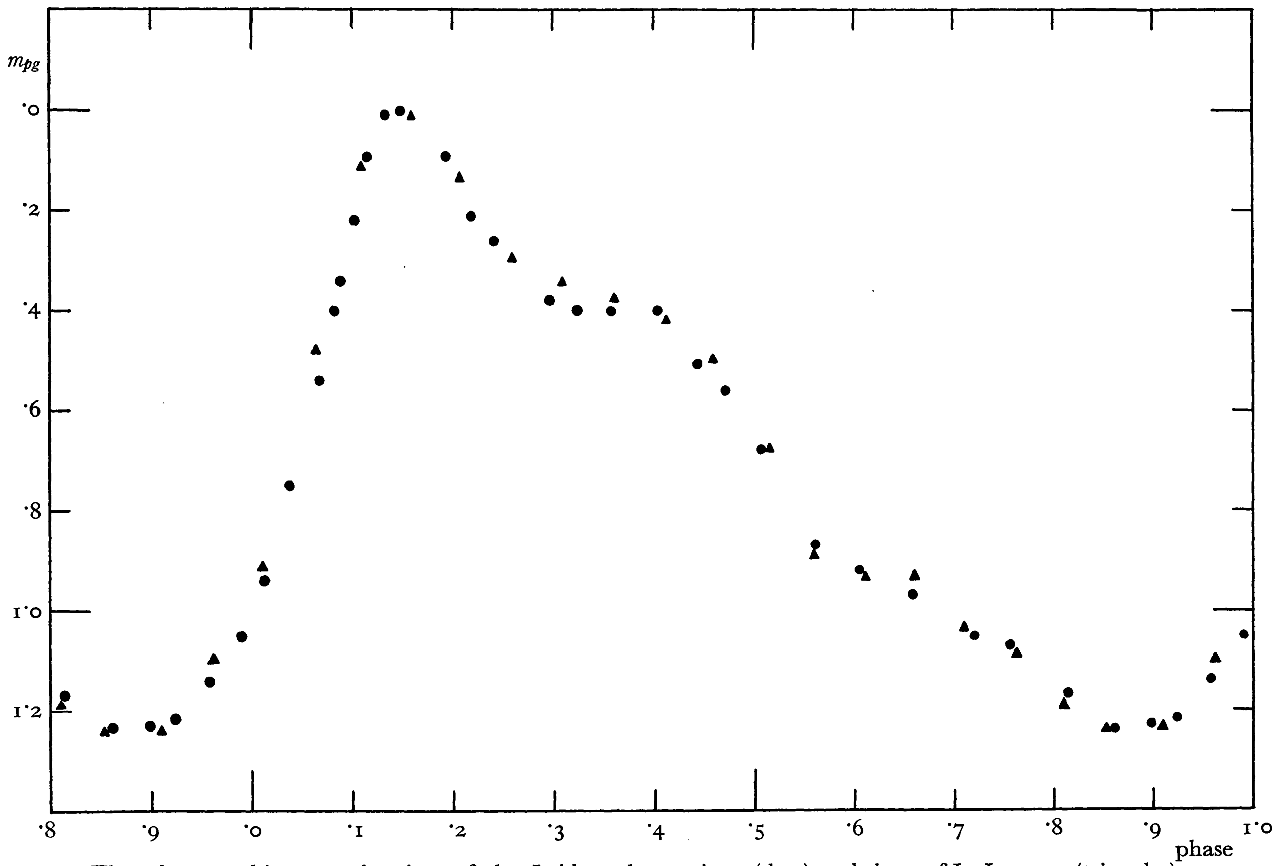
In Table 2 are given the plate number, the heliocentric Julian Day, the phase, the photographic magnitude and the number of exposures used. In Table 3 the normal points are given. In Figure 1 these normal points (dots) are plotted together with the photographic normal points of L. JACCHIA[1]) for this star (triangles); a factor ·924 has been applied to his magnitude system. According to JACCHIA the maximum brightness is $9^{m}·31$. The photographic observations of A. A. WACHMANN[1]) are somewhat less accurate but also show the horizontal part on the decreasing branch.

