Photographic observations of DY Pegasi

Steinmetz, C.H.D.

Photographic observations of DY Pegasi, by *C. H. D. Steinmetz*.

A photographic mean light-curve of the ultra-short-period variable DY Pegasi is presented. The total weight of this mean light-curve is 154000 m⁻². The range is ᵐ·70. The mean light-curve consists of 49 normals, each with a mean error of ᵐ·017. A comparison between the light-curve of this and other ultra-short-period stars has been made.

DY Pegasi is an intrinsic variable of considerable interest because of its extremely short period (P = ᵈ·0729). It was discovered by MORGENROTH in the year 1934 [1]. The known variables with still shorter period are CY Aquarii [2] (P = ᵈ·0610), BAILEY 65 in ω Centauri [3] (P = ᵈ·0627) and VV Puppis [4] (P = ᵈ·0697). CY Aquarii and BAILEY 65 have a regular light-variation, but VV Puppis is known to be rather irregular with regard to the shape of its light-curve and its median brightness, though its period seems to be constant.

DY Pegasi was put on the program of the 13-inch photographic refractor in 1943. Agfa Astro plates of the emulsion number z 1273, 9 cm × 12 cm, were used throughout. The exposure-time was 90 seconds. This exposure-time is sufficiently short not to distort the light-curve. The observations were made intra-focally. The maximum number of exposures made on a single plate was 35, thus covering ·67 of a complete period. Care was taken not to discontinue the observations during the interval occupied by the rising branch, the most valuable part of the light-curve for the determination of the period.

In total 734 exposures were obtained in the time from 1943 July 28 to 1945 December 7, in which the star went through 11257 periods. One photovisual plate of the brand Agfa Isochrom has been taken behind a yellow filter. This plate contains two exposures of equal duration, one of which was taken with free objective, the other with a normal grating (d = l) in front of the objective.

By means of this plate two comparison stars were selected which have approximately the same colour as the variable.

The variable and the comparison stars are:

	B.D.			AHNERT [5])
Var.	+ 16°	4877	—	—
a	+ 16°	4878	$9^m.2$	$10^m.10$
b	+ 16°	4876	$9^m.3$	$10^m.73$

The plates have been measured in the Schilt photometer.

The reduction of these measurements has been performed in the following manner. The millimetre scale which as a rule has been used for the reading of the galvanometer deflections has been replaced by a scale constructed according to WESSELINK's table in *B.A.N.* No. 318, on which provisional magnitudes can be read off directly.

From 4 exposures taken with a normal objective grating (d = l) the difference in magnitude between the comparison stars *a* and *b* was found to be $1^m.00$.

For each exposure the difference in provisional magnitude between the variable and the mean of the comparison stars was determined. In order to obtain the actual difference in magnitude, this is to be multiplied by a factor depending on the gradation. This assumption that actual differences in magnitude are proportional to differences in provisional magnitude has proved very useful. Owing to changes in the seeing the gradation was not found constant for all exposures on the same plate. Therefore instead of using a mean value for all exposures on the same plate, reciprocal relative gradations $(m_{pr}(a) - m_{pr}(b))$ were calculated from the provisional magnitudes of each exposure. Since the variation of the gradation of three successive exposures was small, the gradation-factor actually used for an exposure has been the average factor for the exposure itself and for the two neighbouring exposures. In this way the influence of the accidental errors of the measures on the gradation-factors could be somewhat reduced. By doing so the resulting magnitudes of successive exposures remain practically independent of each other.

The resulting final magnitudes of the variable are given in the third column of Table 3.

The Julian Day Heliocentric Mean Astronomical Time Greenwich is given in the first column. The formula used for the reduction to the sun is:

$$- .00537\ X + .00056\ Y.$$

In this formula X and Y are the rectangular coordinates of the sun in the equatorial system.

