A PHOTOMETRIC INVESTIGATION OF THE SHORT-PERIOD ECLIPSING BINARY, NOVA DQ HERCULIS (1934)

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ABSTRACT

Nova DQ Her (1934) has been found to be an eclipsing binary having the shortest known period, 4^h39^m During 1954, 1530 photoelectric observations of the system in three colors were obtained with the 100-inch Mount Wilson reflector. They indicate that, like UX UMa, the light-curve is of the Algol type, primary eclipse is partial, and no secondary eclipse is visible. Unlike UX UMa, the depth of primary decreases with decreasing wave length Other similarities to UX UMa include a minimum in the light-curve at 0 7*P*, occasional shoulders before and after eclipse, asymmetry of the rising branch of the eclipse-curve, and irregular intrinsic variations A unique feature of the light-curve of DQ Her is the occurrence between phases 0 110*P* and 0 325*P* of rapid variations in light having a period of 1 180 minutes and a range of 0 07 mag in the ultraviolet.

Provisional photometric elements have been derived for the system. The radii of the stars are about 0 10 $R_\odot$, while their masses are abnormally low, about $6 \times 10^{-3}\ m_\odot$. It is possible that the low mass of the secondary star results from various observational errors and that the star is actually a normal M-type dwarf However, unless the system is so abnormal that the photometric elements have no meaning, the mass of the nova component must be very much less than the usually assumed value of 1 5 $m_\odot$ The resemblances between the light-curves of DQ Her and UX UMa suggest that the peculiarities of both systems may be explained by a similar model

During the course of a program of photoelectric observations of old novae, the writer found that Nova DQ Her (1934) is an eclipsing binary with the shortest known period, 4^h39^m. A preliminary discussion of this system has appeared elsewhere (Walker 1954); the present paper gives a detailed analysis of the observations of the star secured during 1954.

Photometric observations of DQ Her were secured on six nights with a photoelectric photometer attached to the 100-inch Mount Wilson reflector. The photometer, filters, and technique of observation have been described previously (Walker and Herbig 1954). On the first night, July 9, the star was monitored for about 15 minutes in ultraviolet light in connection with the program of detecting short-period light-variations in old novae. These first observations indicated that DQ Her was rapidly variable in what appeared to be a nearly periodic manner, the average period of the fluctuations being about 1 minute. This was a rather surprising result, since the rapid light-variations found in other old novae all appear to be random. Consequently, DQ Her was reobserved on July 31 in order to confirm both the reality and the periodic nature of its light-variations; during the course of these observations the binary nature of the star was discovered. As on July 9, the star was monitored continuously in ultraviolet light; on all subsequent nights, yellow, blue, and ultraviolet light-curves were obtained. On July 31, owing to the fact that the star was monitored continuously, adequate comparison-star readings were not obtained. Comparison-star measuremnets are also lacking on August 1, since only a short run was obtained before the sky clouded over. On both these nights, the observations were reduced to no atmosphere by using average extinction coefficients and the readings of the standard radium source to correct for the drift in the sensitivity of the apparatus; an arbitrary zero point of the resulting magnitudes was adopted.

On the three remaining nights, DQ Her was referred to near-by comparison stars,

* Carnegie fellow, 1952–1954

TABLE 1

YELLOW OBSERVATIONS

Helioc JD 2434000+	Helioc Phase	Δ Mag	Helioc JD 2434000+	Helioc Phase	Δ Mag	Helioc JD 2434000+	Helioc Phase	Δ Mag
955 6869	0 8330	-0 044	983 7078	0 5524	+3 716	984 6652	0 4970	+3 601
6898	.8480	+0 028	7092	5596	+3 722	6653	4976	+3 646
6913	.8557	+0 000	7103	5653	+3 705	6655	4986	+3 649
.6921	8598	-0 013	7117	5725	+3 757	6657	4996	+3 629
6944	.8717	-0 021	7193	6118	+3 760	6669	5058	+3 651
6947	.8733	+0 014	7230	6309	+3 771	6734	5394	+3 651
6957	8784	+0 031	7342	6887	+3.764	6746	5456	+3 725
6967	8836	+0 024	7358	6970	+3 724	6751	5482	+3 672
6976	8882	-0 031	7373	7047	+3 743	6793	5699	+3 723
6988	8944	-0 003	7416	7269	+3 764	6809	5781	+3 704
6997	8991	+0 022	7431	7347	+3 741	6831	5895	+3 719
7006	9037	+0 092	7516	7786	+3 667	6848	5983	+3 745
7015	9084	+0 045	7532	7868	+3 676	6900	6251	+3 756
7017	9094	+0 104	7573	8080	+3 654	6966	6592	+3 764
7044	9234	+0 113	7592	8178	+3 633	6987	6701	+3.757
.7056	9296	+0 186	7607	8256	+3 645	7036	.6954	+3 817
7065	9342	+0 286	7618	8313	+3 661	7109	7331	+3 750
7074	9389	+0 384	.7628	.8364	+3.624	7126	7418	+3 770
7085	9445	+0 422	.7641	8431	+3 647	7145	7517	+3 749
7093	9487	+0 567	7684	8653	+3 666	7161	7599	+3 769
7106	9554	+0 690	7703	8752	+3 644	7164	7615	+3 800
7118	9616	+0 746	7731	.8896	+3 657	7192	7759	+3 815
7128	9667	+0 874	7745	8968	+3 654	7249	8054	+3 665
7138	9719	+0 976	7793	9216	+3.763	7262	.8121	+3 678
7149	9776	+1 066	7802	9263	+3.803	7275	8188	+3 662
7159	9828	+1 177	7806	9284	+3 863	7280	.8214	+3 746
7169	9879	+1 257	7819	9351	+3 917	7294	8286	+3 691
7181	9941	+1 327	7821	9361	+3 983	7354	8596	+3 671
7190	.9988	+1 359	7831	9413	+4 071	7371	8684	+3 694
.7203	0055	+1 309	7842	9469	+4 161	7390	8782	+3 649
7217	0127	+1 149	7853	9526	+4 295	.7407	.8870	+3 708
7248	0287	+0 958	7867	9599	+4 440	7423	8952	+3 710
7262	0360	+0 821	.7878	.9655	+4 625	7430	.8989	+3 720
7275	0427	+0 661	7908	9810	+4 833	.7445	.9066	+3 770
.7287	0489	+0 534	7919	9867	+4 958	7475	9221	+3 829
7299	0551	+0 491	7933	9939	+5 097	7493	9314	+3 963
7310	0607	+0 415	7946	.0007	+5 007	.7505	9376	+4 047
7322	0669	+0 329	7959	0074	+5 011	7520	9453	+4 158
7333	0726	+0 263	7973	0146	+4 891	7534	9526	+4 247
7344	0783	+0 186	.7995	0260	+4 763	.7550	9608	+4 471
7359	0860	+0 167	.8006	.0316	+4 683	7564	9681	+4 561
7371	0922	+0 054	.8018	0378	+4 483	.7584	9784	+4 640
7383	0984	+0 063	8037	.0477	+4 284	7595	9841	+4 794
7395	1046	+0 003	8049	.0539	+4 182	.7607	9903	+4 879
7408	1114	+0 025	8063	.0611	+4 098	7618	9960	+4 944
7420	1176	-0 076	8078	.0688	+3 999	7630	0021	+4 913
7424	1196	+0 024	8090	0750	+3.905	7644	0094	+4 902
7432	1238	+0 014	8110	.0859	+3 838	.7658	.0166	+4 831
7470	1434	-0 025	8126	0936	+3 743	7673	.0244	+4.760
7482	1496	+0 042	8131	.0962	+3 676	7687	0316	+4 661
7497	1573	+0 007	8147	.1045	+3 640	7690	0331	+4 586
7509	1635	+0 016	8159	1107	+3 626	7743	0605	+4 194
7522	1702	-0 009	8184	1236	+3 606	7756	0672	+4 067
7531	1749	+0 026	8190	1267	+3 541	7766	0724	+3 974
7541	1800	+0 035	8202	1329	+3 597	7781	0801	+3 936
7553	1862	-0 001	8205	1344	+3 529	7793	0863	+3 899
7569	1945	-0 012	8221	.1427	+3 519	7804	0920	+3.771
7582	2012	-0 012	8238	1515	+3 520	7807	.0936	+3 814
7591	2059	-0 002	8266	.1659	+3 634	7818	0992	+3 745
7598	2095	+0 018	8269	1675	+3 540	7821	.1008	+3 786
.7607	2141	+0 008	8287	1768	+3 576	7834	1075	+3 722
7617	2193	+0 000	8308	1876	+3 582	7848	1147	+3 734
7628	2250	+0 006	8328	.1980	+3 574	7864	1230	+3.736
7664	2436	-0 019	8440	2558	+3 658	7902	.1426	+3 622
7679	2513	+0 011	8462	2672	+3 654	7905	1442	+3 707
7690	2570	+0 001	8568	3219	+3 580	7918	1509	+3.662
7726	2756	-0 022	8571	3235	+3 656	7932	.1581	+3 684
7759	2926	-0 029	8589	3327	+3 596	7946	1654	+3 765
983 6783	4000	+3 541	8604	3405	+3 584	7959	1721	+3 714
6787	4021	+3 521	8676	3777	+3.550	.7973	1793	+3 735
.6790	4036	+3 536	8693	3865	+3 582	7989	1876	+3 737
6794	4057	+3 597	8710	3952	+3 565	8005	.1958	+3 743
6797	4072	+3 562	8724	4025	+3 550	8009	1979	+3 666
.6810	4139	+3 610	8731	4061	+3 584	8041	.2144	+3 729
6863	4413	+3 600	8801	4422	+3.614	8057	2227	+3 708
6885	4527	+3 582	8821	.4526	+3 630	8146	.2686	+3 679
.6905	4630	+3 592	8846	4655	+3 592	8163	2774	+3 686
.7015	5198	+3 684	984 6648	.4950	+3 569	8265	3301	+3 712
7031	5281	+3.670	6650	0.4960	+3 534	8280	0 3379	+3 673
7061	0 5436	+3 683						

TABLE 1

YELLOW OBSERVATIONS

Helioc JD 2434000+	Helioc Phase	Δ Mag.
984.8300	0 3482	+3.691
.8318	.3575	+3 691
8334	.3657	+3.646
.8386	.3926	+3.617
8405	.4024	+3.606
.8425	.4127	+3.664
.8441	.4210	+3.661
.8457	4293	+3.680
8471	.4365	+3.649
8516	4597	+3 681
8536	4701	+3.686
8552	.4783	+3.699
.8624	5155	+3 699
.8643	.5253	+3.749
.8662	.5351	+3.762
.8721	.5656	+3.780
.8748	.5796	+3.810
.8810	.6116	+3.827
985.6737	.7056	+3 820
.6757	7160	+3.812
.6806	.7413	+3.774
6826	7516	+3.754
.6875	7769	+3.769
.6956	.8187	+3.716
6970	.8260	+3.694
.6974	8280	+3.655
.6992	8373	+3.638
.7060	.8725	+3.640
7072	.8787	+3.593
.7084	.8849	+3.616
.7096	8910	+3 635
7106	.8962	+3.686
7118	.9024	+3.705
7133	.9102	+3.714
.7147	.9174	+3.782
.7186	.9375	+3.893
.7200	.9448	+4 005
.7211	.9504	+4.079
7225	9577	+4.213
7238	9644	+4.345
7250	.9706	+4 574
.7262	.9768	+4.675
.7278	.9850	+4.928
.7293	.9928	+5 022
7305	.9990	+5.121
.7318	0057	+4.974
.7331	.0124	+4 884
.7348	.0212	+4 748
.7375	.0351	+4 518
.7390	.0429	+4 334
.7404	.0501	+4.258
7421	0589	+4.146
7437	0672	+3.961
7452	0749	+3.847
.7466	.0821	+3.860
.7480	.0894	+3.797
.7484	.0914	+3.746
.7500	.0997	+3.659
.7516	1080	+3.693
.7527	.1136	+3.682
.7540	.1204	+3.731
.7552	1266	+3 660
.7565	1333	+3 641
7577	.1395	+3 658
.7609	1560	+3.602
.7626	1648	+3.602
.7732	.2195	+3 574
7745	.2262	+3.622
7759	.2335	+3.727
.7773	.2407	+3 684
.7787	.2479	+3.734
.7803	.2562	+3.722
7842	2763	+3.650
7856	.2836	+3.610
7869	2903	+3.623
7891	.3016	+3.629
.7956	.3352	+3.673
.7973	3440	+3.658
.7987	.3512	+3,640
.8032	3745	+3 615
.8043	0.3801	+3.578

