—
16. 7. 1972	115.402	91	− .025 ⊙	− .360 ⊙	—	− .627 ⊙	− .604 ⊙	− .629 ⊙	− .651 ⊙	− .644 ⊙	− .656 ⊙	− .661 ⊙
24. 8. 1972	154.307	81	+ .051 ⊙	− .308 ⊙	− .546 .	− .586	− .563 ⊙	− .584 ⊙	− .607	− .611 ⊙	− .608 ⊙	− .631 .
29. 8. 1972	159.285	31	+ .040 :	− .303 .	− .556 ⊙	− .586	− .570 .	− .569 .	− .611	− .608 ⊙	− .611 :	− .621 :
2. 9. 1972	163.201	70	+ .070 :	− .302	− .543 ⊙	− .581 .	− .566 :	− .569 .	− .595 .	− .587 ⊙	− .606 ⊙	− .609 ⊙
18. 9. 1972	179.188	30	+ .045 :	− .308	− .547 ⊙	− .589	− .569 .	− .571 ⊙	− .598 ⊙	− .610 ⊙	− .617	− .610 ⊙
	2442500											
29. 6. 1975	93.390	97	− .023 ⊙	− .344	− .560 .	− .618 .	− .588 ⊙	− .603 :	− .640 :	− .633 .	− .635 ⊙	− .653 .
30. 6. 1975	94.383	07	− .029 ⊙	− .360 :	− .566 .	− .617	− .592 ⊙	− .608 :	− .642 ⊙	− .637 ⊙	− .653 :	− .660 :
2. 7. 1975	96.404	28	+ .037 .	− .314	− .539 .	− .596	− .560 ⊙	− .574 .	− .608	− .601 :	− .610 .	− .612
3. 7. 1975	97.372	37	+ .059 :	− .308	− .540	− .591 :	− .570 ⊙	− .577	− .601 .	− .611 ⊙	− .604 :	− .605 :
4. 7. 1975	98.373	47	+ .068 :	− .301 .	− .546	− .588	− .577 ⊙	− .580 :	− .600	− .603 ⊙	− .607 .	− .616 .
	2442600											
6. 7. 1975	00.380	68	+ .067 ⊙	− .304 ⊙	− .557	− .592 :	− .597 ⊙	− .581 .	− .604 :	− .584 :	− .618	− .602
8. 7. 1975	02.372	88	+ .015 ⊙	− .325 ⊙	− .554 :	− .605	− .578 .	− .596 .	− .624 :	− .621 ⊙	− .642 :	− .634 .
18. 7. 1975	12.355	88	+ .018	− .329 ⊙	− .552	− .609 .	− .566 ⊙	− .598	− .629 .	− .620 ⊙	− .627 ⊙	− .633 .
22. 7. 1975	16.372	28	+ .049 .	− .309 .	− .547 :	− .592 .	− .547 ⊙	− .573 :	− .611	− .586 ⊙	− .602 ⊙	− .613 .
26. 7. 1975	20.363	68	+ .062 .	− .304 ⊙	− .545 :	− .590	− .571 ⊙	− .583	− .604 :	− .589 ⊙	− .608 ⊙	− .620 :
27. 7. 1975	21.312	77	+ .056 :	− .309 .	− .551 ⊙	− .597 :	− .571 :	− .574 .	− .601	− .580 ⊙	− .605 ⊙	− .607 ⊙
28. 7. 1975	22.328	88	− .009 .	− .348 .	− .564 :	− .620 .	− .577 ⊙	− .595 .	− .638 .	− .620 ⊙	− .636 :	− .641 :
3. 8. 1975	28.294	47	+ .060	− .308 .	− .549	− .588 .	− .557 ⊙	− .571 .	− .600 .	− .592 ⊙	− .603	− .610 ⊙
4. 8. 1975	29.287	57	+ .076	− .291	− .550 ⊙	− .592 :	− .561 ⊙	− .570	− .597 .	− .590 ⊙	− .599 :	− .610 ⊙
9. 8. 1975	34.290	08	− .032	− .360 .	.564 ⊙	− .628 :	− .593 ⊙	− .601 :	− .643 :	− .640 ⊙	− .645 ⊙	− .663 ⊙
10. 8. 1975	35.320	18	+ .005 :	− .343	− .557 :	− .608 .	− .563 ⊙	− .590	− .618 .	− .602 ⊙	− .625 ⊙	− .627
	2442900											
10. 6. 1976	40.427	77	+ .061 .	− .311	− .548	− .592	− .575	− .572	− .603	− .588 :	− .608	− .610 .
17. 6. 1976	47.451	47	+ .061 :	− .304 :	− .549 .	− .590	− .569	− .573	− .602	− .599 :	− .600 .	− .600
20. 6. 1976	50.431	77	+ .056 ⊙	− .310 ⊙	− .541 :	− .597	− .573 :	− .574 ⊙	− .600	− .600 ⊙	− .613 ⊙	− .608 ⊙
24. 6. 1976	54.380	16	− .008	− .349 .	− .564	− .614	− .597	− .598	− .638	− .626 .	− .646	− .646 :
29. 6. 1976	59.410	67	+ .069 :	− .296 :	− .542	− .581 .	− .561	− .561	− .596 .	− .601 :	− .600 .	—
5. 7. 1976	65.343	26	+ .027 .	− .315 .	− .548 ⊙	− .597 .	− .581	− .586	− .615	− .608 ⊙	− .622 :	− .629 :
6. 7. 1976	66.350	36	+ .048 .	− .306	− .541	− .586 .	− .567	− .580	− .602	− .600 ⊙	− .597 .	− .608 :
7. 7. 1976	67.316	46	+ .064	− .303 .	− .542 .	− .586	− .566	− .577	− .601	− .570 .	− .603 .	− .602 :
10. 7. 1976	70.379	77	+ .049 ⊙	− .319 :	− .554 :	− .590 :	− .586 :	− .577 ⊙	− .610 :	− .600 .	− .623 ⊙	− .628 ⊙
31. 7. 1976	91.321	87	+ .014	− .337	− .558	− .600	− .588	− .583 .	− .622	− .618 .	− .630	− .632 .
7. 8. 1976	98.290	57	+ .068 :	− .300 :	− .537 .	− .590 .	− .569 .	− .575 ⊙	− .598 :	− .589 :	− .596 :	− .605 .
8. 8. 1976	99.261	66	+ .069 .	− .296 .	− .548 .	− .580	− .565	− .574	− .590 :	− .596 ⊙	− .602	− .595 ⊙
	2443000											
22. 8. 1976	13.262	07	− .051 :	− .370 .	− .570	− .632	− .605 .	− .616 :	− .649	− .653 ⊙	− .650	− .671 :
23. 8. 1976	14.231	16	− .008 ⊙	− .344 .	− .570 .	− .606 :	− .601 .	− .590	− .628 :	− .626 .	− .637 :	− .635 ⊙
24. 8. 1976	15.250	27	+ .040 .	− .332	− .566 .	− .603 .	− .575	− .582 .	− .614	− .602 ⊙	− .617	− .623 .
25. 8. 1976	16.270	37	+ .047 .	− .302	− .544	− .587	− .571	− .568 .	− .603	− .583 :	− .599 .	− .602 :
26. 8. 1976	17.296	47	+ .068 :	− .304 .	− .551	− .592	− .577	− .574 .	− .604 .	− .583 ⊙	− .604	− .600 .
27. 8. 1976	18.262	57	+ .080	− .295 :	− .543 .	− .588	.568	− .578 .	− .603	− .582 ⊙	− .603	− .610 .
28. 8. 1976	19.272	67	+ .067 .	− .297 :	− .553 :	− .588	− .569	− .565 .	− .594 .	− .594 ⊙	− .605 .	− .606
29. 8. 1976	20.275	77	+ .047 .	− .316 :	− .542 :	− .588	− .576 .	− .577	− .608 .	− .601 ⊙	− .609 ⊙	− .616 ⊙
6. 9. 1976	28.243	57	+ .077 .	− .300	− .541 ⊙	− .592	− .567	− .564 .	− .592	− .600 .	− .608 :	− .595 ⊙
7. 9. 1976	29.213	67	+ .077	− .290 ⊙	− .541	− .578	− .569	− .576	− .589	− .575	− .588	− .604