A provisional value of the period has been derived from the present observations and from the visual observations by A. SOLOVIEV [1]. As SOLOVIEV has not published his individual observations this determination of the period is not very satisfactory. With the resulting reciprocal period, $13^{d^{-1}}.712494$, phases were computed by means of the formula:

$$\text{Phase} = 13^{d^{-1}}.712494\ (\text{J.D. Hel. M.A.T. Grw.} - 2430000).$$

From the observations with phases between $^P.02$ and $^P.15$ the slope of the linear part of the rising branch was found to be $52.92\ \text{md}^{-1}$. By means of this

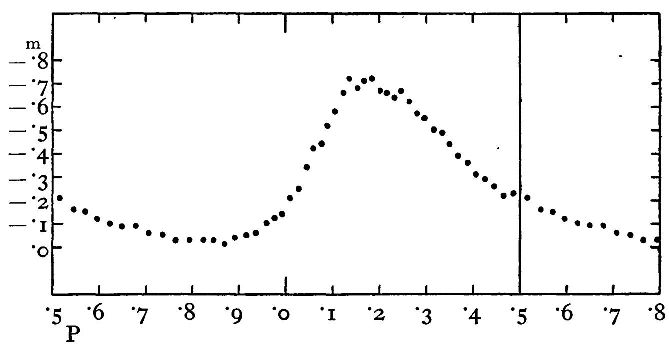
1) *A.N.* No. 6048.
2) *B.A.N.* No. 341.
3) *B.A.N.* No. 247; Leiden Annals, Vol. XVII, part 2, p. 35.
4) *B.A.N.* No. 318.
5) *B.Z.* **21**, 8, 1939.

1) Tadjik Observatory, Stalinabad; *Circular* No. 37, 1938, and No. 44, 1940.

TABLE 1

Plate	J.D. Hel. M.A.T. Grw.	E	O − C
6479	2430976·4150	0	+ ·0004
6481	0976·4882	1	+ 7
6496	0987·3531	150	− 4
6507	1001·4281	343	− 2
6543	1086·3140	1507	− 6
6551	1104·2541	1753	− 4
6604	1288·5390	4280	− 3
6607	1289·5603	4294	+ 1
6611	1290·5080	4307	− 3
6615	1306·4776	4526	− 16
6627	1314·4289	4635	+ 8
6633	1317·4191	4676	+ 10
6641	1318·4390	4690	0
6643	1318·5116	4691	− 4
6655	1320·4810	4718	0
6684	1328·5042	4828	+ 13
6692	1330·4723	4855	+ 4
6736	1671·4749	9531	− 5
6771	1797·3464	11257	+ 1

FIGURE 1



result an accurate epoch, corresponding to brightness $-^{m}\cdot38$, has been derived for each plate from the observations on the rising branch. These epochs, which are given in Table 1, have been used for a least-squares solution of the final period. The resulting ephemeris for a point on the rising branch of brightness $-^{m}\cdot38$ is:

$$2431288^{d}\cdot53932 \;+\; {}^{d}\cdot072926325\,(E - 4280)$$
$$\pm\; 16 \;\pm\; 55 \quad \text{(m.e.)}$$

The corresponding phases in the second column of Table 3 were computed by means of the formula:

Phase $= 13^{d^{-1}}\cdot712468$ (J.D. Hel. M.A.T. Grw. − 2430000).

With this value of the reciprocal period the phase of the corresponding point on the rising branch of SOLOVIEV's mean light-curve is found to be ·03 instead of ·00. This difference is so small that the new ephemeris still appears to be in harmony with all the available observations.

The 734 observations were then arranged according to phase and mean values of 15 (one with 14) were formed. They are given in Table 3 and are shown graphically in Figure 1.

Like CY Aquarii and BAILEY 65 in ω Centauri, DY Pegasi shows a regular variation in brightness, so that VV Puppis is exceptional among the variables with ultra-short period.

It is of interest to compare the mean light-curves of the three regular ultra-short-period variables just mentioned. Therefore in Figure 2 these three mean light-curves are shown together. The amplitudes of CY Aquarii and of BAILEY 65 in ω Centauri have been reduced to that of DY Pegasi, the factor applied for CY Aquarii being ·83, that for BAILEY 65 in ω Centauri being 1·56, and the curves have been shifted in ordinate and abscissa so that the maxima coincide. It is seen that the mean light-curves of DY Pegasi and of CY Aquarii show a strong resemblance; the rise and decline of the brightness seem to be somewhat