TABLE 2

BLUE OBSERVATIONS

Helioc JD 2434000+	Helioc Phase	Δ Mag	Helioc JD 2434000+	Helioc Phase	Δ Mag
955.6873	0.8350	-0.019	983 7068	0.5472	+3.201
6876	.8366	-0.059	7084	5555	+3.209
6901	.8495	-0.055	.7096	.5617	+3 191
.6916	8573	-0.050	.7107	5673	+3.221
.6922	.8604	-0 046	.7122	.5751	+3.249
6925	.8619	-0 096	7198	.6143	+3.207
.6950	.8748	-0.045	.7235	.6334	+3.207
6960	.8800	-0 050	.7346	.6908	+3.248
6969	8846	-0.045	7363	.6996	+3.212
.6978	.8893	-0.044	.7377	7068	+3.213
6991	8960	-0.065	.7408	.7228	+3.219
.7001	.9012	-0 022	7421	.7295	+3.229
.7009	.9053	-0.012	.7434	.7362	+3.214
7019	.9104	+0.019	7521	.7812	+3.099
.7047	9249	+0.081	.7537	7894	+3.119
7058	.9306	+0.112	7562	.8023	+3.119
7067	.9352	+0 232	7578	.8106	+3.068
.7077	.9404	+0.311	.7598	.8209	+3.031
.7087	.9456	+0 412	7612	8282	+3.076
7096	9502	+0.462	.7621	.8328	+3 041
7101	.9528	+0 500	7633	8390	+3.049
7111	9580	+0 562	7644	8447	+3.049
.7120	.9626	+0.633	7674	.8602	+3 086
.7131	.9683	+0.693	7692	.8695	+3.046
.7141	.9735	+0.810	7737	.8927	+3.019
7151	.9786	+0 873	7752	.9005	+3.052
7163	9848	+0.924	.7778	.9139	+3.107
.7173	9900	+0.984	.7795	9227	+3.186
7183	.9952	+1.040	.7809	.9299	+3.195
.7194	.0008	+1.045	7825	.9382	+3.324
7210	.0091	+1.005	.7835	9433	+3.445
7220	.0153	+0 954	.7844	.9480	+3.547
7242	0256	+0.819	.7857	.9547	+3.612
.7250	.0298	+0.784	7871	9619	+3.789
.7267	.0385	+0 648	.7883	9681	+3 880
.7279	0447	+0 533	.7903	.9785	+3.976
7291	.0509	+0 433	7912	9831	+4 026
.7301	.0561	+0 394	7923	9888	+4.086
.7314	0628	+0.298	7938	.9965	+4.158
.7326	.0690	+0.279	.7951	.0032	+4 147
7336	0742	+0.200	.7964	.0100	+4 210
.7349	0809	+0.140	.7976	.0162	+4.049
.7363	.0881	+0.072	.7999	.0280	+3.951
.7374	.0938	+0.058	8009	0332	+3.915
7376	.0948	+0.103	.8026	0420	+3.743
7386	.1000	+0 022	.8040	.0492	+3.600
7399	.1067	+0.041	8051	.0549	+3.526
.7410	1124	+0 039	.8067	0632	+3.418
.7413	.1139	-0 031	.8082	.0709	+3.279
.7426	1207	-0 009	8094	.0771	+3.304
.7435	1253	+0 002	8099	0797	+3.276
7462	.1392	-0.003	.8117	0890	+3 182
.7474	1454	+0.012	.8134	.0978	+3.099
.7483	1501	+0 044	.8151	1065	+3.066
.7486	1516	-0.005	.8164	.1132	+3.026
7501	1594	-0 006	8167	.1148	+3 086
7511	1646	-0 011	.8171	.1169	+3 025
7524	1713	+0 003	.8193	.1282	+3.051
.7535	1769	-0 018	.8210	.1370	+3.015
.7544	.1816	-0.008	.8227	.1458	+3.014
7560	.1899	+0.003	.8242	.1535	+3.054
7573	1966	+0.014	8273	.1695	+3.069
7584	.2023	-0.008	.8290	.1783	+3.059
.7592	.2064	-0 009	8295	.1809	+3 003
.7600	.2105	+0.014	8311	.1892	+3.009
7610	.2157	+0.003	.8315	1912	+3.047
.7621	.2214	+0 013	.8333	.2005	+3.069
.7633	.2276	-0 004	.8450	.2610	+3.105
7655	2389	+0.014	.8469	.2708	+3.081
.7669	.2462	+0.011	8575	.3255	+3.065
.7683	.2534	+0.000	.8592	.3343	+3.051
.7695	.2596	+0.001	.8681	.3803	+3.062
7731	2782	+0.014	.8697	.3885	+3.065
.7764	.2952	-0 007	.8716	.3983	+3.076
983 6828	4232	+3.058	.8739	.4102	+3.073
.6870	.4449	+3.077	.8780	.4314	+3.117
6894	.4573	+3.070	.8807	.4453	+3 096
6910	.4656	+3.072	.8856	.4706	+3 074
7019	.5219	+3.161	984.6660	.5012	+3.103
7037	.5312	+3.168	.6675	5089	+3.163

TABLE 2

BLUE OBSERVATIONS

Helioc JD 2434000+	Helioc Phase	Δ Mag	Helioc JD 2434000+	Helioc Phase	Δ Mag
984 6723	0 5337	+3 193	984 8431	0 4158	+3.144
6739	5420	+3.165	8445	4231	+3 105
6755	5502	+3 195	.8462	4319	+3 121
6779	5626	+3 215	8476	.4391	+3 099
6796	5714	+3 227	8505	.4541	+3 153
6815	5812	+3 219	.8522	4628	+3 165
6836	5921	+3 237	.8541	.4727	+3 166
6855	6019	+3 227	8558	4814	+3.167
6889	6194	+3 258	8630	.5186	+3 187
6973	6628	+3 255	.8649	5289	+3.209
.6994	6737	+3 234	.8668	5382	+3 240
.7023	6887	+3 269	8704	5568	+3.257
7113	7351	+3 199	8729	5697	+3 258
7132	7449	+3 167	8756	5837	+3 272
7149	7537	+3.205	8815	6142	+3.271
7175	7672	+3 205	985 6744	7093	+3.318
7198	7790	+3 199	6762	7185	+3 285
7238	7997	+3 125	6793	.7346	+3.257
7252	8069	+3 064	6814	7454	+3.266
7266	8142	+3 086	6832	.7547	+3 246
7284	8235	+3 102	6862	7702	+3 170
7300	.8317	+3.097	6961	8213	+3 144
7358	.8617	+3.092	.6980	8311	+3.095
7375	8704	+3.092	6996	.8394	+3 113
7378	8720	+3 125	7065	8750	+3 062
7397	.8818	+3.083	7077	8812	+3.045
7412	.8896	+3 100	7088	8869	+3 031
7434	9009	+3.113	7100	8931	+3.079
7450	9092	+3.147	7110	.8983	+3 113
7480	9247	+3.220	7123	.9050	+3.089
7495	9324	+3.315	7139	9133	+3.106
7508	9391	+3.442	7151	.9195	+3.190
7524	9474	+3 520	.7175	.9318	+3.263
7540	9557	+3 625	7191	9401	+3 294
7555	9634	+3 768	.7203	.9463	+3 395
7571	9717	+3 847	7216	.9530	+3.469
7588	9805	+3 936	7230	.9603	+3.612
7599	9861	+4 023	7243	.9670	+3.736
7611	9923	+4.069	7255	.9732	+3.857
7623	9985	+4 057	.7265	9783	+3 949
7634	0042	+4.084	7268	.9799	+4 077
7648	.0114	+4.044	7284	.9881	+4 082
7661	0182	+4 012	7296	.9943	+4 160
7678	0269	+3 961	7309	.0011	+4 119
.7696	0362	+3 829	7321	.0073	+4 117
7722	0497	+3 601	7336	0150	+4 011
7734	0559	+3.557	7363	0289	+3.913
7746	0621	+3.464	7367	0310	+3.792
7759	.0688	+3.406	7380	0377	+3 735
.7772	0755	+3 336	7396	0460	+3 657
7786	0827	+3.312	.7407	.0517	+3.617
7796	.0879	+3.263	7411	.0537	+3.537
7811	.0956	+3 200	7412	.0543	+3.502
7825	1029	+3.203	7425	0610	+3.484
.7838	.1096	+3 168	7429	0630	+3.389
.7854	.1178	+3 179	7441	.0692	+3.339
7869	1256	+3.157	7456	0770	+3 276
7890	1364	+3 197	7471	0847	+3.228
.7891	1369	+3.127	7488	.0935	+3 208
7893	1380	+3.073	7506	.1028	+3.129
.7907	1452	+3 111	7521	.1106	+3 153
.7923	1535	+3 135	7530	.1152	+3.172
7939	.1617	+3 195	.7543	1219	+3.140
.7951	.1679	+3.150	7557	.1291	+3.097
7961	.1731	+3.191	.7570	1359	+3.128
7980	.1829	+3.180	7582	.1421	+3.104
7995	1907	+3 187	7613	1581	+3.061
.8013	2000	+3.201	7630	.1668	+3.076
8045	2165	+3.201	7633	.1684	+3.034
8067	2278	+3.155	7737	2221	+3 071
8152	2717	+3 133	7751	2293	+3.129
.8168	2800	+3.156	.7765	.2366	+3.140
8270	.3327	+3 170	.7779	.2438	+3 175
8286	3410	+3 170	7793	.2510	+3 213
8307	3518	+3 135	7807	2583	+3 200
.8324	3606	+3 107	7848	.2794	+3.082
8341	3694	+3.138	.7861	.2861	+3.084
.8374	3864	+3.077	7895	.3037	+3 084
8393	.3962	+3 099	7961	3378	+3.120
8409	0 4045	+3.101	7979	.3471	+3 124
			7992	3538	+3.098
			.8022	.3693	+3.084
			8036	0.3765	+3.072

TABLE 3

ULTRAVIOLET OBSERVATIONS

Helioc JD 2434000+	Helioc Phase	Δ Mag
954 7106	0 7907	+0.001
7120	7979	-0 013
7127	8016	-0 014
7134	8052	-0 001
7137	8067	-0 016
7141	8088	+0 024
7144	8103	-0.018
7148	8124	-0 006
7151	8139	+0 007
7155	8160	-0.017
7158	8175	+0 027
7162	8196	-0 030
7165	8212	+0 014
7169	8232	+0 014
7172	8248	+0 008
7176	8268	-0 002
7179	8284	-0.005
7183	8305	+0 007
.7186	8320	+0 006
7190	8341	+0.022
7193	8356	+0 009
7197	8377	-0 005
7200	8392	-0.013
7204	.8413	-0 014
7207	.8428	+0 007
7210	8444	+0 008
7212	8454	-0 042
.7216	8475	+0 006
7220	8056	+0.003
7224	8516	-0 007
7227	8532	-0 014
7231	8552	+0 010
7234	8568	-0.022
7238	8589	-0 045
7241	8604	-0 062
.7245	8625	-0 060
.7248	.8635	-0 055
.7252	.8661	-0 050
.7255	8676	-0 053
.7259	8697	-0 062
.7262	.8713	-0 070
7266	8733	-0.042
.7269	.8749	-0 107
7273	8769	-0 072
.7287	.8842	-0 091
7290	8857	-0 102
7294	8878	-0 117
,7297	8893	-0.066
7301	.8914	-0 062
7304	.8929	-0.056
7308	8950	-0.048
7311	8966	-0 064
7315	.8986	-0.055
.7318	.9002	-0 095
7322	9022	-0.072
7325	9038	-0.047
7327	.9048	-0.097
7329	9059	-0 077
7332	9070	-0 056
7335	9090	-0 043
.7338	.9105	-0.023
7342	.9126	-0 022
7346	9146	-0 012
.7349	9162	-0 012
.7350	.9167	-0.044
7352	9177	-0.027
7356	9198	-0.023
7360	.9219	-0.004
7363	.9234	+0.018
7366	.9250	+0.034
7370	.9270	+0 058
7374	.9291	+0 078
7379	9317	+0.097
.7387	9358	+0 152
.7391	9379	+0 156
7394	9394	+0 194
7398	.9415	+0 209
7402	.9436	+0.247
.7405	.9451	+0 277
.7419	0.9523	+0 344