[1]) *Harvard Bulletin* No. 912, 20, 1940.

[1]) *A.N.* **270**, 147, 1940.

FIGURE 1



The photographic normal points of the Leiden observations (dots) and those of L. JACCHIA (triangles).

PHOTOGRAPHIC LIGHT-CURVES OF AH TAURI AND A NEW VARIABLE He 556

BY L. BINNENDIJK

The variable AH Tauri was observed photographically, together with a new variable He 556. The star AH Tauri was found to be a W Ursae Majoris variable with a period of $^{d}·33267447$; the depths of the minima are $^{m}·68$ and $^{m}·65$, respectively. The other star He 556 was discovered by the author to be a variable in 1943; it was found to have a small amplitude, namely $^{m}·4$. From the spectral type it was decided that the variable is very probably of the W Ursae Majoris type with a period of $^{d}·4126022$.

During a photometric survey of the stars in the Pleiades region a new variable was found by the author in the year 1943. This variable, He 556, together with the variable AH Tauri was observed with the 33-cm Leiden photographic refractor; both stars appear on the same plates of size 9 cm × 12 cm. According to the proper motions both stars are fieldstars.

The observations were made by the author (plates 6540 to 6788 inclusive), Dr A. BLAAUW (plates 7080 to 7098 inclusive) and Mr G. PELS (plates 7774 to

7801 inclusive). Because of the lack of plates different emulsions had to be used:

Eastman 40	Plates 6504 — 6561	J.D. 2431062 — 1144
Matter 11475	6563 — 6779	1145 — 1822
Agfa Astro 1280	6786 — 7098	1824 — 2172
Ilford Zenith	7774 — 7801	2832 — 2883

The form of the sensitivity curve is the same for Eastman 40 and Ilford Zenith[1]); the effective wave-length can be taken as μ·433. Data about Matter and Agfa Astro are not known to me. The exposure time was 9 minutes for the first three emulsions and 7 minutes for the last one.

The plates were measured in the new Schilt photometer of the Leiden Observatory by the author (plates 6540 to 7081 inclusive), Mr L. GAYKEMA (plates 7097 and 7098), Mr C. J. KOOREMAN (plates 7774 and 7780) and Mr A. D. FOKKER (plates 7775, 7782 to 7801 inclusive). In Table 1 data concerning the two variables and the six comparison stars are given. The numbers of the stars refer to HERTZSPRUNG[1]), also the right ascension and declination[2]). The photographic magnitudes, colour-indices and spectral types refer to the author's catalogue[3]). In deriving these magnitudes the grating constant ^{m}·97 was adopted.

All galvanometer readings were read off directly in provisional magnitudes on a scale made in agreement with WESSELINK's table[4]). The differences between the provisional magnitude of the variables and the mean provisional magnitude of the comparison stars were formed. These provisional magnitude differences need only be divided by the gradation to obtain magnitudes in the usual scale. A systematic correction of + ^{m}·06 was applied to the magnitudes of both stars on all plates taken during the year 1946. This correction was adopted to make the maximum brightnesses agree with those found on the plates taken in 1944 and 1948. Very probably this effect was caused by the difference in spectral sensitivity between the Matter and Agfa Astro plates on the one hand and the Eastman 40 and Ilford Zenith plates on the other hand.

The Julian Day Heliocentric Mean Astronomical Time Greenwich was computed. The reduction to the sun was read off from a graph giving the light-time as a function of the calendar date constructed after the formula:

$$\text{Reduction} = - {}^{d}{\cdot}00293\, X - {}^{d}{\cdot}00539\, Y.$$

TABLE 1

Star	α (1900)			δ			m_{pg}	C.I.	Sp.
	h	m	s	°	′	″	m	m	
471 AH	3	41	13·2	+ 24	48	26	—	+ ·50	G1p
556 var		41	37·1	25	4	38	—	+ ·55	G0
656		42	3·1	25	2	1	11·68	+ ·69	G1
602		41	47·1	24	58	38	11·86	+ ·18	F6
579		41	43·1	25	1	40	12·13	— ·05	A0
274		40	8·8	24	49	48	12·48	+ ·59	G0
489		41	21·1	24	50	0	12·56	+ ·70	G1
451		41	5·9	24	53	57	12·88	+ ·50	F8

1) *B.A.N.* **8**, 126, 1937.