FIGURE 2

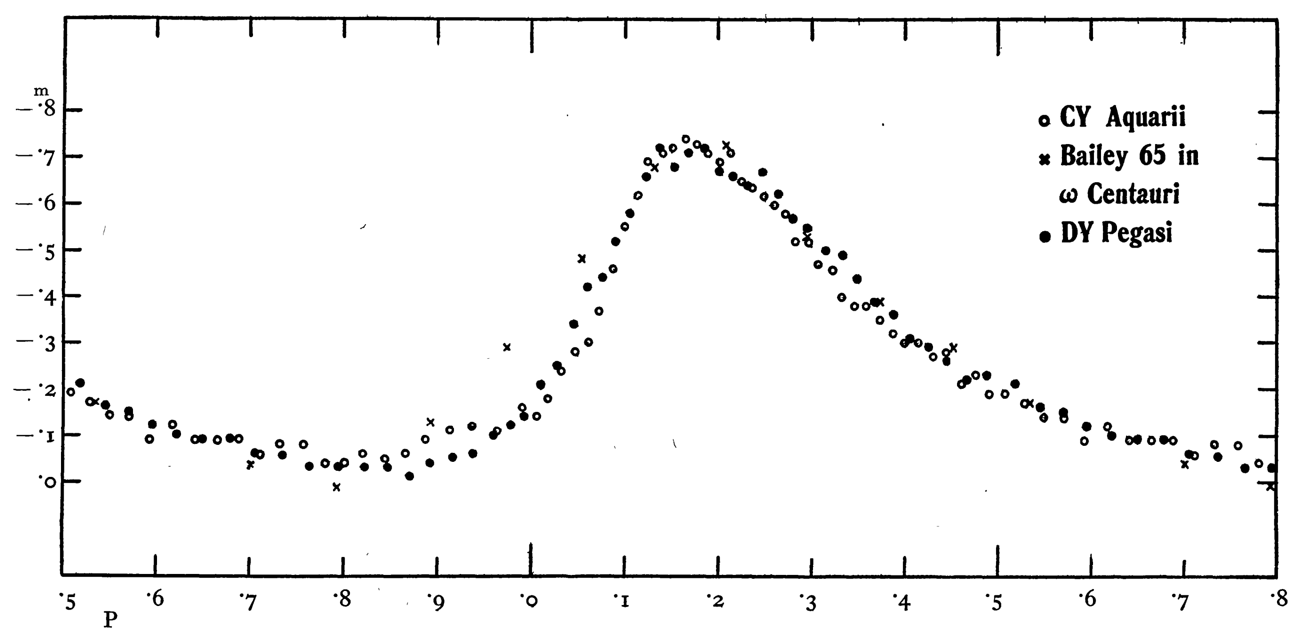


TABLE 2

mean phase	mean brightness	n	mean phase	mean brightness	n	mean phase	mean brightness	n	mean phase	mean brightness	n	mean phase	mean brightness	n
P	m		P	m		P	m		P	m		P	m	
·010	− ·21	15	·168	− ·71	15	·333	− ·49	15	·545	− ·16	15	·823	− ·03	15
·027	− ·25	15	·184	− ·72	15	·349	− ·44	15	·570	− ·15	15	·847	− ·03	15
·044	− ·34	15	·200	− ·67	15	·368	− ·39	15	·596	− ·12	15	·870	− ·01	15
·060	− ·42	15	·215	− ·66	15	·388	− ·36	15	·622	− ·10	15	·892	− ·04	15
·076	− ·44	15	·231	− ·64	15	·406	− ·31	15	·649	− ·09	15	·915	− ·05	15
·090	− ·52	15	·247	− ·67	15	·425	− ·29	15	·678	− ·09	15	·937	− ·06	15
·106	− ·58	15	·263	− ·62	15	·445	− ·26	15	·706	− ·06	15	·959	− ·10	15
·122	− ·66	15	·279	− ·57	15	·466	− ·22	15	·736	− ·05	15	·977	− ·12	15
·136	− ·72	15	·295	− ·55	15	·488	− ·23	15	·764	− ·03	15	·993	− ·14	14
·152	− ·68	15	·314	− ·50	15	·517	− ·21	15	·794	− ·03	15			

steeper in the case of CY Aquarii. On the other hand the mean reduced light-curve of BAILEY 65 in ω Centauri shows a much more gradual rise towards maximum brightness than the other two variables.

The mean error of a single observation derived from the differences in magnitude between observations following each other in phase was found to be ± m·069. Consequently the total weight of the mean light-curve is 734 × (± ·069)$^{-2}$ = 154000 m^{-2}.

The mean error of a normal point is ± m·017.