Table 10. Photometric data for HD 184905

Magnitude differences are in the sense (HD 184905 − HD 184787)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2441100											
16. 7. 1971	49.338	16	− .325 ⊙	− .225 ⊙	− .067 :	− .068 :	− .042	− .074 ⊙	− .077 ⊙	− .051 ⊙	− .040 .	− .045 :
22. 7. 1971	55.311	39	− .290 ⊙	− .197 :	− .058 .	− .059	− .030 ⊙	—	− .049 ⊙	− .045 ⊙	− .044 ⊙	− .035 ⊙
23. 7. 1971	56.377	97	− .386 .	− .249 ⊙	− .084 .	− .084 :	− .053 .	− .069 ⊙	− .088 :	—	− .088 .	− .090
24. 7. 1971	57.320	48	− .300 ⊙	− .217 ⊙	− .064	− .056 ⊙	− .025 .	− .049 :	− .040 :	− .041 ⊙	− .024 ⊙	− .028 ⊙
30. 7. 1971	63.334	74	− .315 ⊙	—	− .061 ⊙	− .053 ⊙	− .019 :	− .028 ⊙	− .054 .	− .057 ⊙	− .044 .	− .010 :
31. 7. 1971	64.347	29	− .296 ⊙	− .195	− .056 ⊙	− .048 ⊙	− .028 .	− .041 ⊙	− .051 ⊙	− .034 ⊙	− .040 :	− .023 ⊙
5. 8. 1971	69.300	97	− .382 ⊙	− .258 ⊙	− .078 ⊙	− .090 ⊙	− .062 ⊙	− .071 ⊙	− .100 ⊙	− .081 .	− .073 :	− .070 ⊙
25. 8. 1971	89.295	81	− .325	− .238	− .069 ⊙	− .062 .	− .030 :	− .050 .	− .063	− .063 ⊙	− .061	− .038 ⊙
27. 8. 1971	91.360	93	− .370 :	− .266 :	− .089 .	− .092 ⊙	− .061 .	− .081	− .096 ⊙	− .091 ⊙	− .079 .	− .099 .
31. 8. 1971	95.295	06	− .376 :	− .251 .	− .073 ⊙	− .083 :	− .055	− .070 .	− .091 :	− .089 ⊙	− .080 .	− .076 .
1. 9. 1971	96.241	57	− .289 ⊙	− .209 .	− .065 .	− .052 :	− .027	− .034 .	− .051 .	− .054 ⊙	− .045	− .046 .
3. 9. 1971	98.340	71	− .293 ⊙	− .216 .	− .066 .	− .052 .	− .024 .	− .038 ⊙	− .054 .	− .056 ⊙	− .037 .	− .030 :
	2441200											
6. 9. 1971	01.203	26	− .302 ⊙	− .203 .	− .061 ⊙	− .051	− .027	− .041 ⊙	− .054 ⊙	− .039 ⊙	− .048 :	− .036 ⊙
9. 9. 1971	04.219	90	− .363 ⊙	− .251 .	− .071 .	− .081 .	− .056	− .073 .	− .090	− .100 :	− .077 :	− .071 .
10. 9. 1971	05.291	48	− .313 :	− .213 :	− .071 .	− .052 .	− .029	− .044 .	− .057 .	− .064 ⊙	− .045 ⊙	− .027 :
15. 9. 1971	10.205	14	− .327 .	− .230	− .070 ⊙	− .069	− .044	− .057 :	− .069	− .074 :	− .063	− .061 :
16. 9. 1971	11.238	70	− .294 .	− .207 .	− .064 .	− .051	− .027	− .046 ⊙	− .047 .	− .057 ⊙	− .044 ⊙	− .037
17. 9. 1971	12.214	23	− .292 :	− .212 :	− .059	− .054	− .034 .	− .041	− .056 .	− .047 ⊙	− .048 :	− .033 :
18. 9. 1971	13.206	77	− .318 :	− .223 .	− .075	− .066	− .033	− .044	− .062	− .063 ⊙	− .044 ⊙	− .050
21. 9. 1971	16.311	45	− .302 ⊙	− .204 .	− .062	− .050 ⊙	− .032	− .047 ⊙	− .054 .	− .061 ⊙	− .047 ⊙	− .034 :
22. 9. 1971	17.306	99	− .375	− .263 .	− .078 :	− .087	− .056 .	− .081 .	− .097 :	− .104 ⊙	− .084	− .089 :
	2442900											
12. 7. 1976	72.361	04	− .373 .	− .249	− .075	− .084	− .062 .	− .067	− .089 .	− .095 .	− .074	− .079 .
14. 7. 1976	74.333	10	− .340 :	− .228 .	− .067	− .071	− .049	− .054	− .073 :	− .081 :	− .059	− .062 ⊙
23. 7. 1976	83.321	98	− .377 .	− .254	− .079	− .087	− .061	− .081 .	− .095 .	− .095 :	− .087	− .082 .
26. 7. 1976	86.319	60	− .308 ⊙	− .206 ⊙	—	− .067 ⊙	− .042 :	− .047	− .054 :	− .063 :	− .038 :	− .036 :
27. 7. 1976	87.406	19	− .312 .	− .219 .	− .065 .	− .058	− .041	− .052 .	− .052 .	− .074 :	− .043 .	− .042
29. 7. 1976	89.306	22	− .296 .	− .212 .	− .067	− .057	− .035	− .034	− .056	− .048 ⊙	− .046	− .030 :
30. 7. 1976	90.292	75	− .316	− .225 .	− .070	− .061 .	− .046	− .048	− .060	− .077 :	− .047	− .053
8. 8. 1976	99.327	65	− .309 .	− .214	− .070	− .053 .	− .034	− .036 .	− .057 .	− .048 ⊙	− .039	− .047 .
	2443000											
20. 8. 1976	11.353	17	− .323 ⊙	− .199 ⊙	− .060 :	− .067 ⊙	− .044	− .053 ⊙	− .063	− .067 ⊙	− .056 ⊙	—
21. 8. 1976	12.345	70	− .308 .	− .212	− .065 .	− .063	− .042 .	− .031	− .056 .	− .059 ⊙	− .033	− .033 :
23. 8. 1976	14.312	77	− .320 :	− .233	− .072	− .069	− .045	− .049	− .064	− .086 ⊙	− .054 .	− .058
24. 8. 1976	15.314	31	—	− .206 ⊙	− .059 :	− .056 .	− .029 .	− .040	− .053 .	− .062 ⊙	− .036 .	− .042 ⊙
25. 8. 1976	16.328	86	− .356 ⊙	− .247	− .076 :	− .080	− .059 .	− .059	− .087 .	− .088 ⊙	− .080 .	− .070 .
26. 8. 1976	17.354	42	− .323 .	− .212 :	− .055	− .049	− .039	− .044 .	− .055	− .059 :	− .048 .	− .041
27. 8. 1976	18.329	95	− .370 :	− .251 ⊙	− .070 ⊙	− .084 .	− .061 .	− .072 .	− .093 ⊙	− .113 ⊙	− .079 ⊙	− .066 :
28. 8. 1976	19.341	49	− .315	− .216	− .067	− .057	− .037	− .041 .	− .051 .	− .070 .	− .046	− .045
29. 8. 1976	20.348	04	− .362 .	− .247	− .074	− .077	− .059	− .074	− .091 :	− .100 ⊙	− .074 .	− .070 ⊙
7. 9. 1976	29.267	87	− .360 ⊙	− .254 :	− .073 .	− .080 :	− .064 .	− .064	− .086 :	− .099 ⊙	− .081 :	− .071 :

Table 11. Photometric data for HD 188041

Magnitude differences are in the sense (HD 188041 − HD 189359)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2441500											
20. 8. 1972	50.312	10	−1.006 ⊙	− .961 .	− .911	−1.030 .	−1.035 :	−1.053	−1.113	−1.112 ⊙	−1.103 .	−1.099 .
26. 8. 1972	56.319	13	−1.011 ⊙	− .954 ⊙	− .890 :	−1.030 .	−1.029 .	−1.052 .	−1.106 ⊙	−1.109 ⊙	−1.099 :	−1.098 ⊙
28. 8. 1972	58.253	14	− .994 ⊙	− .962 ⊙	− .894 :	−1.031 .	−1.030 .	−1.051 :	−1.102 .	−1.121 :	−1.102 ⊙	−1.091 ⊙
26. 9. 1972	87.273	27	− .999 ⊙	− .937 ⊙	− .876 ⊙	−1.035 ⊙	−1.042 ⊙	—	−1.138 .	−1.121 ⊙	−1.119 ⊙	−1.125 ⊙
28. 9. 1972	89.161	27	−1.004 ⊙	− .929 ⊙	− .849 ⊙	−1.029	−1.034 .	−1.051 :	−1.119 .	−1.114	−1.111 .	−1.114 .
	2442200											
30. 6. 1974	29.456	13	−1.013 ⊙	− .973 ⊙	− .901 .	−1.043 :	−1.045	−1.059 .	−1.116	—	−1.101	−1.105 :
1. 7. 1974	30.451	13	−1.009 :	− .964 .	− .901 .	−1.048	−1.049 ⊙	−1.058 ⊙	−1.112	−1.126 ⊙	−1.115	−1.112 ⊙
10. 7. 1974	39.431	17	−1.011	− .957 :	− .898 :	−1.044	−1.044 .	−1.056 :	−1.118 .	−1.119 :	−1.112 .	−1.119
21. 7. 1974	50.367	22	−1.016 ⊙	− .949 :	− .879	−1.045	−1.044 :	−1.056 ⊙	−1.136	−1.133 ⊙	−1.121 ⊙	−1.122 :
26. 7. 1974	55.364	24	−1.003 ⊙	− .936 ⊙	− .861 ⊙	−1.026	−1.028 ⊙	−1.046 ⊙	−1.125 .	−1.125 ⊙	−1.110 ⊙	−1.111 ⊙
3. 8. 1974	63.332	28	− .989 ⊙	− .930 .	− .841 ⊙	−1.037 :	−1.038	−1.048 .	−1.122 .	−1.124 ⊙	−1.102 ⊙	—
16. 8. 1974	76.290	34	− .997 ⊙	− .918 ⊙	− .830 :	−1.038	−1.041 .	−1.058 ⊙	−1.129	−1.137 ⊙	−1.116 .	−1.127 ⊙
18. 8. 1974	78.290	34	−1.004 ⊙	− .926 ⊙	− .831 .	−1.032 .	−1.042 ⊙	−1.047 :	−1.135 .	−1.134 ⊙	−1.123	−1.132 .
	2442500											
30. 6. 1975	94.429	75	−1.007 ⊙	− .970 .	− .912 .	−1.032 .	−1.029 ⊙	−1.055 ⊙	−1.119	−1.115 ⊙	−1.100 .	−1.104 :
3. 7. 1975	97.423	77	−1.026 .	− .962 .	− .904 .	−1.032	−1.050 ⊙	−1.055 ⊙	−1.108	−1.128 .	−1.104 .	−1.108 :
	2442600											
21. 7. 1975	15.361	85	−1.021 :	− .967 ⊙	− .911	−1.036 .	−1.063 ⊙	−1.057 .	−1.116 .	−1.110 ⊙	−1.103 .	−1.103
27. 7. 1975	21.356	87	−1.004 :	− .969 .	− .914 ⊙	−1.036 .	−1.036 ⊙	−1.050 .	−1.106 :	−1.113 .	−1.097 .	−1.105
2. 8. 1975	27.320	90	−1.011 .	− .957 :	− .895 ⊙	−1.023	−1.038 ⊙	−1.044 .	−1.109 .	−1.113 ⊙	−1.091 :	−1.098 :
5. 8. 1975	30.317	91	−1.004 .	− .974 .	− .917 .	−1.034 :	−1.044 ⊙	−1.052 :	−1.107 .	−1.100 :	−1.108 .	−1.097
6. 8. 1975	31.312	92	−1.014 ⊙	− .969	− .916	−1.035 :	−1.057 ⊙	−1.055 .	−1.119 .	−1.119 :	−1.106	−1.100 .
14. 8. 1975	39.304	95	−1.003 :	− .963	− .904 ⊙	−1.033 ⊙	−1.041 ⊙	−1.050 ⊙	−1.115 .	−1.130 ⊙	−1.100 ⊙	−1.092 ⊙
20. 8. 1975	45.277	98	−1.015 .	− .983 ⊙	− .907 .	−1.043 .	−1.030 ⊙	−1.067 .	−1.112	−1.117 :	−1.096 .	−1.096 :
	2442900											
7. 6. 1976	37.490	28	−1.001 :	− .931	− .841 .	−1.026	−1.042 .	−1.047	−1.115	−1.126	−1.116 :	−1.117 ⊙
8. 6. 1976	38.450	28	−1.009 .	− .934 .	− .845 .	−1.040	−1.051	−1.058	−1.126	−1.126 ⊙	−1.125	−1.115
9. 6. 1976	39.491	29	−1.001 .	− .937	− .854	−1.034 .	−1.050	−1.056 .	−1.133 .	−1.148 .	−1.125	−1.129
24. 6. 1976	54.452	36	−1.002 ⊙	− .917 .	− .829 :	−1.032 .	−1.049	−1.060 .	−1.133	−1.144 ⊙	−1.128 .	−1.133 .
26. 6. 1976	56.456	37	− .988	− .910 ⊙	− .804 ⊙	−1.012 .	−1.042	−1.030	−1.119 .	−1.123 ⊙	−1.118 :	−1.125 ⊙
30. 6. 1976	60.371	38	− .991 :	− .906 ⊙	− .810 ⊙	−1.032 ⊙	−1.052 ⊙	−1.045 ⊙	−1.130 ⊙	−1.148 ⊙	−1.138 :	—
5. 7. 1976	65.442	41	−1.010 .	− .912	− .813	−1.037	−1.051	−1.057	−1.134	−1.140	−1.131	−1.125
6. 7. 1976	66.394	41	−1.010 .	− .923 .	− .823 .	−1.035 :	−1.049 .	−1.065	−1.135 :	−1.138 ⊙	−1.132 :	−1.129 .
7. 7. 1976	67.416	41	−1.008 :	− .913 .	− .820	−1.034	−1.039	−1.055 .	−1.134	−1.143 :	−1.125	−1.125 :
9. 7. 1976	69.390	42	−1.009 :	− .921 ⊙	− .819 :	−1.037	−1.047	−1.060 .	−1.139	−1.144	−1.129 .	−1.128
14. 7. 1976	74.383	44	−1.005 ⊙	− .920 :	− .815 :	−1.024 .	−1.040	−1.049	−1.133	−1.159 .	−1.129	−1.121 .
21. 7. 1976	81.345	48	−1.001 .	− .921 :	− .832 ⊙	−1.030 .	−1.046	−1.045 .	−1.134	−1.134	−1.120 ⊙	−1.119 :
23. 7. 1976	83.388	49	−1.002	− .923 :	− .833	−1.036 .	−1.045	−1.057	1.135	−1.136 :	−1.128	−1.122 :
26. 7. 1976	86.364	50	−1.009 :	− .916 :	- .829 .	−1.033 .	−1.052 .	−1.060 :	−1.132 ⊙	−1.139 .	−1.127	−1.122 :
30. 7. 1976	90.375	52	−1.013 .	− .925 .	− .840	−1.038	−1.049	−1.056 .	−1.131	−1.143 .	−1.137 .	−1.126 .
	2443000											
22. 8. 1976	13.345	62	−1.009 :	− .946 :	− .873	−1.039 .	−1.041 .	−1.055 .	−1.118	−1.117 :	−1.112	−1.116 .
6. 9. 1976	28.317	69	−1.025 ⊙	− .971 ⊙	− .894	−1.045 ⊙	−1.048 :	−1.063 .	−1.116 .	−1.115 ⊙	−1.114 :	—
18. 9. 1976	40.239	74	−1.019 ⊙	⊙ .980 ⊙	− .904 ⊙	−1.029 .	−1.052 ⊙	−1.048 :	−1.116 .	−1.103.	−1.106 .	−1.114 :