1) *Mem. Danish Acad.* **4**, No. 4, 1923.
2) *Leiden Annals* **19**, part 1, 1947.
3) *Leiden Annals* **19**, part 2, 1946.
4) *B.A.N.* **8**, 331, 1939.

TABLE 2

Plate	J.D. 243	AH Tauri phase	AH Tauri m_{pg}	var. 556 phase	var. 556 m_{pg}	Plate	J.D. 243	AH Tauri phase	AH Tauri m_{pg}	var. 556 phase	var. 556 m_{pg}
	d	P	m	P	m		d	P	m	P	m
6540	1062·5251	·8883	12·33	·1805	12·41	6560	1143·3533	·8531	12·45	·0791	12·49
	·5389	·9298	12·05	·2139	12·31		·3623	·8802	12·36	·1009	12·55
	·5528	·9716	11·91	·2476	12·18	6561	1144·2972	·6904	11·82	·3668	12·13
	·5666	·0130	11·79	·2810	12·11		·3062	·7175	11·96	·3886	12·08
	·5805	·0548	11·81	·3147	12·06		·3152	·7445	12·00	·4104	12·14
	·5943	·0963	11·70	·3482	12·08		·3242	·7716	12·14	·4322	12·20
	·6082	·1381	11·77	·3819	12·07		·3422	·8257	12·41	·4758	12·16
	·6220	·1796	11·78	·4153	12·11		·3512	·8528	12·51	·4976	12·24
6552	1104·3113	·4952	11·90	·4552	12·09		·3602	·8798	12·41	·5194	12·22
	·3251	·5366	11·79	·4887	12·23		·3692	·9069	12·18	·5413	12·37
	·3390	·5784	11·81	·5224	12·21		·3782	·9339	12·02	·5631	12·41
	·3528	·6199	11·77	·5558	12·33	6563	1145·2891	·6720	11·82	·7708	12·14
	·3667	·6617	11·76	·5895	12·45		·2960	·6928	11·85	·7875	12·12
	·3805	·7032	11·80	·6230	12·54		·3030	·7138	11·90	·8045	12·11
	·3944	·7450	11·91	·6567	12·46		·3099	·7346	11·93	·8212	12·06
	·4082	·7864	12·25	·6901	12·44		·3168	·7553	12·03	·8379	12·13
6559	1142·2987	·6831	11·85	·5231	12·33		·3237	·7760	12·07	·8546	12·09
	·3076	·7098	11·92	·5447	12·40		·3307	·7971	12·18	·8716	12·09
	·3167	·7372	11·97	·5667	12·48		·3376	·8178	12·36	·8883	12·12
	·3256	·7639	12·07	·5888	12·46		·3445	·8386	12·46	·9050	12·11
	·3347	·7913	12·27	·6104	—		·3514	·8593	12·48	·9218	12·08
	·3437	·8183	12·48	·6322	—		·3584	·8803	12·36	·9387	12·10
6560	1143·2992	·6905	11·82	·9480	12·12		·3653	·9011	12·20	·9554	12·12
	·3083	·7179	11·93	·9700	12·22		·3722	·9218	12·11	·9722	12·18
	·3173	·7449	12·02	·9918	12·26		·3791	·9426	11·97	·9889	12·25
	·3263	·7720	12·09	·0136	12·29		·3861	·9636	11·92	·0059	12·23
	·3353	·7990	12·29	·0355	12·35	6777	1822·2855	·6836	11·84	·5677	12·41
	·3443	·8261	12·46	·0573	12·42		·2924	·7044	11·90	·5844	12·46

TABLE 2 (*continued*)