Attention may be drawn to the fact that the periods and the mean light-curves of CY Aqr and DY Peg are practically the same, whereas the spectral types of both stars are respectively B8 — A3 and F5 according to *Katalog und Ephemeriden Veränderlicher Sterne für* 1943.

I want to thank Prof. HERTZSPRUNG for his interest in my work.

TABLE 3

J. D. Hel. − 2430000	phase	Δm
plate *6449*		
d	P	m
934·5138	·491	− ·22
·5152	·510	− ·23
·5166	·529	− ·17
·5180	·549	− ·15
·5194	·568	− ·21
·5207	·586	− ·11
·5221	·605	− ·14
·5235	·624	− ·06
·5249	·643	− ·07
·5263	·662	− ·07
·5277	·682	− ·03
·5291	·701	− ·08
·5304	·719	− ·02
·5318	·738	− ·18
·5332	·757	− ·03
·5346	·776	− ·06
·5360	·795	− ·01
·5374	·815	·00
·5388	·834	− ·04
·5401	·852	− ·02
·5415	·871	+ ·02
plate *6479*		
976·4085	·971	− ·10
·4099	·990	− ·21
·4113	·009	− ·24
·4127	·028	− ·31
·4141	·047	− ·39
·4155	·067	− ·35
·4169	·086	− ·50
·4182	·104	− ·46
·4196	·123	− ·62
·4210	·142	− ·68
·4224	·161	− ·65
·4238	·181	− ·72
·4252	·200	− ·70
·4266	·219	− ·67

J. D. Hel. − 2430000	phase	Δm
d	P	m
976·4279	·237	− ·70
·4293	·256	− ·66
·4307	·275	− ·62
·4321	·294	− ·57
·4335	·314	− ·40
·4349	·333	− ·43
·4363	·352	− ·45
plate *6480*		
976·4397	·399	− ·38
·4411	·418	− ·36
·4425	·437	− ·29
·4439	·456	− ·33
·4453	·475	− ·22
·4466	·493	− ·24
·4480	·512	− ·28
·4494	·532	− ·15
·4508	·551	− ·14
·4522	·570	− ·12
·4536	·589	− ·07
·4550	·608	− ·09
·4563	·626	− ·14
·4577	·645	− ·15
·4591	·665	− ·19
·4605	·684	− ·11
·4619	·703	− ·02
·4633	·722	− ·09
·4646	·740	+ ·02
·4660	·759	− ·04
plate *6481*		
976·4730	·855	− ·02
·4743	·873	− ·04
·4757	·892	·00
·4771	·911	− ·04
·4785	·931	− ·07
·4799	·950	− ·11
·4813	·969	− ·13
·4827	·988	− ·12

J. D. Hel. − 2430000	phase	Δm
d	P	m
976·4840	·006	− ·24
·4854	·025	− ·24
·4868	·044	− ·27
·4882	·064	− ·39
·4896	·083	− ·44
·4910	·102	− ·48
·4923	·120	− ·62
·4937	·139	− ·66
·4951	·158	− ·67
·4965	·177	− ·70
·4979	·197	− ·67
·4993	·216	− ·67
·5007	·235	− ·59
plate *6496*		
987·3425	·903	− ·02
·3439	·922	− ·02
·3453	·941	− ·03
·3467	·960	− ·14
·3481	·980	− ·11
·3495	·999	− ·18
·3508	·017	− ·23
·3522	·036	− ·30
·3536	·055	− ·39
·3550	·074	− ·51
·3564	·093	− ·61
·3578	·113	− ·61
·3592	·132	− ·74
·3605	·150	− ·73
·3619	·169	− ·66
·3633	·188	− ·76
·3647	·207	− ·66
·3661	·226	− ·60
·3675	·246	− ·61
·3688	·263	− ·57
·3702	·283	− ·55
plate *6497*		
987·3744	·340	− ·52