Table 12. Photometric data for HD 192913

Magnitude differences are in the sense (HD 192913—HD 192518)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2442200											
21. 7. 1974	50.490	62	+ .667 .	—	+1.121 .	+1.311 :	—	+1.465 .	+1.551 .	+1.601 ⊙	+1.685 .	+1.729 ⊙
22. 7. 1974	51.444	68	+ .668 ⊙	+ .912 :	+1.140 .	+1.323 :	+1.435 :	+1.466 .	+1.552 .	+1.605 .	+1.694 ⊙	+1.735 ⊙
25. 7. 1974	54.473	86	+ .636	+ .879 ⊙	+1.118 :	+1.284 .	+1.413 .	+1.440 ⊙	+1.531 ⊙	+1.570	+1.666 ⊙	+1.706 ⊙
30. 7. 1974	59.465	16	+ .616 .	+ .863 .	+1.086 ⊙	+1.274	+1.393 .	+1.426	+1.521 ⊙	+1.567 :	+1.658 .	+1.702 ⊙
1. 8. 1974	61.432	27	+ .659 ⊙	+ .884 ⊙	+1.114 ⊙	+1.284 ⊙	+1.415 ⊙	+1.445 ⊙	+1.541 .	—	+1.678 ⊙	+1.722 :
2. 8. 1974	62.437	33	+ .665 :	+ .887	+1.141	+1.314	+1.434 :	+1.464 .	+1.552 :	+1.609 ⊙	+1.687 .	+1.734 :
8. 8. 1974	68.407	69	+ .675 :	+ .906 .	+1.142 .	+1.317 .	+1.429 .	+1.462	+1.556 .	+1.616 ⊙	+1.688	—
13. 8. 1974	73.435	99	+ .604	+ .855 .	+1.087 :	+1.254 :	+1.387 :	+1.404	+1.494 ⊙	+1.547 ⊙	+1.629	+1.666 ⊙
18. 8. 1974	78.370	28	+ .660 .	+ .894 .	+1.109 ⊙	+1.291 ⊙	+1.408 ⊙	+1.455	+1.538 .	+1.584 .	+1.670 :	—
19. 8. 1974	79.386	34	+ .667 :	+ .891	+1.131 .	+1.306 .	+1.420	+1.459	+1.544 .	+1.593 .	+1.686 .	+1.718 .
20. 8. 1974	80.395	40	+ .659	+ .902 ⊙	+1.133 ⊙	+1.311 .	+1.417 :	+1.457	—	+1.589 ⊙	+1.687	+1.720 .
	2442300											
16. 9. 1974	07.324	100	+ .603 :	+ .851 :	+1.096 :	+1.263	+1.380	+1.413 .	+1.498	+1.553 ⊙	+1.628 .	+1.688 ⊙

Magnitude differences are in the sense (HD 192913—HD 191747)

Datum	JD	Phase	ΔU	ΔP	ΔX	ΔY	ΔZ 3	ΔV	ΔHR	ΔS	ΔMR	ΔDR
	2442500											
4. 7. 1975	98.471	28	+ .512 :	+ .658	+ .926 .	+1.052	+1.124 ⊙	+1.125 .	+1.155 .	+1.151 ⊙	+1.223 .	+1.242 :
	2442600											
18. 7. 1975	12.433	11	+ .484 .	+ .642 :	+ .913 .	+1.029	+1.104 :	+1.111 .	+1.130 .	+1.163 :	+1.204	+1.224 .
21. 7. 1975	15.444	29	+ .529 :	+ .669 :	+ .932 :	+1.061 .	+1.129	+1.133 .	+1.164	+1.170 :	+1.232 .	+1.259
26. 7. 1975	20.440	58	+ .549 :	+ .686 .	+ .955 .	+1.076 .	+1.145 ⊙	+1.151 .	+1.173	+1.186 :	+1.238 :	+1.266 .
27. 7. 1975	21.432	64	+ .544 ⊙	+ .676	+ .953	+1.073 :	+1.138 ⊙	+1.146 .	+1.169 .	+1.198 ⊙	+1.232 :	+1.270 ⊙
28. 7. 1975	22.415	70	+ .541 :	+ .691 :	+ .955 :	+1.078 .	+1.139 ⊙	+1.156 .	+1.177	+1.212 ⊙	+1.246 :	+1.270 .
4. 8. 1975	29.372	11	+ .489 :	+ .634 .	+ .913 :	+1.023	+1.107 ⊙	+1.104 .	+1.130 .	+1.131 ⊙	+1.216 :	+1.211
5. 8. 1975	30.440	18	+ .502	+ .663 ⊙	+ .925 .	+1.043 .	—	+1.125	—	+1.155 ⊙	+1.212 .	+1.234 :
9. 8. 1975	34.387	41	+ .522	+ .671 ⊙	+ .932	+1.061 ⊙	+1.133 ⊙	+1.151 ⊙	+1.165	+1.178 ⊙	+1.234 ⊙	+1.264 ⊙
13. 8. 1975	38.363	65	+ .543 :	+ .691 .	+ .945	+1.075	+1.149 ⊙	+1.150 .	+1.172 .	+1.189 .	+1.238 .	+1.254 .
19. 8. 1975	44.341	0	+ .470 .	+ .630 :	+ .908 .	+1.015	+1.100 ⊙	+1.097	+1.117	+1.136 ⊙	+1.183	+1.214 .
20. 8. 1975	45.318	6	+ .476 :	+ .638	+ .904 .	+1.023	+1.100 ⊙	+1.106 .	+1.123	+1. 1470	+1.187	+1.218 :

where S, C, and V denote eight-second integrations for the sky, comparison and variable star in each filter (names are given in parentheses). Each such sequence (block) was used to derive a magnitude difference in all filters between the variable and the comparison star. After applying corrections for the differential extinction all magnitude differences were averaged for each filter. The number of blocks N were estimated from the control calculations made simultaneously with the measurements. These calculations were only made in the V-filter. The measurements were continued as long as it was necessary (if possible) to fulfil the following condition:

$$w = \frac{N^2}{\sum_{i=1}^{n} (\Delta m_i - \langle \Delta m \rangle)\ 1000} \geqq 1 \,. \qquad (1)$$

The number of blocks was on the average six or seven. The magnitude differences between the variable and the comparison stars are listed in Tables 1—12. The individual observations are weighted according to formula 1. The signs after the magnitude differences denote:

1. space	$1 < w$		$\sigma < .0035$
2. .	$0.7 < w \leqq 1$		$.0035 \leqq \sigma < .0050$
3. :	$0.5 < w \leqq 0.7$		$.0050 \leqq \sigma < .0070$
4. ⊙	$w \leqq 0.5$		$.0070 \leqq \sigma$

The resulting light curves are shown in Figures 1—12. In cases with a sufficient number of measurements the observations with $\sigma \geqq 0.007$ mag. were not plotted.