Plate	J.D. 243	AH Tauri phase	AH Tauri m_{pg}	var. 556 phase	var. 556 m_{pg}	Plate	J.D. 243	AH Tauri phase	AH Tauri m_{pg}	var. 556 phase	var. 556 m_{pg}
	d	P	m	P	m		d	P	m	P	m
6777	1822·2994	·7254	11·93	·6014	12·47	7097	2172·4452	·2432	12·05	·2294	12·36
	·3063	·7461	12·02	·6181	12·46	7098	·4590	·2847	12·27	·2629	12·12
	·3132	·7669	12·14	·6348	12·47		·4660	·3057	12·35	·2798	12·19
	·3201	·7876	12·25	·6515	12·49		·4729	·3264	12·43	·2966	12·15
	·3271	·8087	12·40	·6685	12·43		·4798	·3472	12·45	·3133	12·12
	·3340	·8294	12·54	·6852	12·37		·4867	·3679	12·52	·3300	12·09
6778	·3471	·8688	12·56	·7170	12·34		·4937	·3890	12·36	·3470	12·07
	·3541	·8898	12·31	·7339	12·31		·5006	·4097	12·32	·3637	12·11
	·3610	·9106	12·16	·7507	12·25		·5075	·4305	12·18	·3804	12·09
	·3679	·9313	12·03	·7674	12·22	7774	2832·5839	·5815	11·77	·1693	12·45
	·3749	·9523	11·98	·7843	12·23		·5894	·5980	11·85	·1826	12·49
	·3818	·9731	11·91	·8011	12·18		·5950	·6149	11·83	·1962	12·36
	·3887	·9938	11·85	·8178	12·11		·6005	·6314	11·81	·2095	12·42
	·3956	·0146	11·82	·8345	12·20		·6061	·6482	11·85	·2231	12·30
	·4025	·0353	11·87	·8512	12·11		·6116	·6648	11·84	·2364	12·30
	·4095	·0563	11·75	·8682	12·09		·6171	·6813	11·91	·2498	12·22
	·4164	·0771	11·74	·8849	12·10		·6227	·6981	11·88	·2633	12·16
	·4233	·0978	11·80	·9017	12·13		·6282	·7147	11·89	·2767	12·22
	·4302	·1186	11·81	·9184	12·11	7775	·6414	·7543	12·04	·3087	12·18
	·4372	·1396	11·75	·9353	12·16		·6469	·7709	12·10	·3220	12·18
6779	·4510	·1811	11·93	·9688	12·17		·6525	·7877	12·16	·3356	12·11
	·4580	·2021	11·94	·9858	12·24		·6580	·8042	12·32	·3489	12·16
	·4649	·2229	11·99	·0025	12·20		·6635	·8208	12·43	·3622	12·15
	·4718	·2436	12·14	·0192	12·35		·6691	·8376	12·49	·3758	12·09
	·4787	·2644	12·12	·0359	12·31		·6746	·8541	12·51	·3891	12·17
	·4926	·3061	12·36	·0696	12·39		·6802	·8710	12·39	·4027	12·19
	·4995	·3269	12·46	·0863	12·49		·6857	·8875	12·36	·4160	12·06
	·5064	·3476	12·46	·1031	12·46	7780	2833·5851	·5910	11·85	·5959	12·42
6786	1824·3000	·7391	12·01	·4501	12·14		·5910	·6088	11·84	·6102	12·46
	·3069	·7598	12·11	·4668	12·17		·5962	·6244	11·82	·6228	12·49
	·3139	·7809	12·33	·4838	—		·6014	·6400	11·82	·6354	12·45
	·3208	·8016	12·31	·5005	12·17		·6118	·6713	11·89	·6606	12·51
	·3277	·8223	12·44	·5172	12·28		·6170	·6869	11·95	·6732	12·50
	·3346	·8431	12·51	·5340	12·35		·6222	·7026	11·93	·6858	12·39
	·3416	·8641	12·47	·5509	12·35		·6274	·7182	12·00	·6984	12·32