J. D. Hel. − 2430000	phase	Δm
d	P	m
987·3758	·359	− ·41
·3772	·379	− ·39
·3785	·396	− ·39
·3799	·416	− ·28
·3813	·435	− ·29
·3827	·454	− ·18
·3841	·473	− ·26
·3855	·492	− ·26
·3869	·517	− ·17
·3896	·549	− ·17
·3908	·565	− ·14
·3917	·577	− ·16
·3931	·597	− ·20
·3945	·616	− ·11
·3959	·635	− ·09
·3972	·653	− ·04
·3986	·672	− ·10
·4000	·691	− ·10
·4014	·710	− ·02
plate *6506*		
1001·3893	·519	− ·19
·3907	·538	− ·23
·3920	·556	− ·20
·3934	·575	− ·15
·3948	·595	− ·17
·3962	·614	− ·12
·3976	·633	− ·20
·3990	·652	− ·12
·4004	·671	− ·09
·4017	·689	− ·08
·4031	·708	− ·12
·4045	·729	− ·05
·4059	·747	− ·01
·4073	·766	− ·04
·4087	·785	+ ·01
·4100	·803	− ·10
·4114	·822	− ·08
·4128	·841	− ·05
·4142	·861	− ·02

TABLE 3 *(continued)*

J. D. Hel. − 2430000	phase	Δ*m*
d	P	m
1001·4156	·880	− ·08
·4170	·899	− ·07
·4184	·918	− ·09
·4197	·936	− ·09
plate *6507*		
1001·4227	·977	− ·17
·4239	·994	− ·16
·4253	·013	− ·22
·4267	·032	− ·32
·4281	·051	− ·39
·4294	·069	− ·46
·4308	·088	− ·54
·4322	·107	− ·56
·4336	·127	− ·69
·4350	·146	− ·66
·4364	·165	− ·65
·4378	·184	− ·68
·4391	·202	− ·68
plate *6543*		
1086·3074	·956	− ·13
·3088	·975	− ·11
·3101	·993	− ·22
·3115	·012	− ·23
·3129	·031	− ·29
·3143	·051	− ·37
·3157	·070	− ·46
·3171	·089	− ·57
·3185	·108	− ·64
·3198	·126	− ·70
·3212	·145	− ·70
·3226	·164	− ·72
·3240	·184	− ·73
·3254	·203	− ·75
·3268	·222	− ·66
·3282	·241	− ·68
·3295	·259	− ·63
·3309	·278	− ·58
·3323	·297	− ·60
·3337	·317	− ·46
·3351	·336	− ·47
·3365	·355	− ·39
·3378	·373	− ·42
·3392	·392	− ·39
·3406	·411	− ·33
·3420	·430	− ·32
·3434	·450	− ·30
·3448	·469	− ·31
plate *6551*		
1104·2337	·770	− ·09
·2351	·789	− ·02
·2365	·808	− ·04
·2379	·827	− ·06
·2393	·847	− ·03
·2407	·866	− ·11
·2420	·884	− ·05
·2434	·903	− ·08
·2448	·922	− ·08
·2462	·941	− ·09
·2476	·960	− ·13
·2490	·980	− ·15
·2503	·997	− ·20
·2517	·017	− ·33
·2531	·036	− ·29
·2545	·055	− ·35
·2559	·074	− ·44

J. D. Hel. − 2430000	phase	Δ*m*
d	P	m
1104·2573	·093	− ·55
·2587	·113	− ·65
·2600	·130	− ·64
·2614	·150	− ·65
·2628	·169	− ·68
·2642	·188	− ·72
·2656	·207	− ·68
·2670	·226	− ·61
·2684	·246	− ·64
·2697	·263	− ·56
·2711	·283	− ·57
·2725	·302	− ·43
·2739	·321	− ·46
·2753	·340	− ·41
·2767	·359	− ·46
·2781	·377	− ·33
·2794	·396	− ·38
·2808	·416	− ·28
Plate *6604*		
1288·5333	·972	·00
·5346	·990	− ·17
·5360	·009	·00
·5374	·028	− ·15
·5388	·048	− ·49
·5402	·067	− ·68
·5416	·086	− ·50
·5430	·105	− ·63
·5443	·123	− ·67
·5457	·142	− ·74
·5471	·161	− ·73
·5485	·181	− ·72
·5499	·200	− ·56
·5513	·219	− ·66
·5527	·238	− ·64
·5540	·256	− ·62
·5554	·275	− ·49
·5568	·294	− ·57
plate *6607*		
1289·5182	·478	− ·28
·5195	·495	− ·37
·5209	·515	− ·23
·5223	·534	− ·13
·5237	·553	− ·25
·5251	·572	− ·27
·5265	·591	− ·11
·5278	·609	− ·15
·5292	·628	− ·01
·5306	·648	− ·19
·5320	·667	− ·04
·5334	·686	− ·22
·5348	·705	− ·03
·5362	·724	− ·19
·5375	·742	+ ·02
·5389	·761	+ ·01
·5403	·781	− ·12
·5417	·800	− ·17
·5431	·819	− ·08
·5445	·838	− ·12
·5459	·857	− ·04
·5472	·875	− ·15
·5486	·894	− ·22
·5500	·914	− ·20
·5514	·933	− ·06
·5528	·952	− ·11
·5542	·971	− ·06
·5554	·990	− ·21
·5569	·008	− ·24