TABLE 3

ULTRAVIOLET OBSERVATIONS

Helioc JD 2434000+	Helioc Phase	Δ Mag.	Helioc JD 2434000+	Helioc Phase	Δ Mag.	Helioc JD 2434000+	Helioc Phase	Δ Mag
954 7422	0 9539	+0.387	954.7870	0 1853	-0.019	954.8231	0 3717	+0.129
7426	.9560	+0.402	7875	.1879	+0.025	8234	.3733	+0.206
7430	9580	+0 417	7880	1904	-0.023	8238	.3753	+0.280
7433	9596	+0.437	7884	1925	+0 002	8242	.3774	+0 306
7436	9611	+0.467	7888	1946	-0.038	8245	3789	+0 308
7440	9637	+0 476	7891	.1961	-0 015	8248	3805	+0.104
.7443	9647	+0 523	7896	1987	-0 063	.8256	3846	+0 216
7450	9684	+0 550	7900	2008	-0 020	.8259	3862	+0 081
7464	.9756	+0 636	7905	2033	-0.076	8266	.3898	+0 128
7467	9771	+0.666	.7908	.2049	-0 061	8271	3924	+0.173
.7470	.9787	+0.686	.7912	2070	-0.091	.8273	.3934	+0 101
7474	.9807	+0.708	7913	2075	-0.043	8276	.3950	+0 220
7565	0277	+0 641	7918	2101	-0 049	8281	.3975	+0 154
7568	0293	+0 611	7920	.2111	-0.112	.8287	.4006	+0.252
7572	0314	+0.595	.7925	2137	-0 053	.8292	4032	+0.426
.7576	.0334	+0.552	.7930	2163	-0 113	.8294	4043	+0 229
7579	0350	+0.530	7933	.2178	-0.064	8298	4063	+0 145
7582	0365	+0 507	.7938	2204	-0.089	8301	4079	+0 103
7586	0386	+0 482	.7942	2225	-0 073	8308	4115	+0 097
.7590	0407	+0.451	7946	2245	-0 099	.8318	4166	+0 204
.7593	0422	+0.431	7950	2266	-0 075	8322	.4187	+0 134
.7596	.0438	+0.419	.7954	.2287	-0 110	8326	.4208	+0 224
.7599	.0453	+0.393	7958	2307	-0.073	8329	.4223	+0 282
.7602	.0469	+0.371	.7960	.2318	-0.136	8346	.4311	+0 071
7606	0489	+0 339	.7965	.2343	-0.076	.8352	.4342	+0 097
7610	0515	+0 309	.7968	2359	-0.120	.8356	4363	+0.029
7613	.0525	+0 291	7971	.2374	-0 079	.8361	4389	+0.125
7616	0541	+0 270	.7977	.2405	-0 179	8364	4404	+0.076
7620	0562	+0 260	7981	.2426	-0 104	8369	.4430	+0 153
7624	0582	+0.252	7984	.2442	-0 109	.8371	4440	-0 003
7627	0598	+0 250	7995	2498	-0 135	.8377	4471	+0.025
.7630	.0613	+0.232	7998	2514	-0 091	8384	.4507	+0 066
7634	0634	+0.212	.8002	.2534	-0 122	8389	4533	-0 039
.7638	0655	+0 200	.8009	.2571	-0.102	8391	4544	+0 016
7641	.0670	+0 197	8012	.2586	-0.098	.8398	.4580	+0 007
.7644	0686	+0 199	8016	2607	-0 122	8400	4590	+0 100
7648	0706	+0.197	8020	2627	-0 159	8405	4616	+0 092
7652	0727	+0 197	.8023	.2643	-0 123	8412	4652	+0 041
7659	0763	+0 191	.8026	.2658	-0 184	.8415	4667	+0.016
7662	0778	+0 188	8030	2679	-0 134	8416	.4673	+0 093
7666	0799	+0 178	.8036	2710	-0 177	8419	4688	+0 085
7669	0815	+0.160	8040	2731	-0.150	8422	4704	+0 093
7672	0830	+0 107	.8043	.2746	-0 163	8426	4724	+0 028
7676	0851	+0 165	.8047	.2767	-0 111	.8433	4760	+0 023
7680	.0871	+0 154	8050	2782	-0.190	8434	4766	+0 047
.7683	.0887	+0.148	.8055	.2808	-0 130	8439	.4791	+0.003
7686	0902	+0.137	8059	2829	-0.157	8444	.4817	+0 046
7690	.0923	+0 114	8064	.2855	-0.107	8448	.4838	+0.019
7694	0944	+0 147	8067	.2870	-0 156	8454	4869	+0 077
7697	0959	+0 065	8072	2896	-0 071	.8460	.4900	+0.053
7700	0975	+0 106	8075	.2911	-0 089	.8462	4910	+0 043
7704	0995	+0 055	8081	2942	-0 077	8467	4931	+0 085
7707	1011	+0 052	8082	.2948	-0.125	.8474	4972	+0 076
7710	.1026	+0.037	8088	2979	-0 071	8488	5044	-0 045
7714	1047	+0.025	8092	.2999	-0 094	8493	5070	-0 001
7717	1063	+0 015	.8096	3020	-0 084	8499	5101	-0.018
7721	1083	-0 038	8099	.3035	-0.083	8505	5132	-0 014
7724	1099	+0 003	.8103	.3506	-0.102	8509	5153	+0.017
7730	.1130	-0 055	8106	.3072	-0 094	.8516	.5189	+0 082
7734	1155	+0 012	8113	.3108	-0 073	.8520	.5210	+0 040
7738	1171	-0 003	8114	3113	-0.064	.8627	5762	-0.033
7743	1197	+0 017	8116	3123	-0 096	8634	5799	-0 010
7747	1217	-0 005	8120	3144	-0 041	8641	5835	-0 012
7752	1243	+0.001	8126	3175	-0 098	8648	.5871	+0.011
7755	1259	-0 037	8130	.3196	-0 039	8652	.5892	-0.026
7760	1285	+0.002	8133	.3211	-0 105	8655	.5907	+0 014
7763	1300	-0.031	8134	3216	-0 095	8658	.5922	-0 022
7767	1321	+0.013	8138	3237	-0 061	8683	.6052	+0 022
7772	1347	-0 020	8141	.3252	+0.007	8690	6088	+0 022
7777	1372	+0.020	8144	3268	+0 049	8697	6124	+0.026
7780	1378	-0.036	8148	3288	+0 067	8704	6160	+0.015
7784	1409	+0 011	8162	3361	+0 078	8709	.6186	-0.006
7788	1429	-0 025	8166	.3381	+0.058	8712	.6201	+0 042
.7794	1460	-0.001	8169	3397	+0.059	8713	6207	+0 027
7801	1496	+0 018	8172	3412	+0.089	8717	.6227	+0 025
7804	1512	-0 002	8176	3433	+0.039	8724	6263	+0 022
7818	1584	+0 009	.8180	3454	+0 091	8728	6284	-0 018
7822	1605	-0 021	8183	.3469	+0.067	8731	.6300	+0 006
7826	1625	+0 015	.8186	.3485	+0.098	.8738	.6336	-0 005
7829	1641	+0 026	8190	.3506	+0 105	8745	6372	+0.031
7832	1656	+0 050	8194	3526	+0 115	.8752	6408	+0 040
7835	.1672	+0 015	8196	3536	+0 045	8756	6429	+0 009
7838	1687	-0 003	8197	3542	+0.039	8759	.6444	+0.032
7841	1703	+0.037	8204	3578	+0.063	8762	.6460	+0 057
7843	1713	+0 013	.8210	.3609	+0.057	.8766	6480	+0 034
7849	1744	+0.053	8214	3629	+0 081	8773	6516	+0 033
7853	1765	+0 023	.8217	3645	+0 050	.8801	6661	+0 064
7859	1796	+0 049	8221	3666	+0.098	8808	.6697	+0.059
7862	.1811	+0 010	8224	3681	+0 068	8835	6837	+0 049
7866	1832	+0 021	8228	.3702	+0.109	8842	6873	+0 049

TABLE 3

ULTRAVIOLET OBSERVATIONS

Helioc JD 2434000+	Helioc Phase	Δ Mag	Helioc JD 2434000+	Helioc Phase	Δ Mag	Helioc JD 2434000+	Helioc Phase	Δ Mag
954 8849	0 6909	+0 037	954 9312	0 9300	+0 119	955 6995	0 8981	-0 043
8856	6945	+0 029	9315	9316	+0 125	7003	9022	+0 032
8863	6981	+0 011	9318	9331	+0 150	7014	9079	+0 021
8870	7017	+0 030	9322	9352	+0 161	7024	.9135	+0 025
8877	7054	+0 037	9326	9378	+0 188	7040	9213	+0 036
8882	7079	+0 027	9328	9383	+0 224	.7051	9270	+0 026
8887	7105	+0 075	9332	9403	+0 244	7052	9275	+0 113
8890	.7121	+0 050	9335	9419	+0 269	7061	9321	+0 150
8894	7141	+0 109	9338	9434	+0 292	7071	9373	+0 263
8898	7162	+0 080	9356	9527	+0 467	7081	9425	+0 329
8905	7198	+0 069	9360	9548	+0 498	7090	9471	+0 432
8912	7234	+0 067	9363	9564	+0 519	7103	9538	+0 458
8919	7270	+0 066	9366	9579	+0 528	7114	.9595	+0 514
8926	7307	+0 031	9370	9600	+0 538	7124	.9647	+0 568
8933	7343	+0 037	9374	9620	+0 545	7134	9698	+0 665
8940	7379	+0 009	9377	9636	+0 592	7144	9750	+0 763
8947	7415	+0 058	9380	9651	+0 622	7155	9807	+0 776
8961	7487	+0 016	9384	9672	+0 663	7165	9859	+0 855
8968	7524	+0 015	9387	9688	+0 672	7176	9915	+0 891
8975	7560	+0 022	9391	9708	+0 693	7187	9972	+0 917
8982	7596	+0 010	9394	9724	+0 716	7199	0034	+0 925
8989	7632	-0 006	9398	9744	+0 728	7214	0112	+0 828
8996	7668	-0 009	9401	9760	+0 760	7224	0163	+0 788
9002	7699	-0. 021	9405	9781	+0 801	7244	0267	+0. 707
9009	7735	-0 021	9408	9796	+0 825	7253	0313	+0 639
9016	7771	-0 048	9412	9817	+0 858	7272	0411	+0 565
9023	7808	-0 030	9415	9832	+0 900	7274	0421	+0 518
9028	7833	+0 002	9419	9853	+0 921	7284	0473	+0 463
9031	7849	-0 033	9422	9868	+0 979	7294	0525	+0 429
9037	7880	+0 004	9426	9889	+1 066	7306	0587	+0 362
9044	7916	-0 008	9429	9904	+1 025	7317	0644	+0 302
9051	7952	-0 007	9433	9925	+0 913	7328	0700	+0 249
9058	7988	-0 005	9436	9941	+0 945	7331	0716	+0 196
9065	8025	+0 000	9440	.9966	+0 978	7341	0762	+0 169
9072	8061	+0 007	9443	9977	+0 910	7351	0819	+0 132
9079	8097	-0 006	9447	.9997	+0 892	7356	0845	+0 091
9086	8133	-0 002	9450	0013	+0 900	7367	0902	+0 109
9093	8169	-0 013	9464	0085	+0 902	7377	0953	+0 064
9100	8205	+0 001	9468	0106	+0 894	7379	0964	+0 023
9106	8236	+0 000	9471	0121	+0 859	7391	1026	+0 062
9110	8257	+0 029	9475	0142	+0 871	7405	1098	+0 004
9113	8272	-0 003	9478	0158	+0 923	7417	1160	+0 039
9120	8309	-0 031	9482	0178	+0 860	7429	1222	+0 035
9127	8345	-0 034	9485	0194	+0 802	7440	1279	+0 042
9134	8381	-0 034	9507	0307	+0 781	7465	1408	+0 035
9138	8402	-0 014	9510	0323	+0 728	7480	1485	+0 018
9152	8474	-0 070	9513	0338	+0 622	7490	1537	+0 024
9155	8489	-0 062	9516	0354	+0 614	7504	1609	-0 003
9162	8526	-0 062	9519	0369	+0 626	7516	1671	+0 052
9166	8546	-0. 084	9523	0390	+0 598	7528	1733	+0 003
9169	8562	-0 081	9526	0405	+0 515	7538	1785	+0 012
9176	8598	-0 056	9530	0426	+0 513	7549	1842	+0 045
9183	8634	-0 009	9533	0442	+0 484	7565	1924	+0 062
9186	8649	-0 018	9537	0462	+0 455	7578	1992	-0 001
9190	8670	-0 058	9540	0478	+0 406	7588	2043	+0 007
9194	8691	-0 113	9544	0498	+0 410	7594	2074	+0 014
9197	8706	-0 156	9547	0514	+0 405	7604	2126	+0 024
9200	8722	-0 117	9551	0535	+0 399	7613	2172	+0 012
9204	8742	-0 170	9554	0550	+0 398	7624	2229	+0 021
9208	8763	-0 158	9558	0571	+0 388	7635	2286	+0 003
9211	8779	-0 150	9568	0622	+0 356	7660	2415	+0 011
9214	8794	-0 140	9572	0643	+0 325	7676	2498	+0 000
9218	8820	-0 126	9575	0659	+0 321	7686	2549	-0 015
9222	8835	-0 119	9579	0679	+0 336	7697	2606	+0 030
9225	8851	-0 112	9582	0695	+0 301	7699	2616	-0 023
9228	8866	-0 107	9586	0715	+0 269	7703	2637	+0 059
9232	8887	-0 102	9593	0751	+0 260	7708	2663	-0 015
9236	8908	-0 108	9596	0767	+0 229	7714	2694	+0 001
9239	8923	-0 109	9599	0782	+0 203	7722	2735	+0 010
9242	8939	-0 110	9602	0798	+0 162	7738	2818	-0 017
9246	8959	-0 113	9606	.0819	+0 144	7745	2854	-0 020
9250	8980	-0 112	9610	.0839	+0 113	7752	2890	-0 029
9253	8995	-0 101	9613	.0855	+0 080	7769	2978	-0 003
9256	9011	-0 066	9616	0870	+0 107	983 6840	4294	+2 271
9259	9026	-0 052	955 6877	8371	-0 054	6842	4305	+2 290
9262	9042	-0 091	6881	8392	-0 028	6846	4325	+2 305
9265	.9057	-0 038	6905	8516	-0 059	6849	4341	+2 314
9266	9063	-0 075	6906	8521	+0 002	6853	4362	+2 323
9270	9083	-0 081	6909	8536	-0 031	6874	4470	+2 292
9273	9099	-0 085	6919	8588	-0 057	6877	4486	+2 274
9276	9114	-0 102	6926	8624	-0 052	6881	4506	+2 240
9280	9135	-0 098	6929	8640	-0 033	6901	4609	+2 280
9284	9156	-0 091	6940	.8696	-0 006	6915	4682	+2 281
9287	9171	-0 060	6943	8712	-0 037	7026	5255	+2 380
9290	9187	-0 032	6954	8769	-0 013	7042	.5338	+2 383
9294	9207	-0 012	6964	8820	-0 010	7075	5508	+2 451
9298	9228	+0 027	6971	.8857	-0. 030	7089	5580	+2 460
9301	9243	+0 055	6974	8872	-0 050	7099	5632	+2 488
9304	9259	+0 062	6981	8908	-0 048	7113	5704	+2 480
9308	0. 9280	+0 087	6986	0. 8934	-0. 087	7128	0 5782	+2 479