	·3485	·8849	12·47	·5676	12·30		·6326	·7338	12·06	·7110	12·29
	·3554	·9056	12·19	·5844	12·34	7782	2852·4449	·2825	12·21	·3053	12·17
6787	·3692	·9471	12·07	·6178	12·42		·4525	·3053	12·31	·3237	12·21
	·3762	·9681	11·94	·6348	12·45		·4577	·3210	12·35	·3363	12·07
	·3900	·0096	11·84	·6682	12·46		·4629	·3366	12·50	·3489	12·16
	·4108	·0721	11·84	·7186	12·45		·4681	·3522	12·43	·3615	12·07
	·4177	·0929	11·80	·7354	12·30		·4733	·3679	12·42	·3741	12·15
	·4247	·1139	11·80	·7523	12·24		·4785	·3835	12·43	·3867	12·15
6788	·4524	·1972	11·88	·8195	12·06		·4837	·3991	12·19	·3993	12·11
	·4593	·2179	12·02	·8362	12·11		·4889	·4148	12·12	·4119	12·10
	·4662	·2387	12·06	·8529	—		·4941	·4304	12·09	·4245	12·21
	·4732	·2597	12·17	·8699	12·05	7783	2852·5304	·5395	11·81	·5125	12·31
7080	2118·5103	·1180	11·80	·5105	12·22		·5356	·5551	11·85	·5251	12·27
	·5172	·1388	11·81	·5273	12·21		·5408	·5708	11·78	·5377	12·33
	·5242	·1598	11·80	·5442	12·49		·5460	·5864	11·75	·5503	12·36
	·5311	·1806	11·83	·5610	12·41		·5512	·6020	11·74	·5629	12·35
	·5449	·2220	11·98	·5944	12·56		·5564	·6177	11·83	·5755	12·44
	·5519	·2431	12·05	·6114	12·63		·5616	·6333	11·77	·5881	12·44
	·5588	·2638	12·08	·6281	12·47		·5668	·6489	11·74	·6007	12·41
	·5657	·2846	12·12	·6448	12·41		·5720	·6646	11·78	·6133	12·52
	·5726	·3053	12·39	·6615	12·43		·5772	·6802	11·71	·6259	12·45
7081	·5893	·3555	12·57	·7020	12·39	7784	·5935	·7292	12·01	·6654	12·45
	·5962	·3762	12·39	·7187	12·25		·5986	·7445	11·95	·6778	12·53
	·6031	·3970	12·22	·7355	12·15		·6038	·7601	12·02	·6904	12·54
	·6100	·4177	12·19	·7522	12·16		·6090	·7758	12·02	·7030	12·48
	·6170	·4388	12·10	·7691	12·16		·6142	·7914	12·33	·7156	12·37
	·6239	·4595	12·02	·7859	12·22		·6194	·8070	12·21	·7282	12·34
	·6308	·4802	11·93	·8026	12·19		·6246	·8227	12·48	·7408	12·31
7097	2172·3759	·0349	11·90	·0615	12·34		·6298	·8383	12·48	·7534	12·21
	·3828	·0556	11·77	·0782	12·47		·6350	·8539	12·45	·7660	12·24
	·3898	·0767	11·81	·0952	12·42		·6402	·8696	12·40	·7786	12·24
	·3967	·0974	11·89	·1119	12·57	7787	2853·4862	·4126	12·26	·8290	12·12
	·4106	·1392	11·78	·1456	12·51		·4914	·4282	12·09	·8416	12·16
	·4175	·1599	11·83	·1623	12·52		·4966	·4439	11·99	·8542	12·10
	·4244	·1807	11·81	·1790	12·55		·5018	·4595	11·99	·8668	12·13
	·4313	·2014	11·90	·1957	12·47		·5070	·4751	11·96	·8794	12·12
	·4382	·2221	11·95	·2125	12·44		·5122	·4907	11·94	·8920	12·19