J. D. Hel. − 2430000	phase	Δ*m*
d	P	m
1289·5583	·027	− ·15
·5597	·047	− ·22
·5611	·066	− ·50
·5625	·085	− ·47
·5639	·104	− ·67
·5652	·122	− ·72
plate *6608*		
1289·5701	·189	− ·65
·5715	·208	− ·62
·5729	·228	− ·65
·5742	·245	− ·73
·5756	·265	− ·71
·5770	·284	− ·54
·5784	·303	− ·57
·5798	·322	− ·41
·5812	·341	− ·51
plate *6611*		
1290·4927	·840	− ·05
·4940	·858	+ ·09
·4954	·877	+ ·13
·4968	·897	+ ·02
·4982	·916	− ·03
·4996	·935	− ·14
·5010	·954	+ ·05
·5023	·972	− ·18
·5037	·991	− ·02
·5051	·010	− ·31
·5065	·030	− ·33
·5079	·049	− ·34
·5093	·068	− ·53
·5107	·087	− ·44
·5120	·105	− ·65
·5134	·124	− ·60
·5148	·143	− ·76
·5162	·162	− ·70
·5176	·182	− ·69
·5190	·201	− ·67
·5204	·220	− ·68
·5217	·238	− ·61
·5231	·257	− ·62
·5245	·276	− ·69
·5259	·296	− ·60
·5273	·315	− ·47
·5287	·334	− ·56
·5301	·353	− ·48
·5314	·371	− ·52
·5328	·390	− ·38
·5342	·409	− ·37
·5356	·429	− ·25
·5370	·448	− ·32
·5384	·467	− ·13
·5397	·485	− ·30
plate *6614*		
1306·4564	·742	− ·08
·4577	·760	− ·06
·4591	·779	− ·08
·4605	·798	+ ·13
·4619	·818	− ·13
·4633	·837	− ·03
·4647	·856	− ·03
·4660	·874	− ·04
·4674	·893	− ·02
·4688	·912	− ·02
·4702	·931	+ ·12
·4716	·951	+ ·09

J. D. Hel. − 2430000	phase	Δ*m*
d	P	m
1306·4730	·970	− ·02
·4744	·989	− ·05
plate *6615*		
1306·4785	·045	− ·44
·4799	·064	− ·49
·4813	·084	− ·48
·4827	·103	− ·75
·4841	·122	− ·76
·4854	·140	− ·84
·4868	·159	− ·71
·4882	·178	− ·74
·4896	·197	− ·61
·4910	·217	− ·63
·4924	·236	− ·53
·4938	·255	− ·64
·4951	·273	− ·55
·4965	·292	− ·53
plate *6616*		
1306·5000	·340	− ·68
·5014	·359	− ·27
·5028	·378	− ·30
·5041	·396	− ·11
·5055	·415	− ·36
·5069	·435	− ·16
·5083	·454	− ·39
·5096	·472	− ·14
·5111	·492	− ·22
plate *6627*		
1314·4225	·978	− ·16
·4239	·996	− ·14
·4253	·015	− ·14
·4267	·035	− ·16
·4281	·054	− ·38
·4294	·072	− ·39
·4308	·091	− ·57
·4322	·110	− ·58
·4336	·129	− ·72
·4350	·148	− ·66
·4364	·168	− ·78
·4378	·187	− ·74
·4391	·205	− ·78
·4405	·224	− ·70
·4419	·243	− ·79
·4433	·262	− ·76
·4447	·281	− ·54
·4461	·301	− ·59
·4474	·318	− ·54
·4488	·338	− ·50
·4502	·357	− ·41
·4516	·376	− ·34
·4530	·395	− ·32
·4544	·414	− ·27
·4558	·434	− ·28
·4571	·451	− ·28
·4585	·471	− ·20
·4599	·490	− ·19
·4613	·509	− ·20
·4627	·528	− ·22
·4641	·547	− ·13
·4655	·567	− ·13
·4668	·584	− ·08
·4682	·604	− ·11
·4696	·623	− ·22