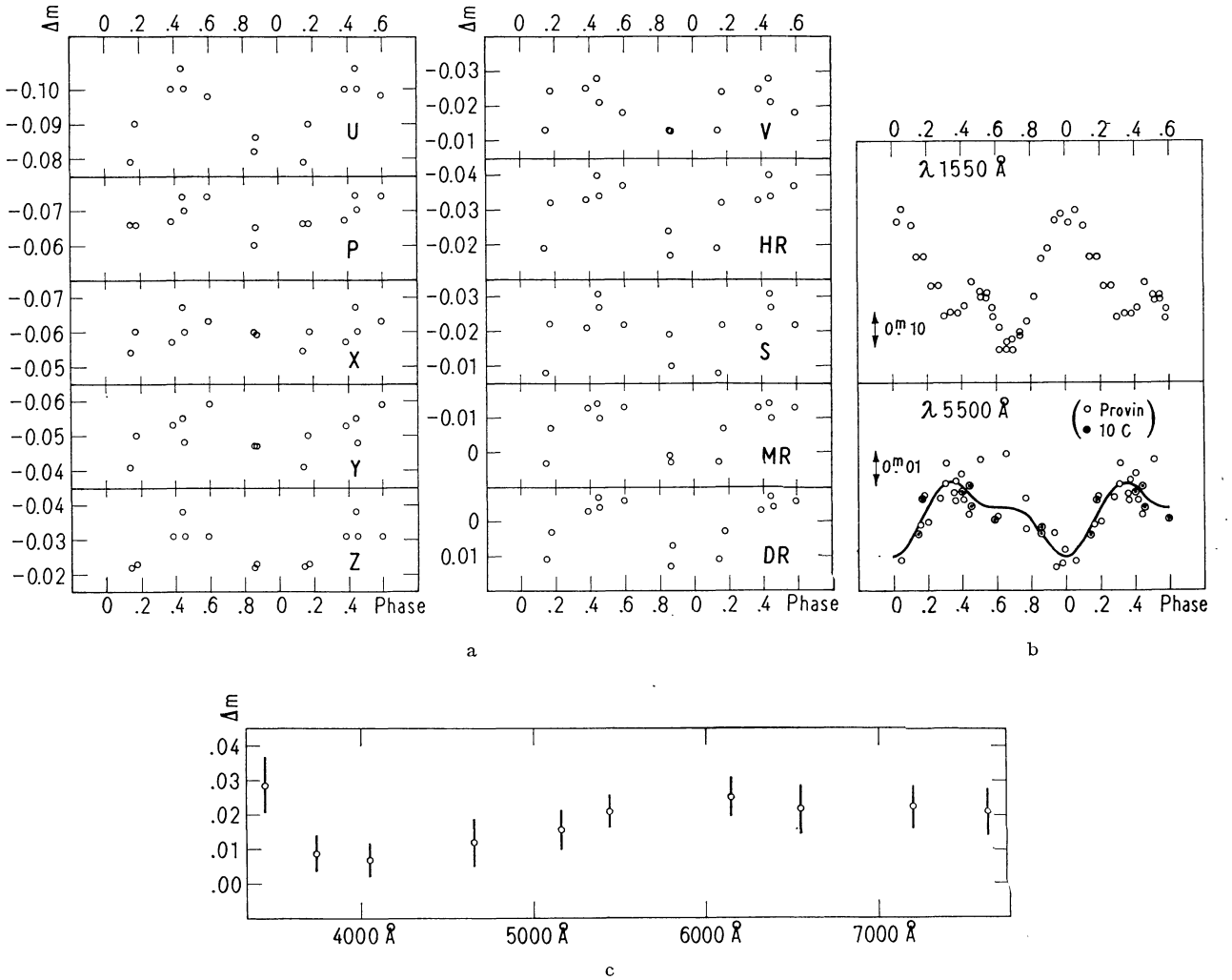


Fig. 1a. Photometric observations of IOTA Cas plotted according to the ephemeris $JD\ (V_{min}) = 2437247 + 1^d.74050\,E$. Magnitude differences are in the sense (HD 15089—HD 12111).

Fig. 1b. The ultraviolet and visible light curves of IOTA Cas. The curve drawn through the V-curve is the best fit to the equation: $V = a_0 + a_1 \cos 2\pi\varphi + b_1 \sin 2\pi\varphi + a_2 \cos 4\pi\varphi + b_2 \sin 4\pi\varphi$.

Fig. 1c. Amplitudes of IOTA Cas in the visible.

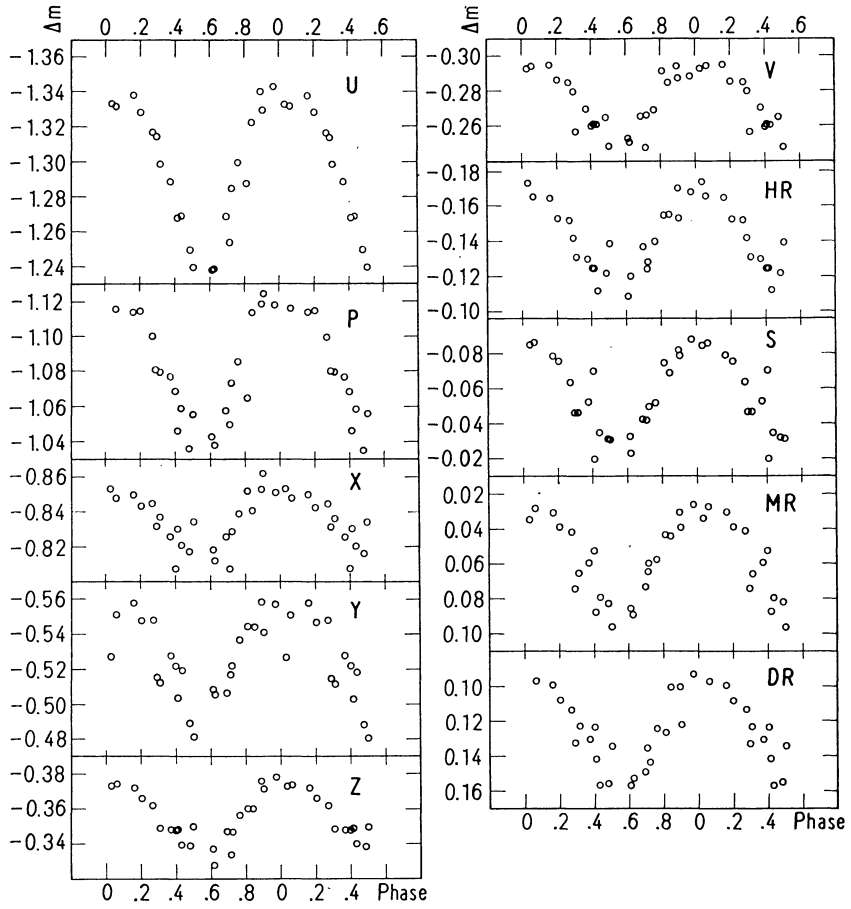


Fig. 2. Photometric observations of 56 Tau plotted according to the ephemeris $JD\ (U_{max}) = 2442299.51 + 1^d.56896\ E$. Magnitude differences are in the sense (HD 27309 − HD 27176).

3. Discussion of Individual Stars

A. *HD 15089 = IOTA Cas, Sr, Cr*

Photoelectric observations of IOTA Cas have already been made by Provin (1953a), Rakos (1962), Klock (1965), and van Genderen (1970). The analysis of all these photoelectric observations (minima in V) together with the ten-colour photometry (Figure 1a and Table 1) give the following ephemeris:

$$JD\ (V_{min}) = 2437247.704 + 1^d.74050\ E \pm 0^d.00003$$

It is practically the same period as that derived by Bahner (1950) from the intensity variations of the K-line ($P = 1^d.7405$).

The ultraviolet light curves (Molnar et al., 1975) are in inverse correlation to the photometric variability in the visible (Fig. 1b) and to the variations of the equivalent widths of FeII, CrII (Molnar et al., 1975), and SrII (Bahner, 1950 and Molnar et al., 1976). The amplitudes at all wavelengths in the visible are very small. They never exceed 0.03 magnitude (Fig. 1c). In the case of HD 15089 B- and C-components were included in the diaphragm. Consequently, the real amplitudes are about 10 percent larger (0.002 mg. in the V-band). The amplitudes were estimated in the following manner:

1. Amplitudes in all bands were calculated relative to the V-band. Linear relations were assumed: $C + A \cdot \Delta Fi = \Delta V$ where A is the relative amplitude, ΔFi the magnitude difference in a given band, ΔV the magnitude difference in the V-band, and C the fitting constant.
2. The absolute amplitude in the V-band was derived from the ten-colour measurements and from Provin's (1953a) data (Fig. 1b). The curve drawn through the photometric points is the last square fit to the equation:

$$V = a_0 + a_1 \cos 2\pi\varphi + b_1 \sin 2\pi\varphi + a_2 \cos 4\pi\varphi + b_2 \sin 4\pi\varphi\ , \qquad (2)$$

where a_0, a_1, a_2, b_1, b_2 are fitting parameters. The amplitude was then defined as a magnitude difference between the primary maximum and minimum.