TABLE 2 (*continued*)

Plate	J.D. 243	AH Tauri phase	AH Tauri m_{pg}	var. 556 phase	var. 556 m_{pg}	Plate	J.D. 243	AH Tauri phase	AH Tauri m_{pg}	var. 556 phase	var. 556 m_{pg}
	d	P	m	P	m		d	P	m	P	m
7787	2853·5174	·5064	11·94	·9046	12·18	7799	2880·4949	·5992	11·78	·2884	12·14
	·5226	·5220	11·87	·9172	12·10		·5001	·6148	11·78	·3010	12·11
	·5278	·5376	11·88	·9298	12·14		·5053	·6304	11·82	·3136	12·18
	·5329	·5530	11·84	·9422	12·09		·5105	·6461	11·74	·3262	12·10
7788	·5433	·5842	11·81	·9674	12·18		·5157	·6617	11·82	·3388	12·22
	·5485	·5999	11·76	·9800	12·15		·5209	·6773	11·69	·3514	12·12
	·5537	·6155	11·77	·9926	12·24		·5261	·6929	11·82	·3640	12·13
	·5589	·6311	11·72	·0052	12·28		·5313	·7086	11·91	·3766	12·14
	·5641	·6468	11·74	·0178	12·38		·5365	·7242	11·88	·3892	12·14
	·5693	·6624	11·83	·0304	12·40		·5416	·7395	11·99	·4016	12·21
	·5745	·6780	11·84	·0430	12·44	7800	·5503	·7657	12·06	·4227	12·07
	·5797	·6936	11·86	·0556	12·39		·5552	·7804	12·14	·4346	12·06
	·5849	·7093	11·87	·0682	12·53		·5600	·7948	12·24	·4462	12·05
	·5901	·7249	11·95	·0808	12·63		·5648	·8093	12·30	·4578	12·23
7793	2864·4061	·2372	11·98	·2949	12·17		·5697	·8240	12·38	·4697	12·27
	·4113	·2528	11·97	·3075	12·12		·5745	·8384	12·43	·4813	12·19
	·4165	·2684	12·16	·3201	12·14		·5794	·8532	12·56	·4932	12·21
	·4217	·2841	12·14	·3327	12·13		·5842	·8676	12·46	·5049	12·23
	·4269	·2997	12·26	·3453	12·12		·5891	·8823	12·33	·5167	12·29
	·4321	·3153	12·35	·3579	12·08		·5939	·8967	12·31	·5284	12·28
	·4373	·3310	12·49	·3705	12·06	7801	2883·5530	·7916	12·28	·7002	12·44
	·4425	·3466	12·48	·3831	12·10		·5578	·8061	12·29	·7118	12·24
	·4477	·3622	12·33	·3958	12·16		·5842	·8854	12·48	·7758	12·28
	·4529	·3778	12·40	·4084	12·16		·5890	·8998	12·25	·7874	12·18
7794	·4629	·4079	12·16	·4326	12·17		·5939	·9146	12·11	·7993	12·03
	·4681	·4235	12·05	·4452	12·12		·5987	·9290	12·06	·8109	12·24
	·4733	·4392	11·97	·4578	12·20		·6036	·9437	11·97	·8228	12·03
	·4785	·4548	12·01	·4704	12·17		·6084	·9582	11·87	·8344	12·09
	·4837	·4704	11·89	·4830	12·20		·6133	·9729	11·95	·8463	12·09
	·4889	·4861	11·89	·4956	12·20		·6181	·9873	11·87	·8579	12·09
	·4941	·5017	11·88	·5082	12·25		·6229	·0017	11·86	·8696	12·00
	·4993	·5173	11·83	·5208	12·34		·6278	·0165	11·80	·8814	12·15
	·5045	·5330	11·75	·5334	12·28		·6326	·0309	11·79	·8931	12·15

Table 2 gives the plate number, the Julian Day, the phase (see later) and magnitude for AH Tauri and the same two data for He 556.