TABLE 3

ULTRAVIOLET OBSERVATIONS

Helioc JD 2434000+	Helioc Phase	Δ Mag	Helioc JD 2434000+	Helioc Phase	Δ Mag	Helioc JD 2434000+	Helioc Phase	Δ Mag.
983 7203	0 6169	+2.494	984 6862	0 6055	+2 493	984 8547	0 4758	+2.434
7242	.6371	+2.519	6892	6210	+2 534	8565	4850	+2 424
.7351	6934	+2.505	6896	6231	+2 562	.8634	5207	+2 497
7368	7021	+2.492	6980	6664	+2 543	8656	5320	+2 513
7384	.7104	+2.507	7000	6768	+2 577	.8675	5419	+2.536
7412	.7249	+2.564	7030	6923	+2 580	8711	.5605	+2.559
.7426	.7321	+2.534	7120	.7387	+2.557	8737	.5739	+2 538
.7439	.7388	+2.538	.7138	.7480	+2 538	.8761	5863	+2 580
.7528	.7848	+2.437	.7154	7563	+2 542	.8820	6167	+2.601
.7541	7915	+2.465	.7158	7584	+2 564	985.6750	.7124	+2.611
7568	8054	+2.459	.7183	7713	+2 582	.6766	.7206	+2.572
.7587	8152	+2 397	7203	7816	+2 534	.6770	.7227	+2 525
7603	8235	+2 424	7244	8028	+2 476	6800	7382	+2.559
7615	.8297	+2 465	7258	.8100	+2.448	6820	7485	+2.546
7625	8349	+2.388	7272	8173	+2 481	6839	.7583	+2 547
.7637	8411	+2 421	7289	8260	+2 488	6869	7738	+2 518
.7648	.8468	+2.432	7306	.8348	+2.478	.6966	8239	+2 508
.7678	8622	+2.450	7363	.8643	+2 475	.6984	8332	+2 408
7699	8731	+2 406	7384	8751	+2 439	6987	8348	+2.447
7740	.8943	+2.387	.7402	.8844	+2 462	.6999	8410	+2 444
7758	9036	+2 436	7416	.8916	+2 464	7069	8771	+2 423
7787	9185	+2.494	7420	.8937	+2.497	7080	8828	+2 412
7801	.9258	+2.508	7439	.9035	+2 500	7092	8890	+2.393
.7815	9330	+2 583	7456	9123	+2 545	7103	8947	+2.465
7828	9397	+2 697	7482	9257	+2 594	7114	9003	+2 463
.7837	9444	+2 791	7488	9288	+2 632	7126	9065	+2 435
7849	9506	+2 840	.7500	9350	+2 695	7130	9086	+2 383
.7862	9573	+2.927	.7502	9360	+2 711	7142	9148	+2 492
7875	.9640	+3.025	7514	9422	+2 786	.7155	9215	+2 548
7885	.9692	+3.172	.7530	9505	+2 850	7182	.9355	+2 533
7905	.9795	+3.162	7544	9577	+2.974	7196	9427	+2 593
7915	.9846	+3.217	7561	.9665	+3.059	7209	9494	+2.717
7928	9914	+3 283	7579	.9758	+3.106	.7220	9551	+2 776
7941	9981	+3 335	7591	9820	+3 205	7235	.9628	+2 856
7953	0043	+3 355	7603	9882	+3 222	7246	.9685	+3 005
.7968	.0120	+3 459	7614	9939	+3 243	7258	9747	+3 067
7979	.0177	+3.202	7626	0001	+3 234	.7273	9825	+3 189
8002	0296	+3.165	7639	0068	+3 256	7288	9902	+3.274
.8014	0358	+3.136	7653	0140	+3 244	7300	9964	+3.315
.8030	.0440	+2 966	7666	0207	+3.183	7314	.0036	+3 262
.8044	0513	+2.858	7682	.0290	+3 169	7327	0104	+3 233
.8058	.0585	+2 781	7702	0393	+3.034	.7343	0186	+3.148
8072	.0657	+2.674	7729	.0533	+2 875	.7368	0315	+3 066
8087	0735	+2 626	7737	0574	+2.810	.7373	0341	+2 992
8106	.0833	+2 499	7751	.0646	+2 755	.7384	0398	+2 950
8124	0926	+2 411	7764	0714	+2 687	7399	0475	+2 914
8141	.1014	+2.390	7778	.0786	+2 584	7417	0568	+2 804
8155	1086	+2 355	7789	.0843	+2 637	7432	.0646	+2 685
8176	.1194	+2 336	7800	0899	+2 576	7446	0718	+2 603
8183	1231	+2 326	7803	0915	+2 516	7460	0790	+2 519
8196	.1298	+2 258	7814	0972	+2 561	7475	0868	+2 509
.8199	1313	+2 300	7817	0987	+2 593	7494	0966	+2.446
8214	1391	+2 239	.7829	.1049	+2 522	.7510	1049	+2.428
8217	1406	+2 282	7843	1122	+2 484	.7524	1121	+2 449
8231	1479	+2 311	7859	1204	+2 490	.7536	1183	+2 421
8233	1489	+2 348	7874	1282	+2 497	7548	.1245	+2 418
.8246	1556	+2.316	7897	1400	+2 412	7563	.1322	+2 394
8278	1721	+2 433	7911	1473	+2 397	7573	1374	+2 395
.8282	1742	+2 336	7914	.1488	+2 428	7586	1441	+2 414
8301	1840	+2 328	7928	1561	+2 437	7616	1596	+2 347
.8321	1943	+2 318	7944	.1643	+2.481	7617	1601	+2 306
8335	2016	+2 324	7954	1695	+2 501	7620	1617	+2 404
8339	2036	+2 369	7967	.1762	+2 470	7634	.1689	+2 362
8456	2641	+2 381	7985	1855	+2 468	7635	1694	+2 308
8478	2754	+2 371	.7999	1927	+2 503	.7638	1710	+2.359
8578	.3271	+2.301	8002	1943	+2.482	7642	1730	+2 297
8584	3302	+2 260	8017	2020	+2 479	7643	.1736	+2 380
8599	3379	+2 277	8020	.2036	+2 515	.7649	1767	+2 296
8686	3828	+2 323	.8050	2191	+2.491	7653	1787	+2 349
8703	3916	+2 326	8061	.2247	+2 480	.7658	.1813	+2 394
8721	4009	+2 341	8157	.2743	+2 371	.7661	1829	+2 343
8746	4138	+2 329	8173	2826	+2 397	7666	.1854	+2 293
8792	4376	+2 378	.8274	.3348	+2 405	7668	.1865	+2 342
8814	4490	+2.400	8293	.3446	+2 405	7673	1891	+2 293
8835	4598	+2 400	.8310	.3533	+2 399	7742	2247	+2 328
8865	4753	+2 288	8314	3553	+2.343	.7757	2324	+2 381
984 6661	5017	+2 384	8329	.3632	+2.388	7769	.2386	+2 447
6666	.5043	+2 401	.8347	.3725	+2.344	.7784	2464	+2 325
6681	.5120	+2 434	8378	.3885	+2 287	.7799	2541	+2 430
6730	5373	+2 465	8383	3911	+2 334	7813	2614	+2.440
.6742	5435	+2 425	8398	.3988	+2.330	7852	2815	+2 363
6745	5451	+2 464	8412	4060	+2.313	.7866	2887	+2.329
6759	.5523	+2 464	8417	.4086	+2.392	7900	3063	+2 340
.6782	5642	+2 483	8419	4096	+2 348	7966	3404	+2.429
6786	5662	+2 524	.8436	4184	+2 367	7984	3497	+2 414
6802	.5745	+2 493	8451	.4262	+2.370	7998	.3569	+2 376
6820	5838	+2 504	8466	4339	+2 346	.8028	3724	+2.331
6825	5864	+2 462	8482	.4422	+2 323	8039	0 3781	+2 359
6827	.5874	+2.482	8509	4561	+2 346			
.6843	0 5957	+2.495	8528	0.4659	+2.396			

and these in turn were tied in to the U, B, V system of Johnson and Morgan (1953). The chart of the field of DQ Her in Fig 8 shows the locations of these stars, and their magnitudes and colors are listed in Table 4. Star B was used as the primary comparison star, and the magnitudes of DQ Her on August 29, 30, and 31 are given in terms of the instrumental magnitude difference in each color, DQ Her *minus* B, reduced to no atmosphere.

The (1530) observations of DQ Her in yellow, blue, and ultraviolet light are given in Tables 1, 2, and 3, respectively. For each observation, the tables list the heliocentric Julian date and the phase computed from the elements:

$$\text{Minimum} = \text{Helioc. JD } 2434954.94475 + 0^{d}1936223\,E\,.$$

The observed times of minimum light from which these elements were derived, together with the residuals, observed time *minus* time computed from the foregoing elements, are listed in Table 5.