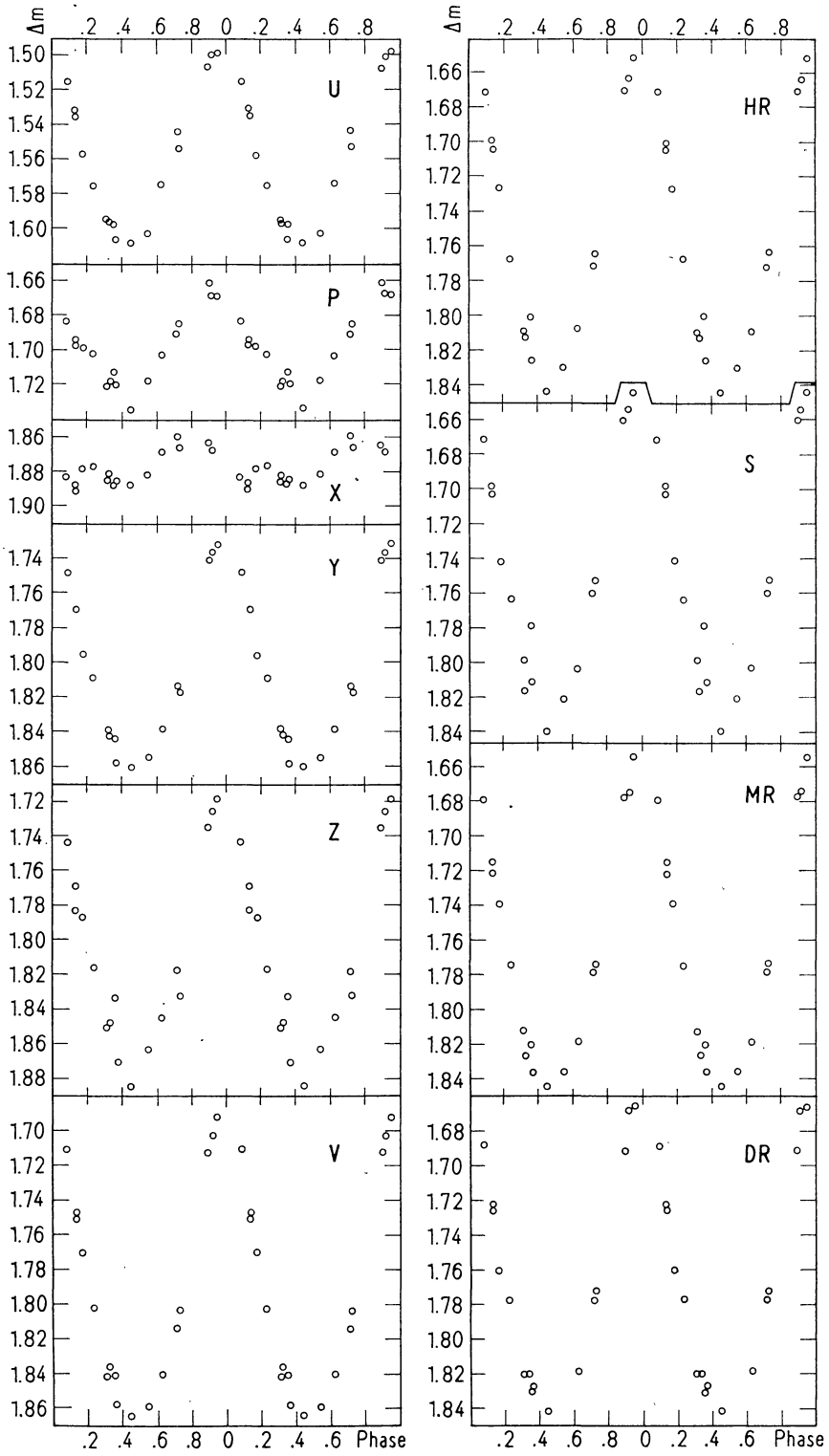


Fig. 3. Photometric observations of HD 51418 plotted according to the ephemeris $JD\ (V_{max}) = 2441241.654 + 5^d.4379\ E$. Magnitude differences are in the sense (HD 51418 − HD 50973).

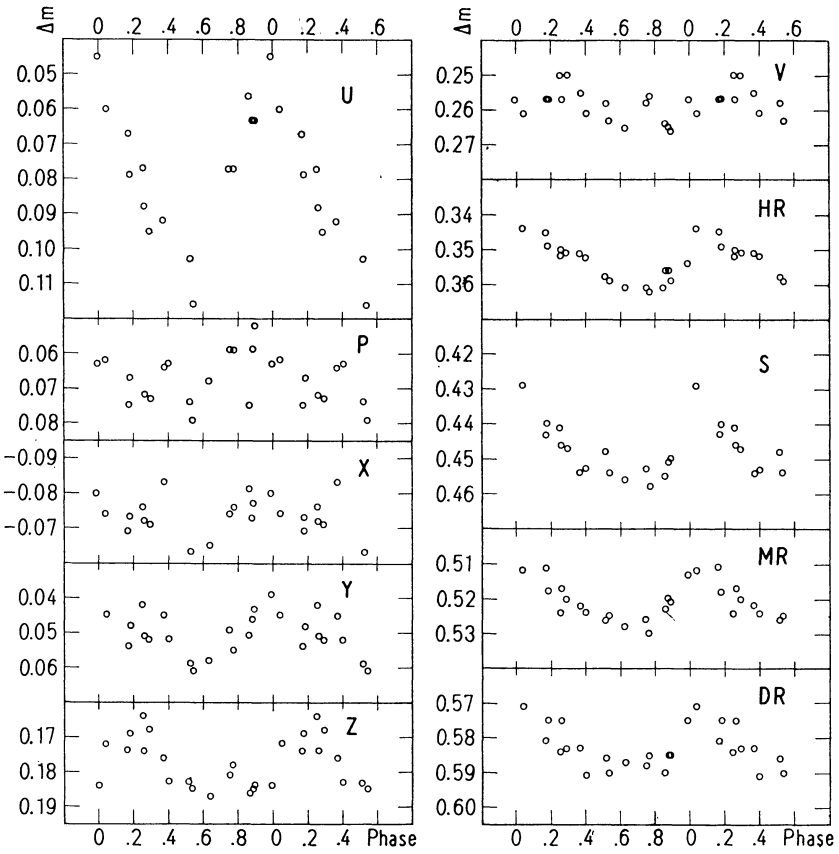


Fig. 4. Photometric observations of 53 Cam plotted according to the ephemeris $JD\,(U_{max}) = 2441701.41 + 8^d.0278\,E$ Magnitude differences are in the sense (HD 65339−HD 65301).

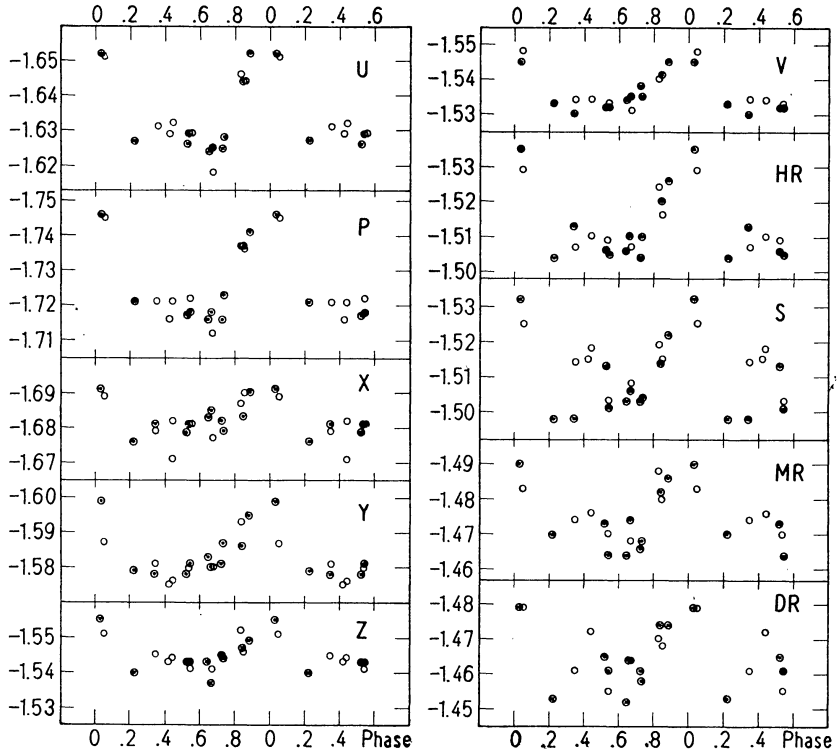
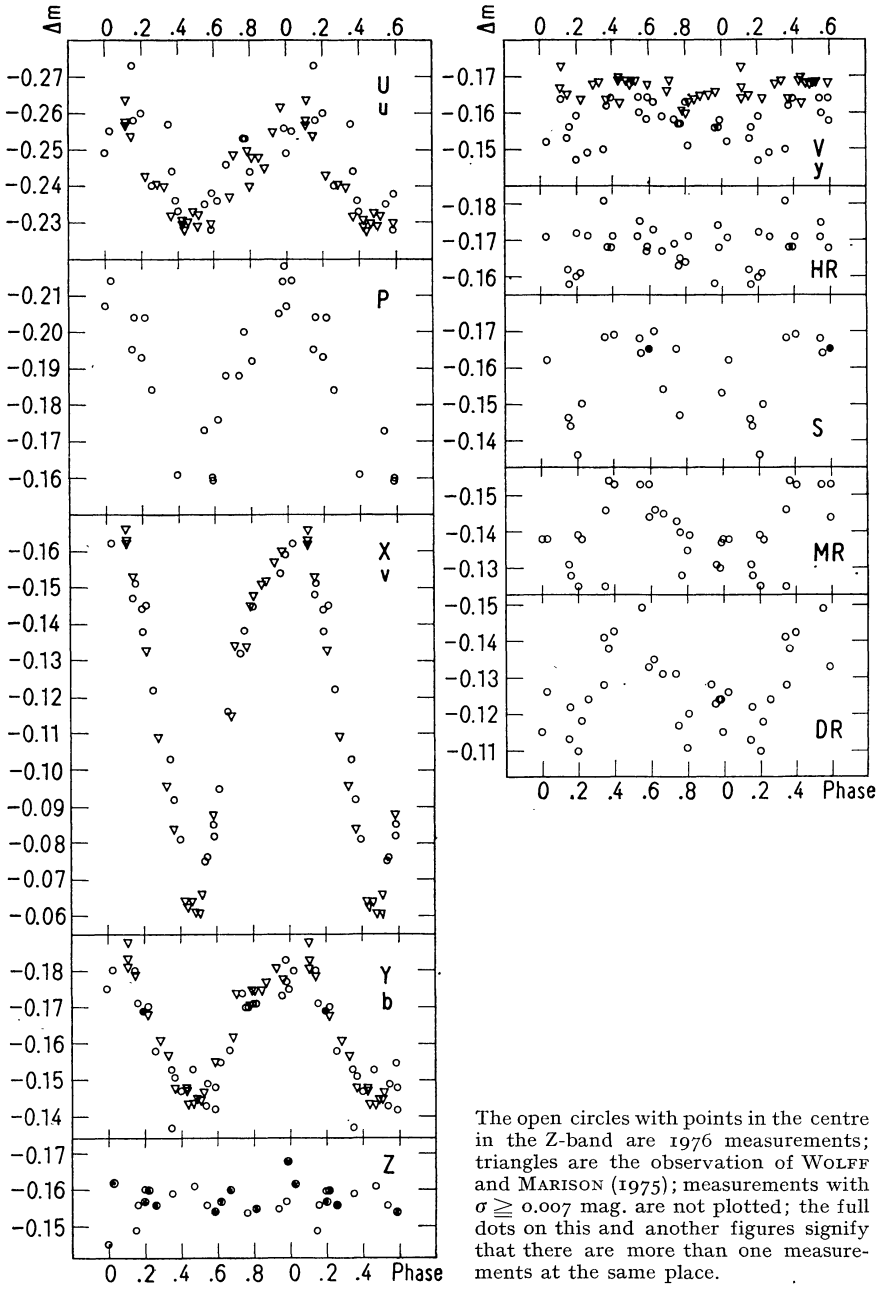


Fig. 5. Photometric observations of EPSILON UMa plotted according to the ephemeris JD (CaII min int.) $= 2426437.01 + 5^d.0887\,E$. Magnitude differences are in the sense (HD 112185−HD 106591). The open circles are 1975 measurements; circles with points in the centre are shifted (see text) 1976 measurements.