AH Tauri. The Julian date of each wholly observed minimum was found according to the method of HERTZSPRUNG[1]). For the determination of the epoch in the case that only one of the two branches was observed, the following procedure was adopted. With a provisional period a provisional light-curve was derived. The determination of the epoch of minimum was then made by shifting in time the provisional light-curve with respect to the observed branch, in such a way that the sum of the squares of the differences of the magnitudes between the two curves became a minimum. Weights were assigned depending on the number of observations and on the slope of the part of the light-curve covered by the observations. A least-squares solution gave:

$$\text{Min. I} = 2431822^{d}\cdot3396 + {}^{d}\cdot33267447\,(E - 2284).$$
$$\pm \quad 3 \pm \quad 12 \quad \text{m.e.}$$

The phases were computed from the formula:

$$\text{Phase} = 3^{d^{-1}}\cdot0059415\,(\text{J.D.} - 2430000).$$

In Table 3 are given the epochs of primary minimum, the number of periods elapsed, the weights and the O–C.

TABLE 3

J.D. Min. I	E	p	$O-C$
d			d
2431062·5106	0	1	− ·0005
1142·3516	240	1	− 14
1143·3511	243	1	+ 1
1144·3497	246	3	+ 6
1145·3483	249	3	+ 12
1822·3390	2284	5	− 6
1824·3357	2290	3	0
2118·7518	3175	4	− 8
2172·6451	3337	2	− 7
2832·6723	5321	2	+ 3
2852·6339	5381	2	+ 14
2864·6082	5417	3	− 5
2880·5786	5465	2	+ 15
2883·5702	5474	1	− 10

The phases of primary and secondary minimum are $^{P}\cdot8462$ and $^{P}\cdot3462$ respectively.

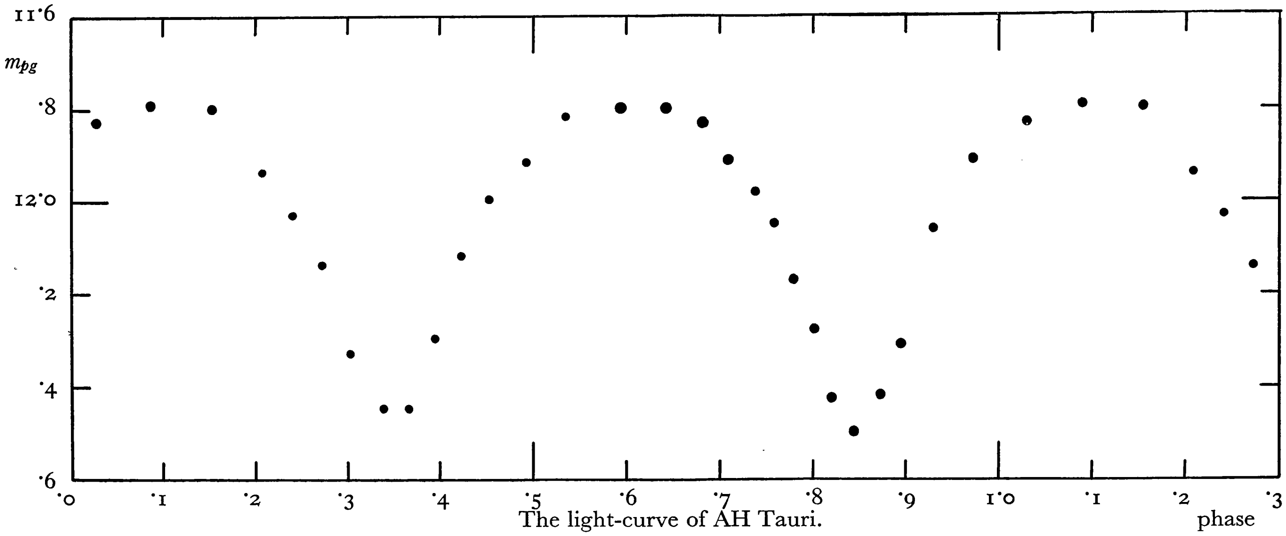
Table 4 and Figure 1 give the normal points of the light-curve, n being the number of observations in each normal point. The depths of the minima are $^{m}\cdot68$ and $^{m}\cdot65$. The mean error of a normal point, consisting of 10 exposures, is found to be $\pm\, ^{m}\cdot011$.

H. SHAPLEY and E. M. HUGHES[1]) adopted AH Tauri to be a cluster-type variable with half the present period; no light-curve was given. However, the

[1]) *B.A.N.* **4**, 179, 1928; **5**, 39, 1929.