TABLE 4

MAGNITUDES AND COLORS OF COMPARISON STARS

Star	V	$B-V$	$U-B$
A	15 82	+0 37	+0 01
B	10 56	+0 51	+0 01
C	11 53	+1 45	+1 68

TABLE 5

OBSERVED MINIMA OF DQ HERCULIS

Helioc JD 2434+	O−C (Day)	Color	Helioc. JD 2434+	O−C (Day)	Color
954 7515	+0 0004	*UV*	983 79575	+0 00128	*UV*
954 94495	+ 00020	*UV*	984 76270	+ 00012	*Y*
955 71887	− 00037	*Y*	984 76295	+ 00037	*B*
955 71900	− 00024	*UV*	984 76329	+ 00071	*UV*
955 71931	+ 00007	*B*	985 72981	− 00089	*B*
981 665. .	000	*Pg**	985 72981	− 00089	*UV*
983 79431	− 00016	*Y*	985 72985	−. 00085	*Y*
983 79483	+0 00036	*B*	989 797	0 000	*Pg**

* Minimum observed photographically by J B Oke at Toronto

The individual light-curves, plotted against phase, are shown in Figures 1–5. The observations on July 31 between phases $0.470P$ and $0.852P$ are of low weight, owing to difficulty with the offset guiding device. The light-curves display the following features:

1. Primary eclipse is partial and lasts about 1 hour, from $0.889P$ to $0.111P$. Its depth decreases as one goes to shorter wave lengths, being about 1.4 mag. in the yellow, 1.0 mag. in the blue, and 0.8 mag. in the ultraviolet. These depths vary from cycle to cycle. There is no trace of a secondary eclipse. A very shallow secondary would be obscured by the intrinsic variations of the star, discussed later; all we can say is that the depth of secondary must be ≤ 0.03 mag.

2. Shoulders sometimes occur both before and after eclipse; their structure and height vary from cycle to cycle. The one preceding eclipse begins at about $0.70P$, while that following eclipse, if it occurs, usually lasts until about $0.20P$, although there is considerable variation, as on July 31.

3. The rising branch of the eclipse curve is asymmetric between 0.050P and 0.111P (the end of eclipse), and during some cycles there is a definite stillstand, as on July 31.

4. Between 0.20P and 0.45P the light of the system is relatively constant or increases slightly. After 0.45P, the light-level decreases, reaching a minimum at 0.70P, and then increases again until the beginning of the next primary eclipse. The amount of this decrease is about 0.15 mag. in yellow light; the variation with wave length is discussed later. On most nights the occurrence of this minimum and of the shoulder before eclipse are confused. On these nights, following the minimum at 0.70P, the brightness of the system does not surpass, and may not even attain, the level of "constant" light between

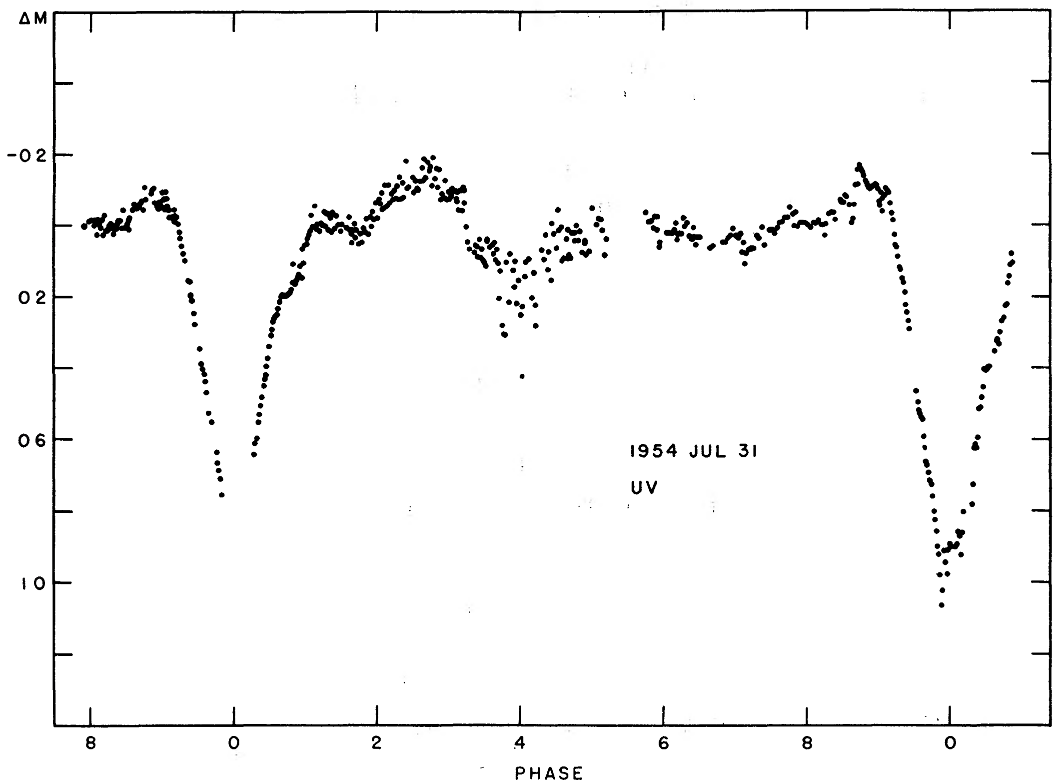

FIG 1.—Photometric observations of DQ Her. The ordinate is the instrumental magnitude, reduced to no atmosphere The zero point is arbitrary The abscissa is the phase computed from zero phase = Minimum = Helioc JD 2434954 94475 + 0ᵈ1936223E

phases 0.20P and 0.45P. Thus one could describe the light-curve as showing a decrease in light until 0.70P, followed by a shoulder preceding eclipse or as displaying only a light-minimum between 0.45P and the beginning of the following eclipse at 0.89P.

5. Intrinsic variations occur throughout the cycle of the system, with periods of from 1 to 40 minutes and amplitudes up to at least 0.15 mag. Over most of the cycle these periods and amplitudes appear to occur at random. However, one of the most striking features of the light-curve is that, between 0.110P and 0.325P, there occur extremely rapid variations with a definite periodicity, which are superimposed upon the random fluctuations of longer period. The period of these variations, determined from the observations on July 31, is 1.180 minutes, and their amplitude is about 0.035 mag. in the ultraviolet. Some trace of these variations persists until about 0.50P. Owing to the shortness of the period of these variations, they can be properly observed only by monitoring the star continuously in a single color. Altogether, DQ Her has been monitored on

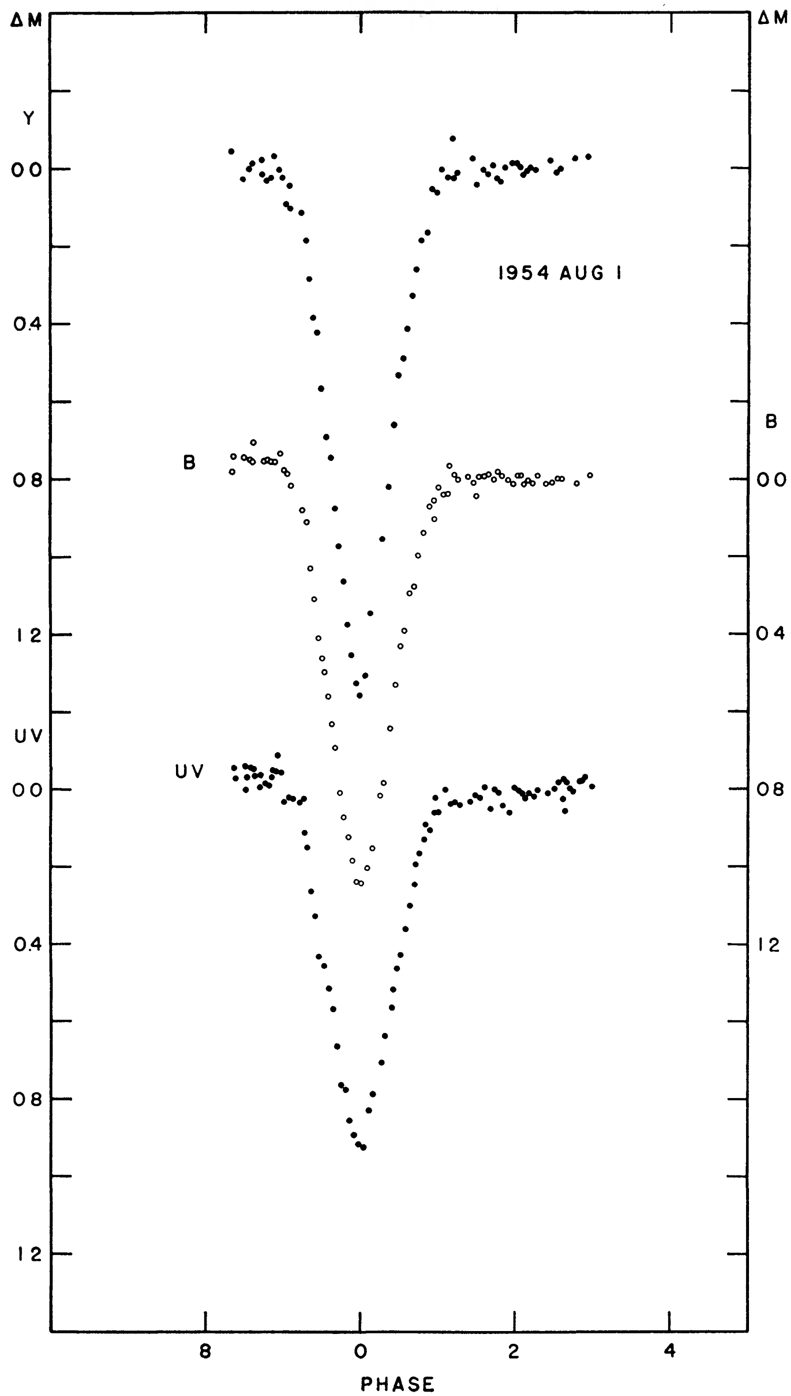

FIG 2 —Photometric observations of DQ Her Ordinate and abscissa as in Fig 1 three nights during some part of the foregoing phase interval: July 9, when the variations were first discovered, July 31, and August 31, when again these periodic variations occurred. Sections of the light-curve have been traced from the Brown recorder sheets for these three nights and have been combined in Figure 6 according to the phase in the 4-hour period. These tracings are still in intensity units. However, a vertical distance corresponding to 0.10 mag. has been marked for each of the runs. The residuals, ob-

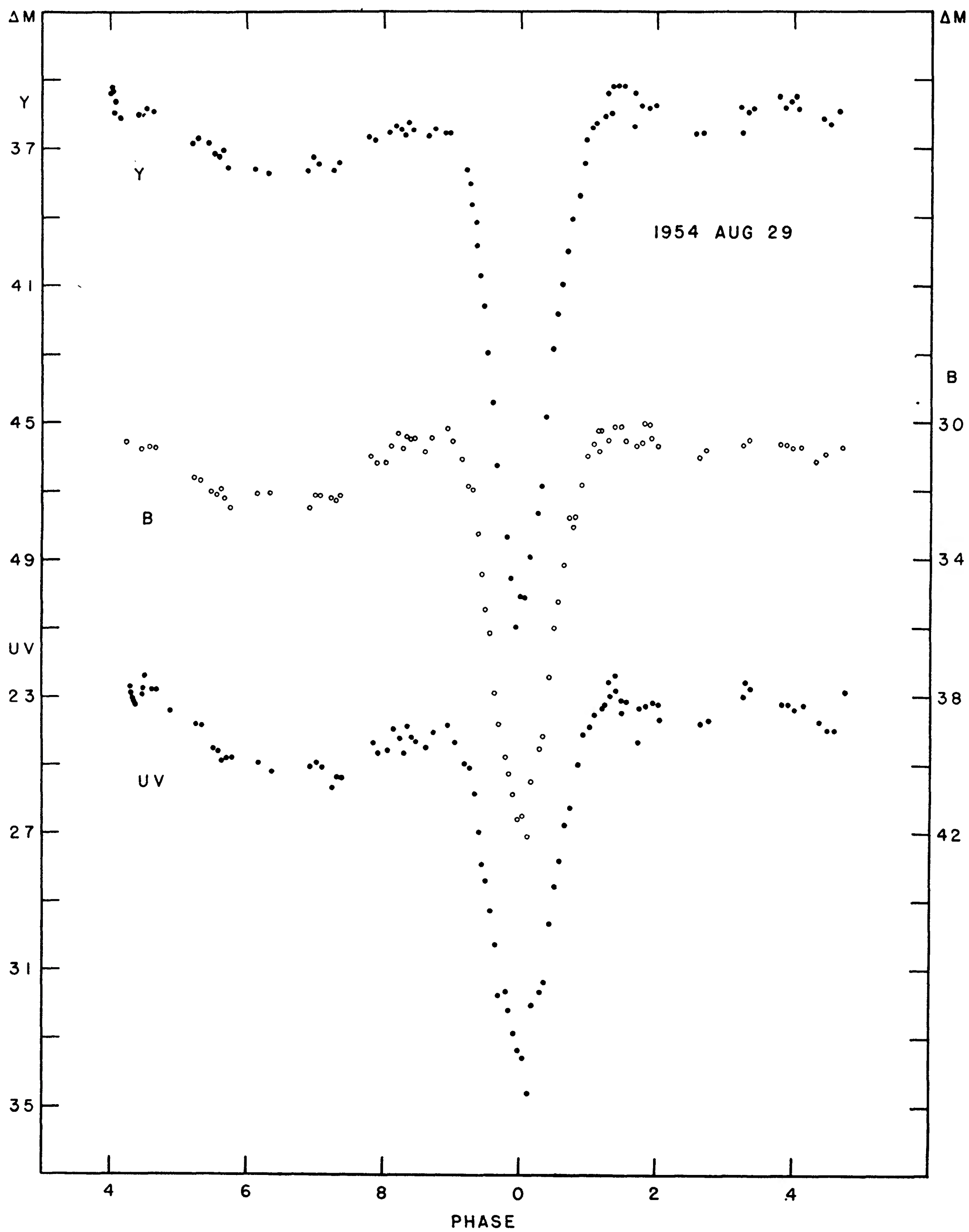

FIG. 3.—Photometric observations of DQ Her. The ordinate is the instrumental magnitude difference, DQ Her *minus B*, reduced to no atmosphere. Abscissa as in Fig. 1.