The open circles with points in the centre in the Z-band are 1976 measurements; triangles are the observation of Wolff and Marison (1975); measurements with $\sigma \geqq 0.007$ mag. are not plotted; the full dots on this and another figures signify that there are more than one measurements at the same place.

Fig. 6. Photometric observations of CQ UMa plotted according to the ephemeris $JD\ (U_{max}) = 2441450.74 + 2^d.44988\ E$. Magnitude differences are in the sense (HD 119213 − HD 120874).

In order to balance the ultraviolet light variability (Molnar et al., 1976) the visible amplitudes of 0.03 magnitude are needed. So it seems that also in the case of IOTA Cas the total flux is not constant over the cycle. The effect is similar to that observed at ALPHA 2CVn, EPSILON UMa, HD 188041 and HD 119213 (Musielok 1976): the bolometric flux of the star becomes fainter at phases corresponding to maximum light for wavelength longward of lambda 'null'.

B. *HD 27309=56 Tau, Si 4200*

The first observations for 56 Tau in our ten-colour system have been made in 1973−74 (Schoeneich et al., 1976b). This paper used the period of 2.7098 days obtained from *UBV*-observations made in 1971 (Hildebrandt, 1975). Winzer (1974b) found from his data a period of $1^d.5691$ days. These two periods are correlated. The 1976 ten-colour observations have shown, that the shorter one is the more correct.

Our data in all bands (Table 2) can best be represented by the elements:

$$\text{JD}\ (U_{max}) = 2442299.51 + 1^d.56896\ E \pm 0^d.00003$$

The resulting light curves are shown in Figure 2. (In Fig. 2 the 1973 and 1974 data for the *Z*-band are shifted by 0.024 mag. in order to get the best coincidence with the 1976 points.)

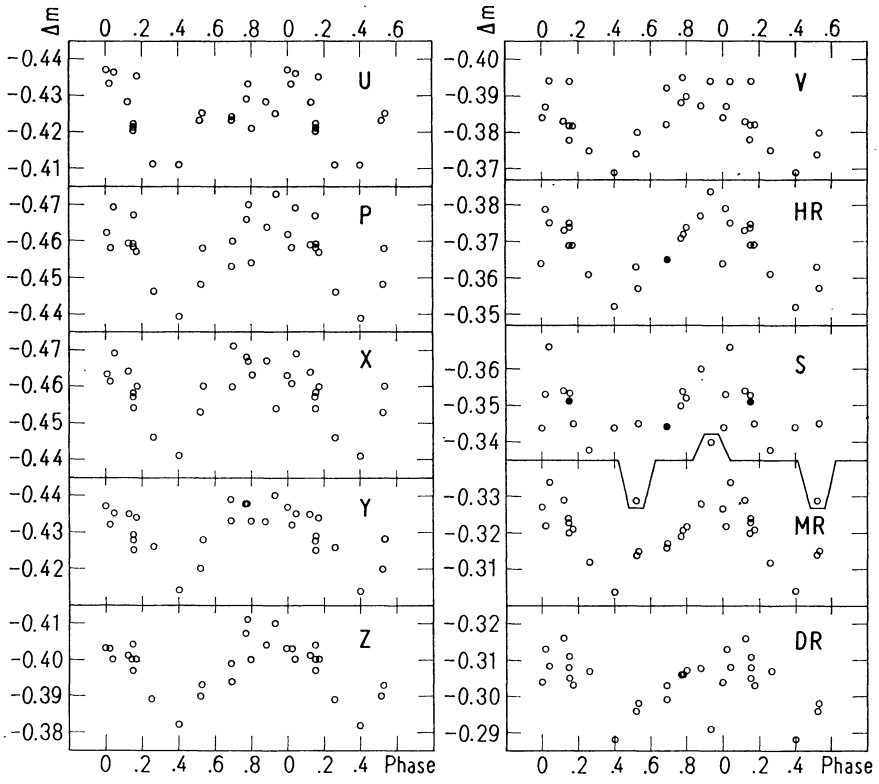


Fig. 7. Photometric observations of CHI Ser plotted according to the ephemeris. *JD* (SrII max) = 2434134.06 + $1^d.59584\,E$. Magnitude differences are in the sense (HD 140160—HD 141187).

Due to two observations made in the neighbourhood of the Moon and affected by the inhomogeneous sky background, the amplitudes in the red bands which were given by Schoeneich et al. (1976b) are systematically too large.

If these two observations are neglected, the amplitude-wavelength relation for HD 27309 shows a typical form for a Si type peculiar star.

C. *HD 51418=NY Aur, Eu, Sr, Cr*

A first description of the photometric and spectroscopic variability of HD 51418 was given by Gulliver and Winzer (1973). They gave the following ephemeris for the light variability of this star:

$$JD\,(V_{max}) = 2441241.654 + 5^d.4379\,E.$$

The ten-colour photometry (Table 3) has confirmed these elements. The resulting light curves are shown in Figure 3. The amplitude in *U* is 0.11 mag. It decreases to 0.03 mag. in the *X*-band and then increases to 0.19 mag. in the *HR*-, *S*-, and *MR*-bands. HD 51418 shows a similar effect as ALPHA 2CVn (Pyper 1969): The light curves are not in phase. The *P*- and *X*-light curves are shifted by about 0.1 and 0.2 in phase relative to the light curves in the other bands, which are in phase with the line intensity variations of the rare earth (Gulliver and Winzer 1973). On the other hand the *X*-band light curve matches the intensity variations of the SrII-lines (Gulliver and Winzer 1973). Due to the very large decrease of the amplitude in the *X*-band and the mentioned phase shift this star is a good object for checking Peterson's (1970) and Wolff and Wolff's (1971) hypothesis on the light variability of Ap-stars.

D. *HD 65339=53 Cam=AX Cam, Sr, Cr, Eu*

Photoelectric observations of HD 65339 have already been made by many observers. (Jarzebowski 1960, Rakos 1962, Preston and Stepien 1968, and Wolff and Wolff 1971).

A few observations of this star in our ten-colour system were made in 1973 (Schoeneich et al., 1976a). New observations were carried out in the winter seasons 1975 and 1976. The comparison star was again HD 65301.

All photometric observations in *U* can best be represented by the following elements:

$$JD\,(U_{max}) = 2441701.41 + 8^d.0278\,E \pm 0^d.0011$$

using the period given by Preston and Stepien (1968).

Our measurements are given in Table 4 and the light curves are shown in Figure 4. (In Figure 4 the 1975 data for the *Z*-band are shifted by 0.017 mag. in order to get the best coincidence with the 1976 points.) The light curves are not in phase. The *Z*- and *V*-light curves appear to be shifted by more than 0.2 in phase relative to that in the *U*-band.

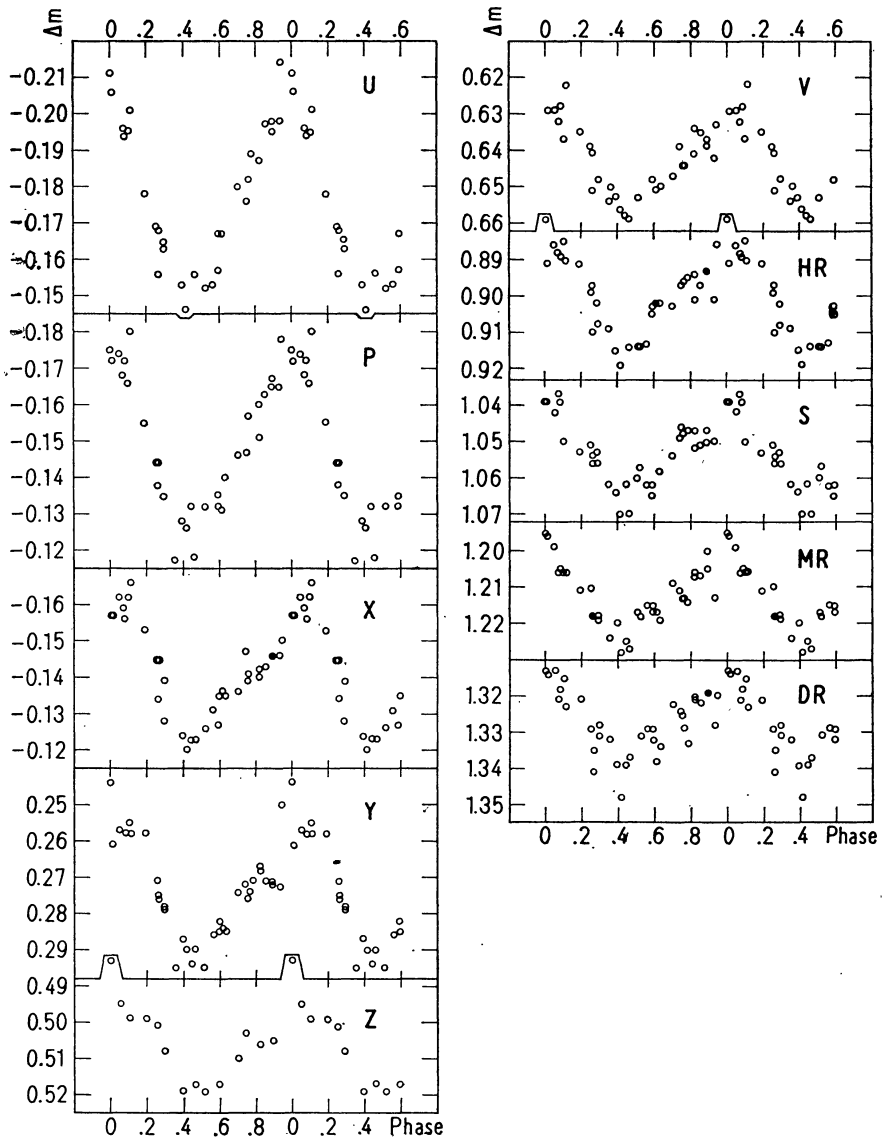


Fig. 8. Photometric observations of PHI Dra plotted according to the ephemeris. JD (U_{max} = 2442229.40 + 1^d.71646 E. Magnitude differences are in the sense (HD 170000—HD 170153). Measurements with $\sigma \geqq 0.007$ mag. and the Z-band measurements from 1975 are not plotted.