TABLE 3 *(continued)*

J. D. Hel. − 2430000	phase	Δm
plate *6633*		
d	P	m
1317·4000	·806	+ ·02
·4013	·824	+ ·19
·4027	·843	+ ·13
·4041	·862	+ ·09
·4055	·881	− ·05
·4069	·900	− ·05
·4083	·920	·00
·4096	·939	− ·03
·4110	·957	− ·31
·4124	·976	− ·02
·4138	·995	+ ·02
·4152	·014	− ·25
·4166	·033	− ·33
·4180	·053	− ·45
·4193	·071	− ·32
·4207	·090	− ·47
·4221	·109	− ·41
·4235	·128	− ·81
·4249	·147	− ·64
·4263	·167	− ·75
·4277	·186	− ·82
·4290	·204	− ·68
·4304	·223	− ·68
·4318	·242	− ·84
·4332	·261	− ·52
·4346	·280	− ·68
·4360	·300	− ·55
·4374	·319	− ·48
·4387	·337	− ·42
·4401	·356	− ·37
·4415	·375	− ·34
·4429	·394	− ·51
·4443	·413	− ·23
·4457	·433	− ·36
·4470	·450	− ·26
plate *6640*		
1318·4000	·518	− ·32
·4014	·538	·00
·4028	·557	− ·05
·4042	·576	− ·19
·4056	·595	− ·11
·4070	·614	+ ·02
·4084	·634	− ·05
·4097	·651	+ ·02
·4112	·672	− ·16
·4125	·690	− ·18
·4139	·709	− ·15
·4153	·728	+ ·13
·4167	·747	− ·09
·4181	·767	− ·07
plate *6641*		
1318·4229	·832	− ·13
·4243	·852	− ·09
·4257	·871	− ·10
·4271	·890	− ·11
·4284	·908	− ·01
·4298	·927	+ ·03
·4312	·946	− ·14
·4326	·965	− ·16
·4340	·984	− ·17
·4354	·004	− ·17
·4368	·023	− ·23
·4381	·041	− ·42
·4395	·060	− ·41
·4409	·079	− ·47

J. D. Hel. − 2430000	phase	Δm
d	P	m
1318·4430	·107	− ·59
·4444	·127	− ·63
·4458	·146	− ·76
·4471	·164	− ·75
·4485	·183	− ·74
·4499	·203	− ·64
·4513	·222	− ·57
·4527	·241	− ·69
·4541	·260	− ·59
·4555	·279	− ·56
·4568	·297	− ·55
·4589	·326	− ·46
·4603	·345	− ·47
·4617	·364	− ·48
·4631	·384	− ·29
·4645	·403	− ·26
·4658	·421	− ·33
·4672	·440	− ·21
·4686	·459	− ·26
·4700	·478	− ·27
plate *6643*		
1318·5143	·086	− ·53
·5157	·105	− ·59
·5171	·124	− ·75
·5185	·143	− ·70
·5199	·162	− ·75
·5212	·180	− ·71
·5226	·199	− ·80
·5240	·219	− ·80
·5254	·238	− ·85
·5268	·257	− ·61
·5282	·276	− ·71
·5296	·295	− ·48
·5309	·313	− ·63
·5323	·332	− ·50
·5337	·352	− ·54
·5350	·371	− ·40
·5365	·390	− ·39
·5379	·409	− ·36
·5392	·427	− ·29
·5406	·446	− ·24
·5420	·466	− ·20
·5434	·485	− ·20
·5448	·504	− ·29
·5462	·523	− ·14
·5476	·542	− ·31
·5489	·560	− ·11
·5503	·579	− ·13
·5517	·599	− ·15
·5531	·618	− ·12
·5545	·637	− ·13
·5559	·656	− ·11
·5573	·675	+ ·01
·5586	·693	− ·03
·5600	·712	+ ·09
·5614	·731	− ·05
plate *6654*		
1320·4238	·270	− ·69
·4252	·289	− ·57
·4265	·307	− ·60
·4279	·326	− ·55
·4293	·345	− ·46
·4321	·383	− ·48
·4335	·403	− ·30
·4349	·422	− ·27
·4363	·441	− ·30
·4376	·459	− ·17