served maxima *minus* maxima computed with $P = 1.180$ minutes, for the observations of July 31 are shown in Figure 7. The accuracy in determining the observed times of maximum light was about ± 0.1 minute. While only a very limited amount of material is available, it suggests that these variations are a permanent feature of the light-curve. The fact that they occur during only a part of the 4-hour period indicates that they probably result in some way from the binary nature of the system and that only a portion of the star is involved in their production.

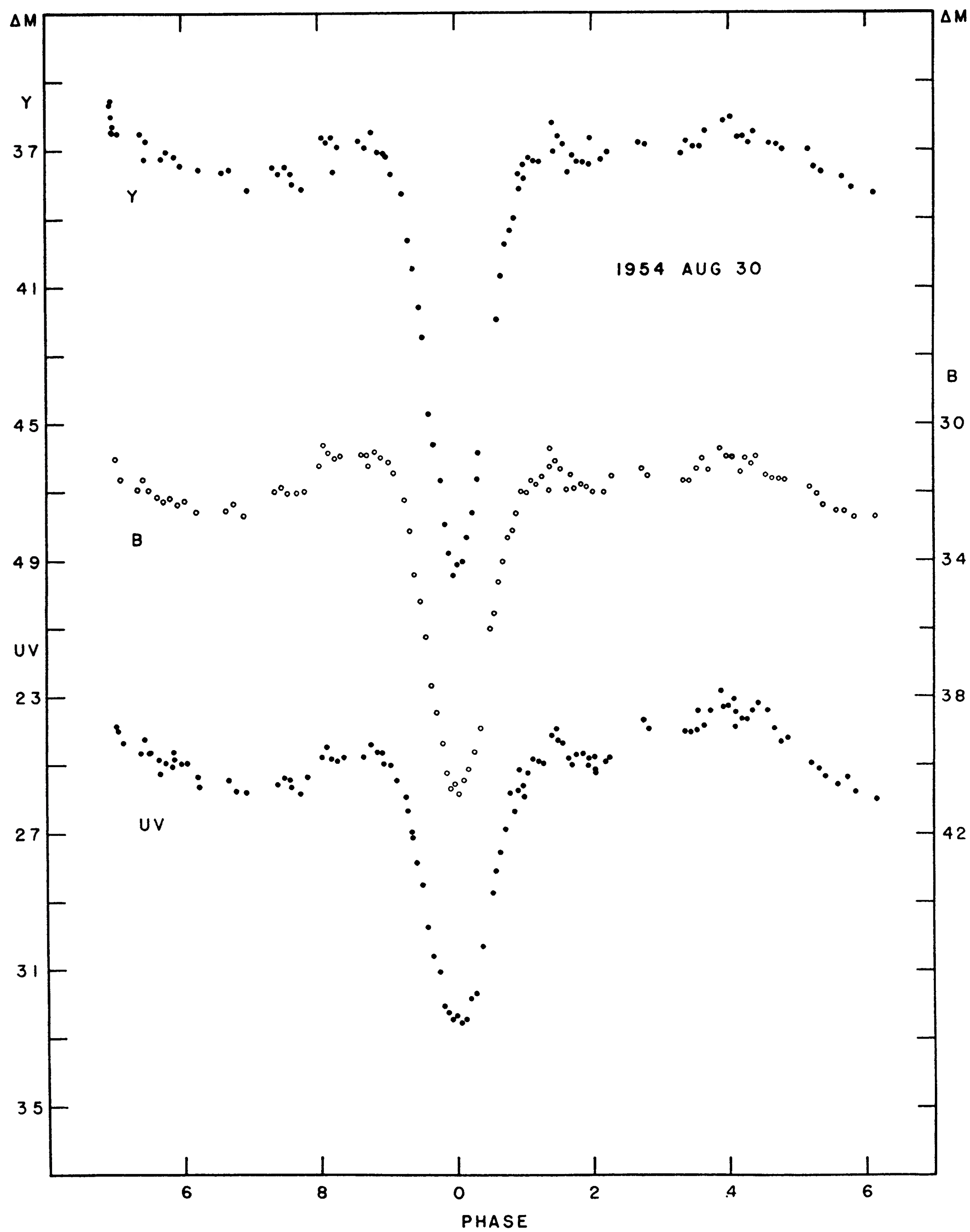

FIG 4.—Photometric observations of DQ Her Ordinate and abscissa as in Fig. 3

6. Adopting the color of the system as normal between $0.11P$ and $0.40P$, the $B-Y$ color of the star remains constant until about $0.70P$, after which the star becomes bluer, maximum blueness outside eclipse occurring at the top of the shoulder preceding eclipse ($0.89P$). The amount of this blue excess is about 0.10 mag. The $UV-Y$ color of the system, on the other hand, increases slightly after $0.40P$, the star becoming about 0.05 mag. redder at $0.70P$ and about 0.07 mag. redder at $0.89P$. As mentioned previously, the

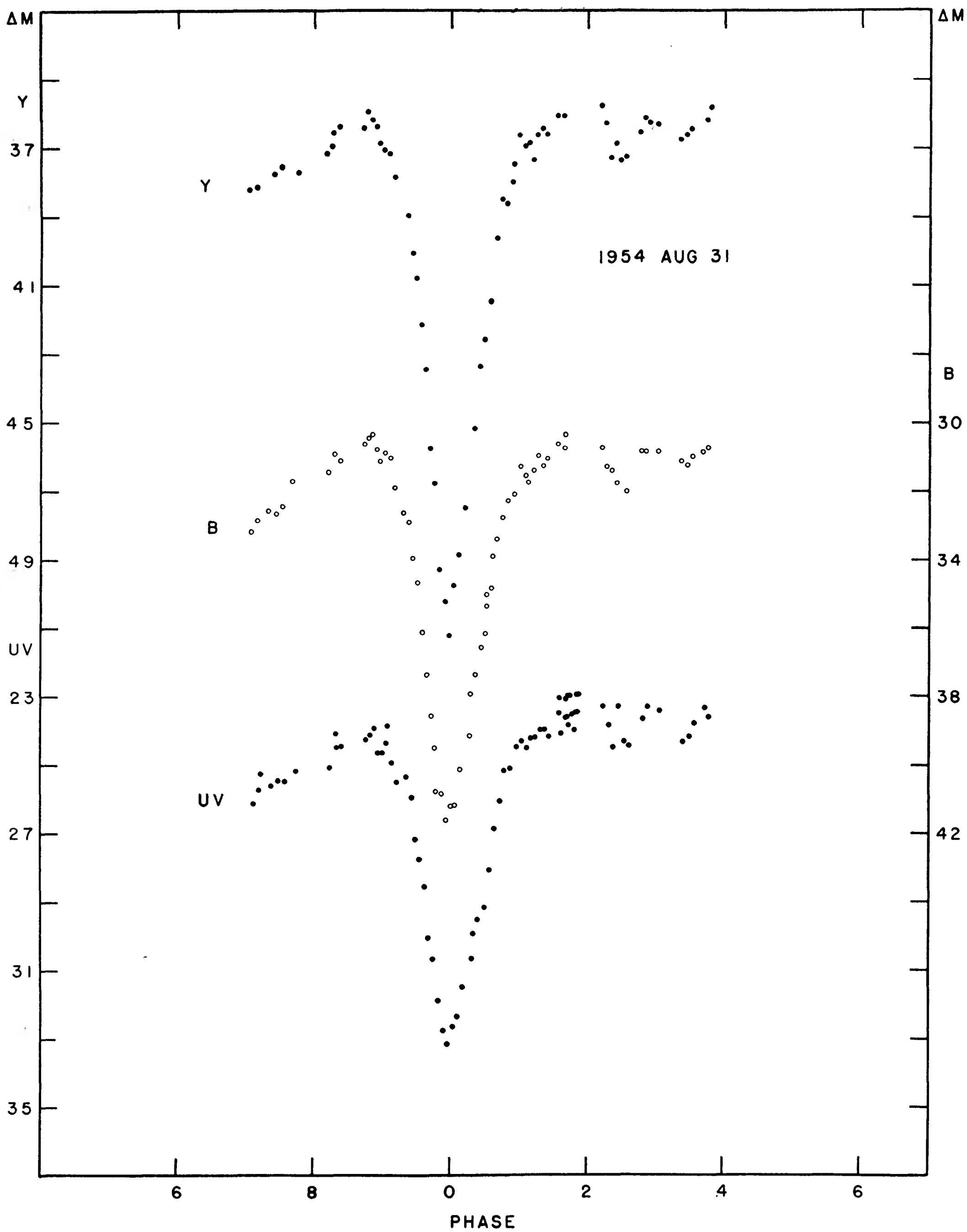

FIG. 5 —Photometric observations of DQ Her. Ordinate and abscissa as in Fig. 3

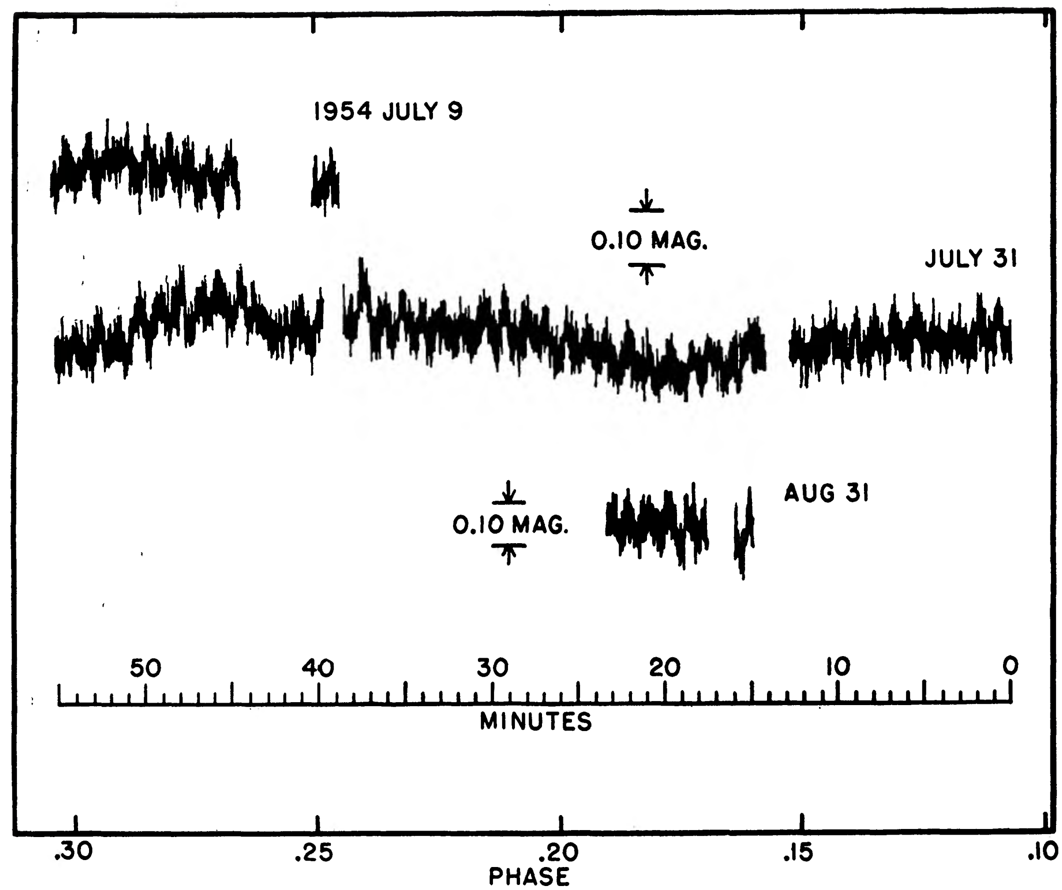

FIG. 6.—Tracings from Brown recorder sheets, showing rapid, periodic variations in ultraviolet light. The period of these fluctuations, determined from the observations on July 31, is $P = 1\ 180$ minutes The abscissa is the phase in the 4-hour period.