E. *HD 112185=EPSILON UMa, Cr*

Recent OAOII observations (Molnar 1975) have shown pronounced light variations in the ultraviolet which are in reverse correlation to the visible light variations measured by Provin (1953b). The visible light curve varies in phase with the intensity variations of the CrII-lines, and oppositely to the CaIIK-line (Deutsch 1947). The results of our own photometry are given in Table 5 and Figure 5. The phases are calculated according to the ephemeris given by Swensson (1944):

$$JD \text{ (CaII min.int.)} = 2426437.01 + 5^d.0887\, E$$

(In Swensson's paper this value is by mistake given as 2246437.01)
The light curve in U varies in phase with the V-curve, so that the 'null wavelength region' is located between reddest OAOII filter and the bluest from the ten-colour system (3320 Å $< \lambda$ 'null' $<$ 3450 Å). The ten-colour measurements were obtained in the winter seasons 1975 and 1976. Both series show a discrepancy in the mean brightness differences between the variable and the comparison star. We cannot exclude an apparative reason for this effect. Consequently, the measured discrepancy need not have an astrophysical reason.

In Figure 5 the 1976 data are shifted in order to get the best coincidence with the 1975 points. The used shifts are: 0.004, 0.006, 0.011, 0.011, 0.009, 0.009, 0.013, 0.010, 0.010, and 0.006 mag. for the U-, ... DR-bands, respectively. Our V-light curve did not show a double wave character as Provin's (1953b) 5500 Å light curve.

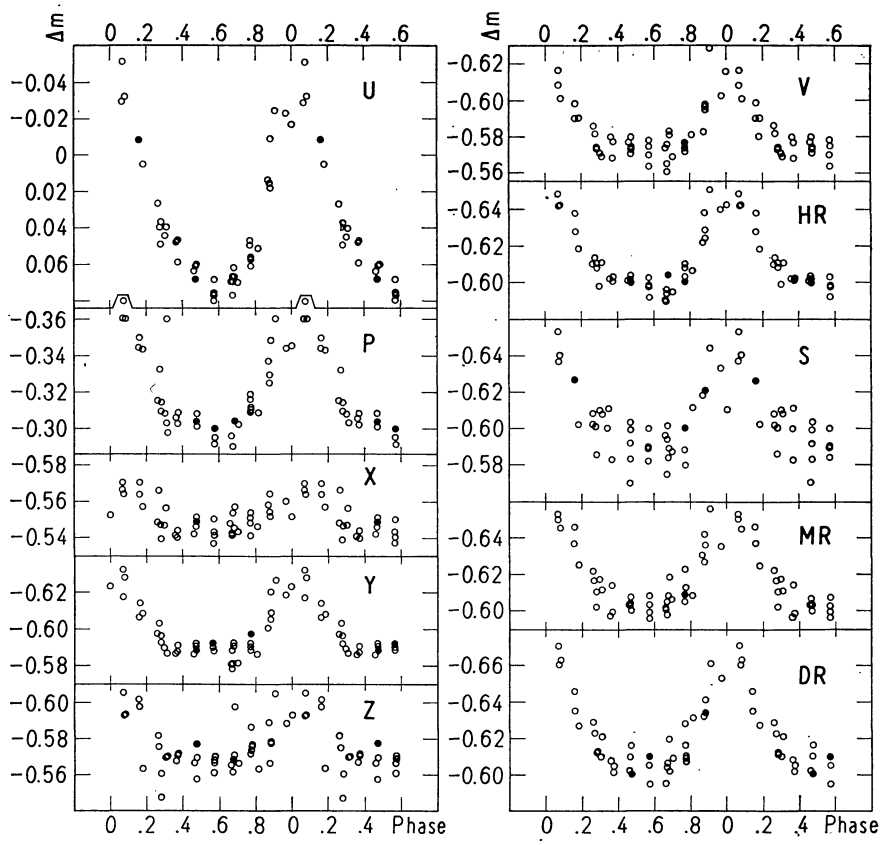


Fig. 9. Photometric observations of V535 Her plotted according to the ephemeris $JD\,(V_{max}) = 2438543.8 + 9^d.9750\,E$. Magnitude differences are in the sense (HD 173650—HD 174261).

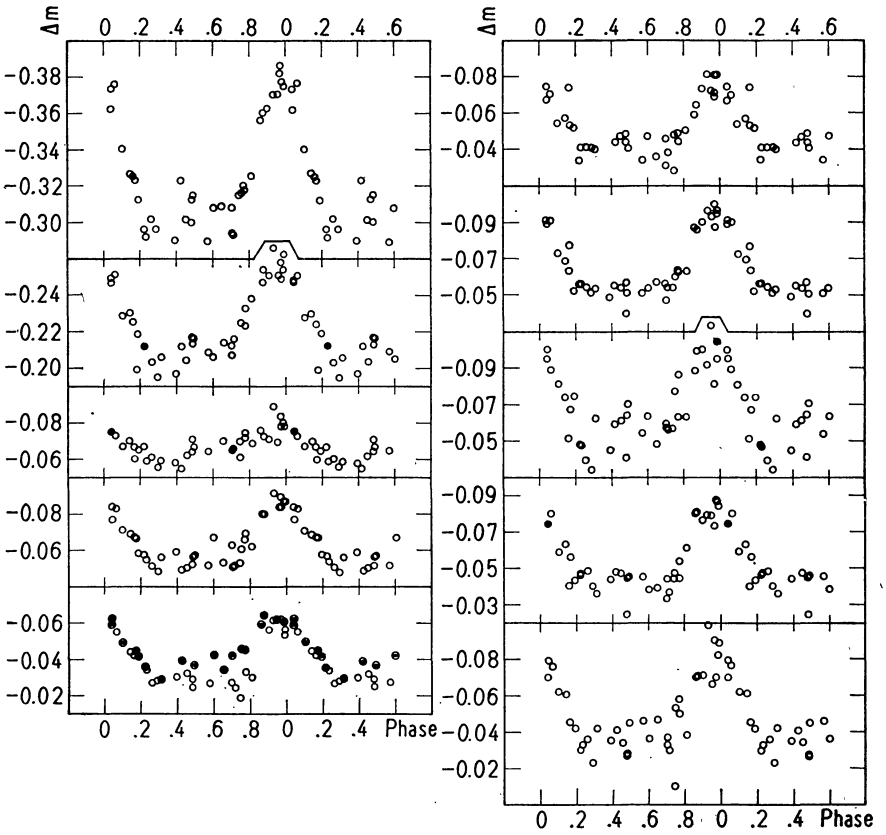


Fig. 10. Photometric observations of HD 184905 plotted according to the ephemeris $JD\,(U_{max}) = 2440800.27 + 1^d.84539\,E$. Magnitude differences are in the sense (HD 184905—HD 184787). The open circles with the points in the centre in the Z-band are 1976 measurements.

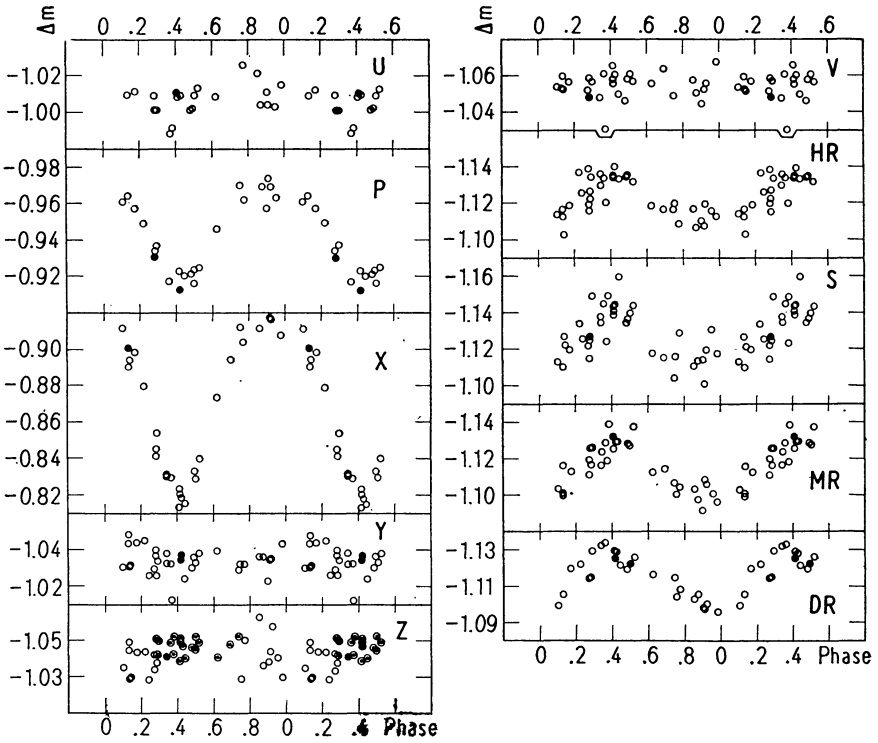


Fig. 11. Photometric observations of HD 188041 plotted according to the ephemeris JD (magn.min) = 2432323 + 224^d.5 E. Magnitude differences are in the sense (HD 188041 − HD 189359). Measurements with $\sigma \leqq 0.007$ mag. are plotted only in Z- and S-bands. The open circles with the points in the centre in the Z-band are 1976 measurements.