[1]) *H.A.* **90**, 168, 1934.

FIGURE 1



The light-curve of AH Tauri.

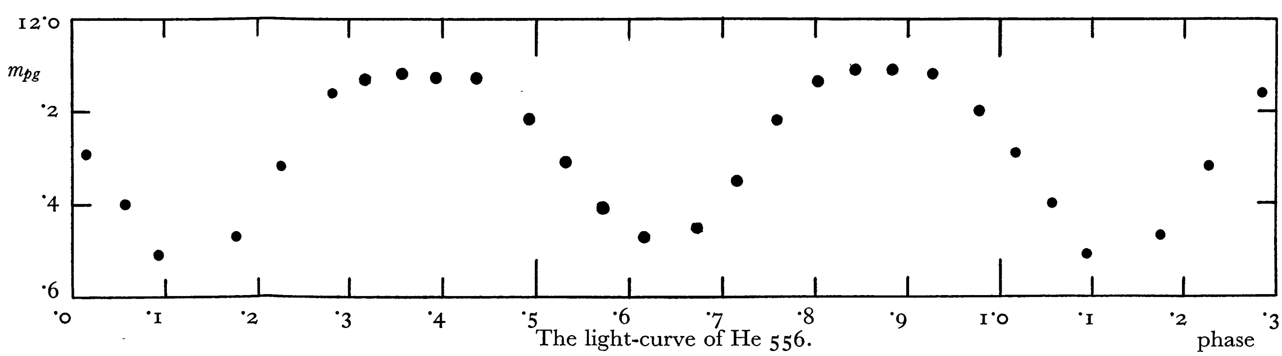
spectral type G1 is rather late for a cluster-type variable. Further we find a small difference of $^{m}\cdot 03$ between the depths of the two minima and therefore it appears proper to consider AH Tauri a W Ursae Majoris-type star.

He 556. The amplitude of the light-variation is only $^{m}\cdot 4$ and from the photometric data alone no decision can be reached whether the variable is of the cluster type or of the W Ursae Majoris type (Figure 2). In the first case the increasing branch seems to be a little steeper than the decreasing branch, whereas in Figure 2 the minima seem to indicate a very small difference in depth. However, the use of different emulsions during the observing period may be the reason for both effects.

TABLE 4

Phase	m_{pg}	n	Phase	m_{pg}	n
P	m		P	m	
·0267	11·83	10	·5934	11·80	15
·0898	11·79	10	·6403	11·80	15
·1535	11·80	10	·6806	11·83	15
·2063	11·94	7	·7107	11·91	15
·2402	12·03	7	·7373	11·98	10
·2725	12·14	7	·7588	12·05	10
·3032	12·33	7	·7810	12·17	10
·3337	12·45	7	·8001	12·28	10
·3614	12·45	7	·8216	12·43	10
·3949	12·30	7	·8423	12·48	10
·4225	12·12	7	·8723	12·42	10
·4523	12·00	7	·8946	12·31	10
·4908	11·92	7	·9304	12·06	10
·5341	11·82	7	·9712	11·91	9

FIGURE 2



The light-curve of He 556.

The spectral type is Go. A special spectral plate for this star was taken at the McDonald Observatory by Dr W. P. BIDELMAN. He confirmed the late spectral type and found rather broad lines. The broadening of the lines is probably due to rotation of the star, orbital revolution or both. From this spectroscopic evidence it is very probable that the variable is of the W Ursae Majoris type and we will consider this case from now on.

The Julian dates of minima were found in the same way as for the other variable and are given in Table 5. A least-squares solution gave for the epoch of the principal minimum (phase $^{P}\cdot 1343$):

$$\text{Min. I} = 2431822^{d}\cdot 5193 + {}^{d}\cdot 4126022\,(E_I - 1842).$$
$$\pm\ 15 \pm\ 9 \quad \text{m.e.}$$

The phases were computed from the formula:

$$\text{Phase} = 2^{d^{-1}}\cdot 423642\,(\text{J.D.} - 2430000).$$