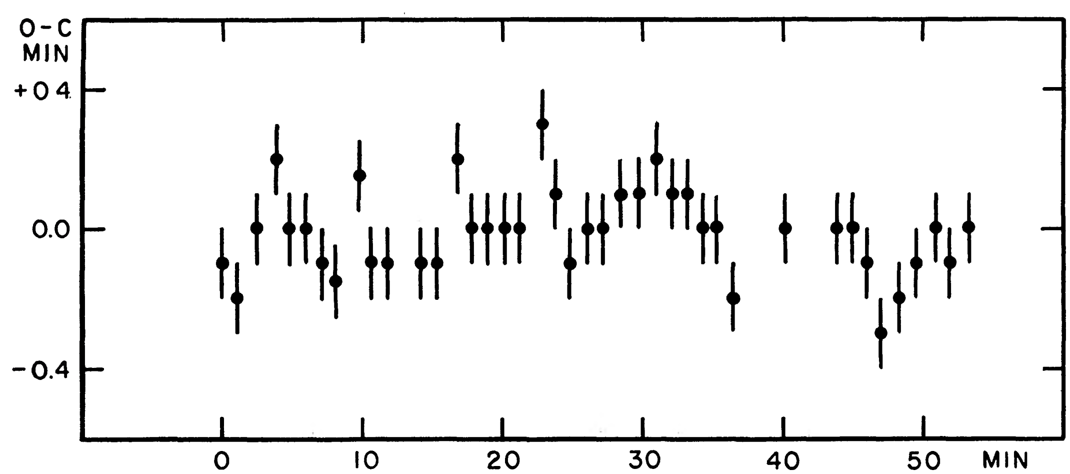

FIG. 7.—Residuals between the observed maxima of the 1-minute light-variations on July 31, shown in Fig 6, and the maxima computed using $P = 1.180$ minutes.

depth of eclipse varies with wave length, so that the star is bluer than normal in both color systems during eclipse. Figure 8 shows that the nebulosity surrounding DQ Her is relatively bright photographically in comparison to the star. Consequently, it appears likely that the decreasing depth of eclipse with decreasing wave length results from the filling-in of the light-curve by radiation from the expanding shell. If we assume that the depth of eclipse is actually the same in all wave lengths and that the yellow light-curve is unaffected by light from the nebulosity, we find that this filling-in is probably responsible also for the peculiar color changes between $0.40P$ and $0.70P$; on these assumptions, the depths of the light-minimum at $0.70P$ become 0.15 mag. in the yellow, 0.26 in the blue, and 0.40 in the ultraviolet. However, this filling-in of the light-curve will not account for the anomalous brightness of the star in blue light at phase $0.89P$. At this time the system is brightest in the blue and faintest in the ultraviolet, relative to the light-levels between $0.11P$ and $0.40P$.

Since the magnitude differences, DQ Her *minus* B, were left on the instrumental system, the colors of DQ Her derived from the tabulated magnitude differences and the colors of star B will not be exactly on the U, B, V system. The magnitude and colors of DQ Her have therefore been converted to this system for three selected times on Aug 29 and are given in Table 6. Applying the corrections discussed for the effect of radiation from the nebulosity upon the measured blue and ultraviolet intensities of the star, we obtain the following corrections to the colors: $\Delta B-V = +0.092$ mag., and $\Delta U-B = +0.233$ mag. Thus the "corrected" colors of the star at $0.45P$ become $B-V = +0.09$ mag., and $U-B = -0.69$ mag.

Whether or not these corrections are applied, the star falls into the portion of the $U-B$ and $B-V$ diagram populated by the white dwarfs (Johnson and Morgan 1953). The occurrence of a star in this part of the diagram indicates either that the star is highly reddened by interstellar absorption or that it is intrinsically more luminous in the ultraviolet than a normal main-sequence star having the same $B-V$ color. Using either the corrected or the observed colors of DQ Her, a total visual absorption of about 1 mag. would be required to account for the location of the star in the diagram. The distance modulus of DQ Her has been determined by Baade (1940) from the linear expansion and radial velocity of the shell surrounding the star. From the major and minor axes of the elliptical shell, Baade derived distance moduli of 6.52 and 7.07 mag., or an average value of 6.8 mag. Combining this with the measured visual magnitude $V = 14.2$ from Table 6, the absolute visual magnitude of the nova is now $M_v = +7.4$. Thus the star is intrinsically faint and is so close to the sun that the amount of interstellar absorption should be fairly small; at the galactic latitude of DQ Her (25°), the average visual absorption for a star having a distance modulus of 6.8 mag. is only about 0.40 mag. Another possible source of absorption is provided by the debris of the nova explosion which surrounds the star. An estimate of this absorption can be made from the known size of the shell, the size of the star (discussed later), the amount of material ejected during the nova outburst (Whipple and Gaposchkin 1936), and the coefficients of interstellar absorption calculated by Greenstein (1937). Assuming that the composition of the ejected material is the same as that of the atmosphere of a normal star, the total absorption to be expected is only a few thousandths of a magnitude. It would seem, therefore, that the location of DQ Her in the $U-B$ and $B-V$ diagram must result primarily from an abnormal brightness of the star in the ultraviolet.

At the present time, very little is known concerning changes in the spectrum of the star during the 4-hour period. Figure 9 shows two spectra of DQ Her taken by Humason with the prime-focus nebular spectrograph on the 200-inch reflector. In general, the spectrum is still very similar in appearance to what it was in 1949 and 1950 (Swings and Jose 1949, 1952). The most striking change shown by Humason's plates is that the higher members of the Balmer series, which appear in emission at phase $0.57P$, have disappeared at $0.07P$. These lines thus must originate close to the stars and not in the sur-

FIG. 8.—Chart of the field surrounding nova DQ Her (1934), from a photograph with the 100-inch reflector. The scale is 6.78″/mm. DQ Her is indicated by the arrow. A, B, and C are the comparison stars referred to in the text.

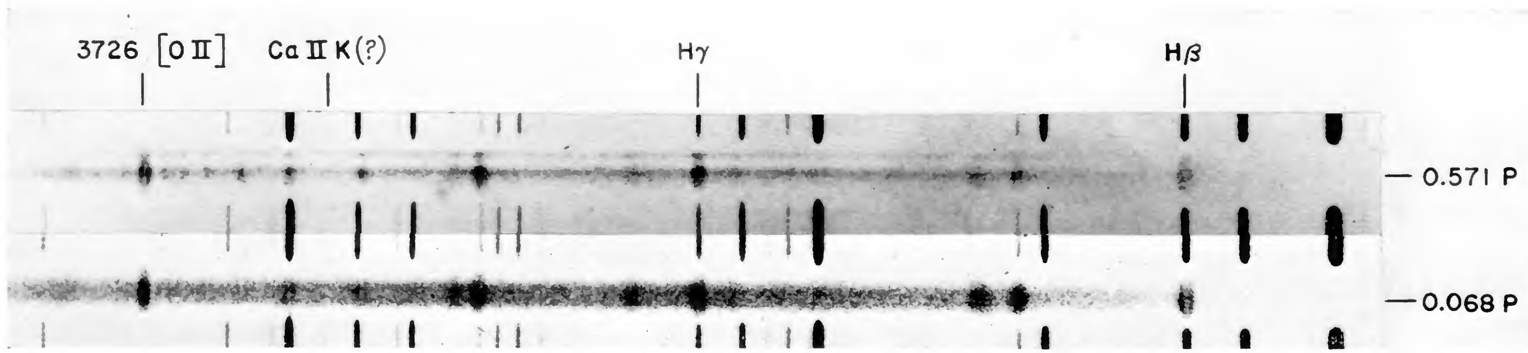

FIG. 9.—Spectra of DQ Her taken by M. L. Humason with the prime-focus nebular spectrograph on the 200-inch reflector. The upper plate was taken at JD 2434991.650, and the lower at JD 2434994.650.

rounding shell. Even so, velocities obtained from them might not reflect the true velocity of either of the stars. The Balmer continuum appears in emission at both phases. This is undoubtedly part at least of the explanation of the anomalous brightness of the star in the ultraviolet, as shown by the photoelectric observations. The spectrum shows practically no absorption features. There are indications of a few faint lines, but, with only a small number of plates available, their reality is very uncertain. One such feature occurs at the position of Ca II K. However, if it is real, it may be of interstellar origin; a weak interstellar K line was found by Williams (1935) during the outburst of the nova. Thus the prospects of obtaining the velocity-curve of the star do not appear very favorable. However, in view of the importance of this system, it is extremely desirable that velocity measurements be attempted.

We have already seen that the $B-V$ color of DQ Her is that of a star of spectral class A. On the other hand, if the spectrum were that of a normal A star, we should expect to see some trace of at least the wings of the strong hydrogen absorption lines. The absence of a strong Balmer absorption spectrum indicates either that the temperature of the star is much higher than that given by the color or that the hydrogen lines of the nova are abnormally weak. We have seen that the effect of interstellar reddening is too small to account for the observed color of the star. Consequently, the latter interpretation appears the more likely. It should be noted that the presence in the spectrum of emission lines such as He II 4686 also suggest a higher temperature than that of an A star. The cause of this discrepancy is not known. The abnormal brightness of the star in the ultraviolet might suggest that the lines of high excitation are somehow produced by very intense radiation in the far ultraviolet.

TABLE 6

MAGNITUDES AND COLORS OF DQ HERCULIS

Helioc JD 2434+	Phase ($P=1$)	V	$B-V$	$U-B$
983 688	0 450	14 18	0 00	−0 92
983 769	870	14 24	− 11	− 73
983 872	0 400	14 16	+0 01	−0 84

TABLE 7

ADOPTED LEVELS OF UNIT INTENSITY

Date 1954	ΔM_y for Unit Intensity	Date 1954	ΔM_y for Unit Intensity
Aug 1	0 000	Aug. 30	+3 700
29	+3 650	31	+3 650

The photometric elements of the system have been derived from the yellow light-curve, since, as we have already discussed, it appears likely that this curve is least affected by the filling-in of radiation from the nebulosity surrounding the star. Owing to the variation in the brightness of the star outside eclipse, there is some uncertainty involved in choosing the proper unit of light-intensity. The adopted levels of unit intensity are given in Table 7. The elements were derived with the aid of the nomograms published by Merrill (1952, 1953*a*, *b*). In making the solution it was assumed that the secondary star is of zero brightness, that the coefficient of limb darkening is 0.6, and that the orbit is circular. Since the light-curve is of the Algol type, no corrections for ellipticity or reflection effect were required. Only the descending branch of the eclipse-curve was used in deriving the elements, owing to the asymmetry of the rising branch, discussed earlier.