J. D. Hel. − 2430000	phase	Δm
d	P	m
1320·4390	·478	− ·13
·4404	·497	− ·23
·4418	·516	− ·20
·4432	·536	− ·10
·4446	·555	− ·16
·4459	·573	− ·19
·4473	·592	− ·10
·4487	·611	− ·19
·4501	·630	− ·13
·4515	·649	− ·08
·4529	·669	− ·08
·4543	·688	− ·07
·4556	·706	− ·11
·4570	·725	− ·08
·4584	·744	+ ·01
·4598	·763	+ ·03
·4612	·782	− ·04
plate *6655*		
1320·4646	·829	− ·09
·4660	·848	− ·09
·4674	·867	+ ·01
·4688	·887	− ·02
·4702	·906	− ·01
·4716	·925	− ·11
·4730	·944	− ·07
·4743	·962	− ·16
·4757	·981	− ·16
·4771	·001	− ·23
·4785	·020	− ·20
·4799	·039	− ·35
·4813	·058	− ·39
·4826	·076	− ·48
·4840	·095	− ·54
·4854	·114	− ·59
·4868	·134	− ·70
·4882	·153	− ·69
·4896	·172	− ·57
·4910	·191	− ·70
·4923	·209	− ·65
·4937	·228	− ·56
·4951	·247	− ·56
·4965	·267	− ·64
·4979	·286	− ·55
·4993	·305	− ·47
·5007	·324	− ·50
·5020	·342	− ·43
·5034	·361	− ·37
·5048	·380	− ·34
·5062	·400	− ·38
·5076	·419	− ·29
·5090	·438	− ·31
·5103	·456	− ·25
·5117	·475	− ·27
plate *6674*		
1326·5621	·441	− ·21
·5635	·460	− ·15
·5649	·479	− ·23
·5662	·497	− ·24
·5676	·516	− ·23
·5690	·535	− ·18
·5704	·555	− ·13
·5718	·574	− ·13
·5732	·593	− ·05
·5746	·612	− ·03
·5759	·630	+ ·01
·5773	·649	+ ·05
·5787	·669	− ·10

J. D. Hel. − 2430000	phase	Δm
d	P	m
1326·5800	·688	− ·03
·5815	·707	− ·09
·5829	·726	− ·11
·5843	·745	− ·03
·5856	·763	+ ·01
·5870	·782	− ·02
·5884	·802	− ·05
·5898	·821	+ ·03
plate *6684*		
1328·4847	·804	+ ·01
·4861	·824	− ·10
·4874	·841	+ ·03
·4888	·861	+ ·07
·4902	·880	+ ·06
·4916	·899	− ·02
·4930	·918	− ·06
·4944	·937	− ·08
·4958	·957	− ·05
·4971	·975	− ·17
·4985	·994	− ·11
·4999	·013	− ·15
·5013	·032	− ·18
·5027	·051	− ·26
·5041	·070	− ·35
·5055	·090	− ·49
·5068	·108	− ·58
·5082	·127	− ·63
·5096	·146	− ·65
·5110	·165	− ·80
·5141	·208	− ·67
·5153	·224	− ·72
·5166	·242	− ·57
·5179	·260	− ·59
·5193	·279	− ·50
·5207	·298	− ·52
·5221	·317	− ·44
·5235	·337	− ·41
·5248	·354	− ·40
·5262	·374	− ·36
·5276	·393	− ·24
·5290	·412	− ·23
·5304	·431	− ·17
·5318	·450	− ·21
plate *6692*		
1330·4502	·756	− ·04
·4516	·776	+ ·04
·4530	·795	+ ·03
·4544	·814	+ ·02
·4557	·832	+ ·06
·4571	·851	− ·05
·4585	·870	− ·04
·4599	·889	+ ·01
·4613	·909	− ·06
·4627	·928	·00
·4641	·947	− ·14
·4654	·965	− ·13
·4668	·984	− ·14
·4682	·003	− ·22
·4696	·022	− ·29
·4710	·042	− ·25
·4724	·061	− ·39
·4738	·080	− ·46
·4751	·098	− ·49
·4765	·117	− ·59
·4779	·136	− ·68
·4793	·155	− ·56
·4807	·175	− ·60