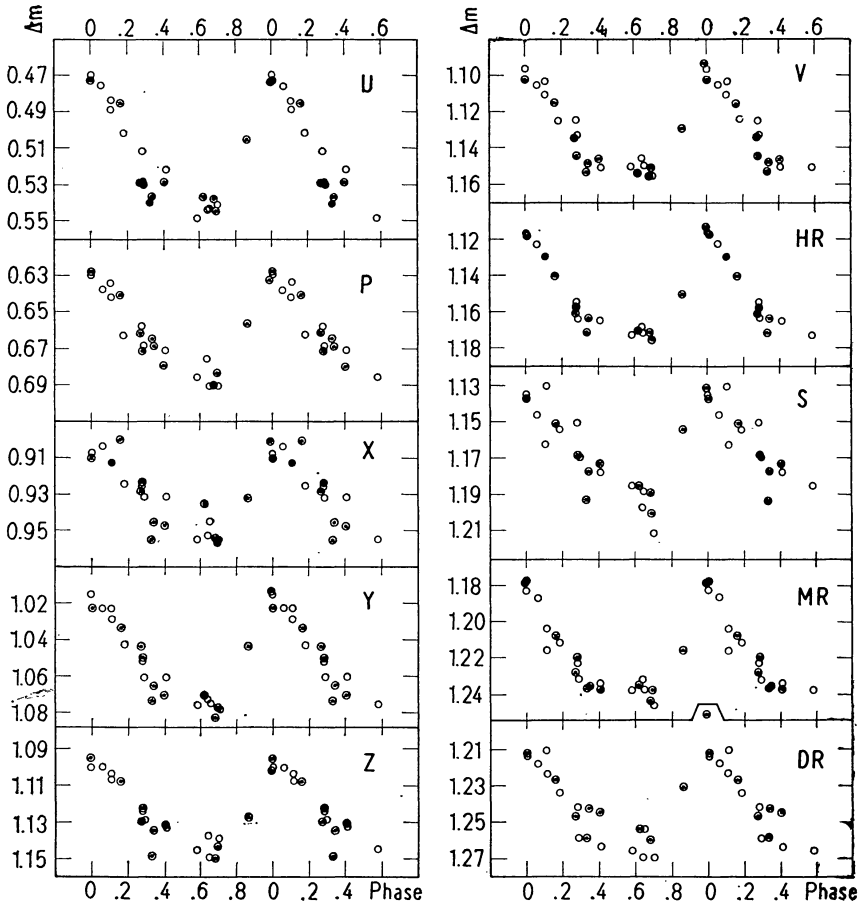


Fig. 12. Photometric observations of MW Vul plotted according to the ephemeris JD (V_{max}) = 2442644.3 + 16^d.846 E. The open circles denote magnitude differences in the sense (HD 192913 − HD 191747). The open circles with the point in the centre denote the magnitude differences in the sense (HD 192913 − HD 192518) shifted according to the mean magnitude differences between both comparison stars.

F. *HD 119213=CQ UMa, Sr, Cr*

Photometric observations of HD 119213 have recently been made by Burke and Howard (1972), Winzer (1974b), and Wolff and Morrison (1975). The analysis of our own data in the *U*-, *X*-, and *Y*-bands together with the *u*, *v*, *b* photometric observations taken from Wolff and Morrison (1975) yield the following ephemeris:

$$JD\,(U_{max}) = 2441450.74 + 2^d.44988\,E \pm 0^d.00005$$

The results of the ten-colour photometry are given in Table 6 and Figure 6. The *Z*-light curve remains relatively flat, while the *U*-, *P*-, *X*-, and *Y*-light curves vary oppositely to that in the *V*-, *HR*-, *S*-, *MR*-, and *DR*-bands. A similar feature was first discovered by Molnar (1973) in ALPHA 2CVn and later one found in all Ap-stars for which the ultraviolet measurements were made (Leckrone 1975).

The spectrum variations of CQ UMa were described by Bonsack (1974). He found variations in the K-line and in the Cr-lines. His observations reduced with the given above ephemeris show that CrII-, SrII-lines and the CaII K-line vary in phase and reach maximum intensity at phase corresponding to maximum light in the *U*-band.

Mikulasek (1978) found that EuII-and TiII-lines vary in antiphase to CrII-lines. It is possible that the intensity variations of these lines produce the strong light variations in the *X*- and *v*-bands.

G. *HD 140160=CHI Ser, Sr, Cr*

Table 7 and Figure 7 give the results of the ten-colour photometry for CHI Ser. The ephemeris is taken from Deutsch (1952):

$$JD\,(\text{SrII max}) = 2434134.06 + 1^d.59584\,E\,.$$

The visible light curves vary in phase with the equivalent widths of SrII-lines. Leckrone (1975) reported from the OAOII ultraviolet observations the 'null wavelength region' at 2980 Å.

H. *HD 170000=PHI Dra, Si*

HD 170000 is a visual binary and a spectroscopic binary. The visual companion (sep 1″, Δm = 1.7 mag.) was included in the diaphragm, so the amplitude in the *V*-band becomes about 0.006 mag. larger.
Recently, Winzer (1974b) has found a period of 1.7164 days for the light variations of PHI Dra. Our own data (Fig. 8 and Table 8) have confirmed his period. They can best be represented by the following ephemeris:

$$JD\,(U_{max}) = 2442229.40 + 1^d.71646\,E \pm 0^d.00006\,.$$

The ultraviolet light variations have recently been studied by Jamar (1977) by means of the data of the S2/68 ultraviolet sky Survey Telescope on the TD 1 satellite. He found large amplitude light variations at wavelengths below 1600 Å and an inversely correlated variation around 2400 Å. These variations are interpreted as inversely correlated absorptions by the silicon and iron patches on the stellar surface. Jamar's observations reduced with the given above ephemeris yield the following phase relation between the ultraviolet and visible light curves: The 1400 Å variation is inversely and the 2400 Å variation is directly correlated with the light variability in the *Y*-band. Jamar (1977) discussed two 'null wavelengths regions':

The first one between 1600 Å and 1900 Å, and the second around 2740 Å, where no variability was found (amplitude smaller than 0.002 mag.). It is possible that a ocapity source which varies in phase with the Si is responsible for the amplitude depression in that wavelength band. The 'null wavelength region' then lies between 1600 Å and 1900 Å.

I. *HD 173650=V535 Her, Sr, Cr, Si*

The analysis of already published photoelectric observations (Wehlau 1962, Burke et al. 1969, and van Genderen 1971) together with the ten-colour photometry (Figure 9 and Table 9) give the following ephemeris of the light variations:

$$JD\,(V_{max}) = 2438543.8 + 9^d.9750\,E \pm 0^d.0006\,.$$

It is practically the same period as that determined by Burke et al. (1969) ($P = 9^d.9748 \pm 0^d.0020$). The new measurements have only improved the accuracy of its determination.

A point of note is a very flat minimum in the light curves at wavelengths longward of 4500 Å. For example, in the *Y*-band the star shows no variability over about 0.4 of the period.

The spectrum variations of this star have been studied by Rice (1970), who finds variations in the line strength of EuII, GdII, ZrII, FeII, SrII, MnII, TiII, and CrII. All these elements vary in phase with the *V*-light curves.

J. *HD 184905=V1264 Cyg, Si, Cr, Sr*

The *O*—*C* analysis of the *U* (*UBV* or ten-colour) or *u* (*uvby*) maxima measured by Burke et al. (1970), Morrison and Wolff (1971), Hildebrandt (1972), Schoeneich et al. (1976a), and the new measurements presented in this paper (Table 10) give the following ephemeris of the light variability:

$$JD\,(U_{max}) = 2440800.27 + 1^d.84539\,E \pm 0^d.00005\,.$$

(Brodskaja (1976) has independently found from the already published measurements, as well as from her own, a period P = 1.84540 days.)

The light curves shown in Figure 10 somewhat differ from those given by Schoeneich et al. (1976a). The larger number of observations and the higher accuracy of the 1976 measurements account for the clearer details in the form of the light curves.

At the shorter wavelengths (*U*-, *P*-, and *X*-bands) a secondary maximum is indicated as was shown in previous papers. In the red bands, especially in the *HR*-band, we have an extended phase region of constant brightness similar to HD 173650. This fact, connected with the rotator model, indicates a very discrete distribution of the surface inhomogenity similar to limited spots.

The line intensity variations of HD 184905 were described by Kumaigorodskaya and Chunakova (1975). The line strength variations of EuII, SrII, SiII, CaII, and FeII are all in phase. Using the ephemeris given here we find that the ten-colour light curves are in phase with the line intensity variations.

K. *HD 188041=V1291 Aql, Sr, Cr, Eu*

The period of HD 188041 was determined by Wolff (1969):

$$JD\ (\text{magn.min.}) = 2432323 + 224^{d}.5\ E\ .$$

The ten-colour photometry (Table 11, Figure 11) has confirmed this ephemeris — there is a good agreement between the *uvby* photometry (Jones and Wolff 1973) and our own data. The existence of a 'null wavelength region' in the 4500 Å—5000 Å region is evident. Spectral variations of HD 188041 and their influence on the light curves have been studied by Jones and Wolff (1973). Rare earth's and iron peak elements vary in phase. The r maxima occur at minimum light in the *v*- and *X*-bands. Jones and Wolff (1973) have made measurements of the local line blocking for this star in the *v*- and *b*-bands. The agreement between their measurements and the observed *v*-light curve support the hypothesis that line blanketing can account for the light variability of this star. On the other hand, the existence of the λ 'null' in the region 4500 Å—5000 Å yields variations in the integrated flux of HD 188041 (Musielok 1976), which cannot be explained by the blocking and backwarming model.

L. *HD 192913=MW Vul, Si*

The first photometry of HD 192913 has been made by Winzer (1974a) in the *UBV* system. Preliminary results of the ten-colour photometry were published by Schoeneich et al. (1976b). Unfortunately, those measurements were made with HD 192518=21 Vul as the comparison star (summer season 1974). Winzer (1974a) has shown that this star is slightly variable. In the summer season 1975 HD 191747=18 Vul was used as the comparison star. The analyses of Winzer's measurements in the *V*-band together with our *V* photometry, yields the following ephemeris:

$$JD\ (V_{max}) = 2442644.3 + 16^{d}.846\ E \pm 0^{d}.008\ .$$

The results are given in Table 12 and Figure 12. In Figure 12 the 1974 data are shifted according to the mean magnitude differences between both comparison stars: HD 191747—HD 192518 = 0.130, 0.222, 0.185, 0.240, 0.285, 0.310, 0.380, 0.415, 0.450, 0.475 in the *U* ... *DR*-bands, respectively.

Acknowledgement: The authors wish to express their gratitude to Dr. Walter Fuertig for his invaluable assistance with the electronics of the observational equipment.

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