Since the depth of eclipse and the shape of even the descending branch of the light-curve vary from cycle to cycle and since the depth of secondary eclipse is uncertain, there appeared to be little point in carrying out a very elaborate analysis of the eclipse-curve. In preparing the observations, the light-curve was obtained by simply drawing a free-hand curve through a plot of all the observations; normal points were not formed. The nomograms were then used to obtain only the first approximation to the elements. These elements are listed in Table 8, using Merrill's notation. Primary eclipse is an occultation. Consequently, the nova component has been designated throughout the remainder of the paper by the subscript s, while the slightly larger secondary star has been denoted by the subscript g. Figure 10 shows the fit of the elements to the observed light-curve. The ordinate of the eclipse-curve is intensity, in units of the uneclipsed light, while the abscissa is the phase in degrees. It appears from the figure that the representation of the observations is quite satisfactory, even from this first solution; the error of representation is less than the changes in the eclipse-curve from night to night, except possibly between phases $-23°$ to $-30°$. Some preliminary trials with other sets of elements and different

TABLE 8

ELEMENTS OF DQ HERCULIS

λ_1	0 286	e	0.00*
λ_2	1 000*	ρ_g	3 7 $\rho_\odot$†
Limb darkening	0 60*	ρ_s	6 6 $\rho_\odot$†
α_0^{oc}	0.716	Abs. vis. mag. of primary	+7 4
k	0 83±0 07	Abs. vis. mag. of secondary	≧+10 7
L_g	< 0 05	T_e (primary)	10000° K‡
L_s	> 0 95	a	2 1×10^5 km§
J_g/J_s	< 0 0004	R_g	0 11 $R_\odot$§
r_g	0 366±0 010	R_s	0 10 $R_\odot$§
r_s	0.30±0 02	$m_g=m_s$*	6×10^{-3} $m_\odot$
i	76°7±1°7		

* Assumed
† Computed from the photometric elements, assuming equal masses
‡ From observed $B-V$ color.
§ Calculated from absolute visual magnitude and T_e of primary

degrees of limb darkening indicated that the fit of this part of the curve could not be materially improved. The discordance of this section of the curve is thus probably to be ascribed to some nongeometrical origin, such as gas streams surrounding the stars.

Interestingly, it is possible to fit a theoretical curve through the asymmetric rising branch. Using the same assumptions as before, one obtains the following elements for the rising branch: $k = 0.91$, $r_g = 0.38$, $i = 77°3$. Since the light-curves show quite clearly that this branch of the eclipse-curve is abnormal, these elements have little weight. However, they suggest that even if the descending branch is also complicated by the presence of gas streams or clouds, the elements derived from it are not grossly in error.

If we assume a value of the mass ratio, the mean densities of the stars may be computed from the formulae given by Russell (1912). Taking the masses of the stars to be equal, their densities are $\rho_g = 3.7\ \rho_\odot$, and $\rho_s = 6.6\ \rho_\odot$.

As mentioned earlier, the color of the star is about $B-V = 0.00$, or $B-V = +0.09$ if some correction is made for light from the surrounding nebulosity, which cannot be excluded in measuring the star. For the purposes of this discussion, let us adopt the color $B-V = 0.00$, since the correction for the light of the nebula is rather uncertain and will be, to some extent, offset by the effect of any possible interstellar absorption. Owing to the abnormal brightness of the star in the ultraviolet, the $B-V$ color probably gives a more reliable estimate of the effective temperature of the star than would an estimate which includes this ultraviolet radiation. If the other old novae are also anomalously bright in the ultraviolet, this could account for the extremely high temperatures which have been assigned to them (McLaughlin 1941), since these estimates have been based upon the length of the ultraviolet extension of the spectrum.

The effective temperature corresponding to $B-V = 0.00$ is about 10000° K. Adopting this value, the radius of the nova component may then be derived by means of the equation

$$\left(\frac{R}{R_{\odot}}\right)^2 = \frac{L}{L_{\odot}}\left(\frac{T_{e\odot}}{T_e}\right)^4 .$$

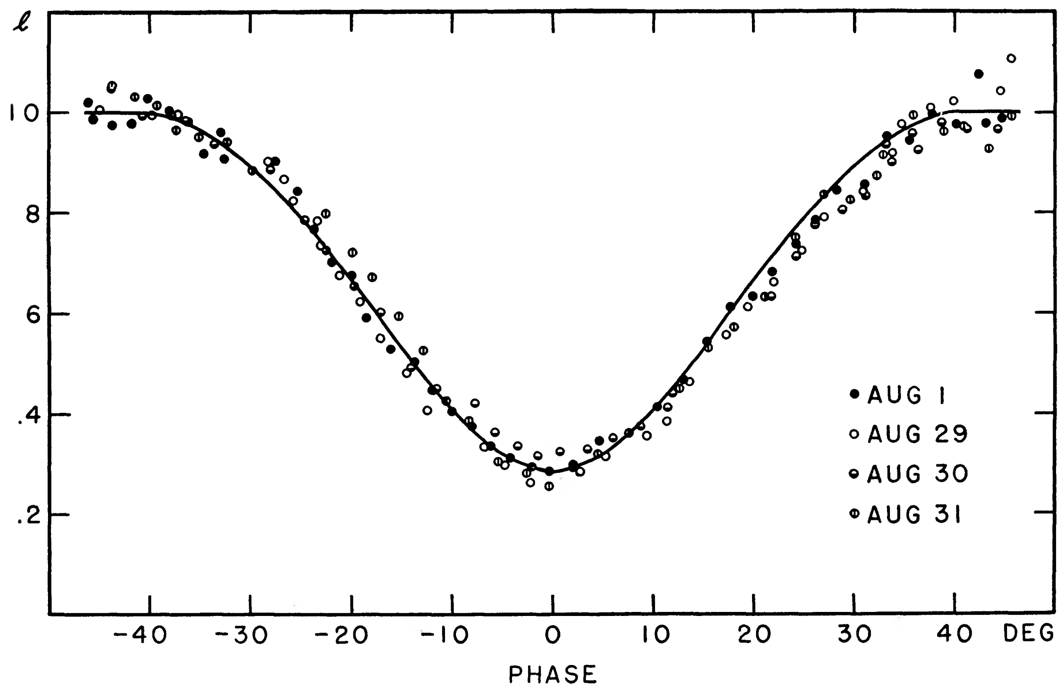

FIG. 10.—Primary eclipse of DQ Her in yellow light. The ordinate is the intensity in units of the uneclipsed light. The abscissa is the phase in degrees. The points represent individual observations. The solid line is the theoretical eclipse-curve computed from the elements given in Table 8.

Taking the absolute visual magnitude of the nova equal to +7.4, the radius of the nova becomes 0.10 $R_{\odot}$, while, from the ratio of the radii given by the photometric solution, the radius of the secondary star is 0.11 $R_{\odot}$, and the radius of the circular orbit becomes 0.31 $R_{\odot}$ or 2.1×10^5 km.

From the absence of a detectable secondary eclipse, we conclude that the secondary star must be at least 3.3 mag. fainter than the nova component. Thus its absolute visual magnitude must be $\geq +10.7$, which, for a main-sequence star, corresponds to a spectral type equal to or later than dM3. The radius derived here is also fairly consistent with that of a dwarf M star. However, the density is much too low and leads to a mass of only about 6×10^{-3} $\mathfrak{m}_{\odot}$. This is also the mass of the nova, since we have assumed that the mass ratio is unity. The mass of a late M dwarf is about 0.1 or 0.2 $\mathfrak{m}_{\odot}$, while the mass of an old nova has been assumed to lie in the range from 1.5 to 3 $\mathfrak{m}_{\odot}$ (McLaughlin 1941).

The possible sources of error in our determination of the masses of the components of DQ Her are: (1) an error in the distance modulus; (2) an error in the bolometric correction or in the effective temperature derived from the $B-V$ color, owing to the peculiar energy distribution of the star; (3) an error in the assumed value of the mass ratio; and (4) an error in the photometric elements arising from some complication of the light-curve, either by the presence of detached clouds or streams of material in the system or by some unusual structure of the stars themselves, such as extended atmospheres.

While it might be possible to account for the discrepancy in the mass of the secondary star, it is very difficult to see how any of the first three of these sources of error could account for the smallness of the mass of the nova. For example, if we suppose that the distance modulus is in error and that the true mass of either star is 0.1 $m_{\odot}$ and that the densities given by the photometric elements are correct, then the error required in the distance modulus is 2.0 mag. Baade (1955) states that his estimate of the distance modulus (Baade 1940) could be in error by at least a magnitude. According to Baade, the relationship between absolute magnitude at maximum light and the rate of decline in brightness after maximum found by Arp for the novae in M31 gives a distance modulus for DQ Her of 7.8 mag., 1 mag. greater than the value derived from the expansion parallax. With this value of the distance, the radius of the nova is 0.14 $R_{\odot}$, the radius of the secondary is 0.17 $R_{\odot}$, and their masses are $m_s = m_g = 0.02\ m_{\odot}$. Thus an error in the distance modulus might account in large part for the discordance of the mass of the secondary star if, as we have assumed, it is actually a normal M dwarf. However, if the mass of the nova is to be 1.5 $m_{\odot}$, an error of 4.5 mag. is required in the distance modulus; an error of this size would appear to be completely out of the question. If the observed values of the distance and density are correct, the effective temperature would have to be 5450° K for a mass of 0.1 $m_{\odot}$ and 3600° K for a mass of 1.5 $m_{\odot}$. As we have seen, if any uncertainty exists, it is whether the temperature is still higher than the value of 10000° K used in these calculations. There remains the possibility of an error in the bolometric correction, because of the peculiar energy distribution of the old nova. Yet it is hard to see how such an error could be large enough to account for the abnormally small masses. Likewise, the small mass of the nova cannot be accounted for by an error in the assumed mass ratio. At most, this can amount to a factor of only 2.

Another explanation which can be ruled out is that the light-curve is produced by a dark spot on the surface of a single star. From the observed depth of eclipse in yellow light, it is clear that even if such a spot were completely dark, it would have to cover very nearly the entire hemisphere of the star. This, in turn, would require that the duration of the light-minimum be very nearly half the period. This conclusion would apply even if the star were completely darkened at the limb.

It is much more difficult to determine whether the small masses could result from an error in the photometric elements arising from some complication of the system. If the radius of the nova is 0.10 $R_{\odot}$ and the mass is 0.1 $m_{\odot}$, then the radius of the nova in terms of the radius of the orbit must be $r_s = 0.12$, while if the mass is 1.5 $m_{\odot}$, $r_s = 0.05$. These values are far outside the probable errors of the elements derived from the observed light-curve. It is easy to show that an error of this sort could not be introduced by the filling-in of the eclipse-curve by light from the shell. However, there is the possibility that the light-curve is not produced by a simple geometric eclipse of stars having sharp boundaries, whose distribution of surface brightness follows the ordinary law of limb darkening. It has already been pointed out that the detached material in the system, whose presence is indicated by the asymmetry of the eclipse-curve, probably has little effect upon the values of the elements. On the other hand, the discordance of the masses could very easily be accounted for if one or both of the stars were surrounded by an extended atmosphere. If this were so, one might expect that the light-curve could not be represented on the assumption of a simple geometric eclipse. The fact that the light-curve can be represented on this basis within the errors of observation means that if complications of some sort do exist, it is not possible to demonstrate that fact from the present material.

Thus we must conclude that if the photometric elements are reliable, the small mass of the secondary star might be explained by the combined effects of errors in the distance modulus, temperature, bolometric correction, and mass ratio but that these sources of error are not sufficient to allow the mass of the nova to be as large at 1.5 $m_{\odot}$. The question of the reliability of the photometric elements must be left undecided; it is to be hoped that photoelectric observations over a period of years may help to clarify this problem.

Whipple and Gaposchkin (1936) have estimated the mass of material ejected by Nova Her up to the time of the great minimum to be between 3 and 13 $\times 10^{28}$ g. Even if the mass of the nova were only 6×10^{-3} $m_{\odot}$, this would amount only to between 2 and 11 $\times 10^{-3}$ of the mass of the nova. Consequently, despite the uncertainty in the mass of the nova, the fractional loss of mass remains very small; we are still correct in considering the nova phenomenon to be a rather "superficial" one which does not radically affect the structure of the star.

There are many striking similarities between DQ Her and the other known eclipsing binary of comparable period, UX UMa. The periods of the two systems are very nearly equal, that of UX UMa being only 4 minutes longer than the period of DQ Her. Both stars have Algol-type light-curves, and, in addition, both at times display shoulders before and after eclipse, asymmetry of the rising branch of the eclipse-curve, a minimum at about $0.7P$, and intrinsic variability (Linnell 1950; Johnson, Perkins, and Hiltner 1954; Walker and Herbig 1954). One difference is that the nearly continuous light-curves of UX UMa obtained in 1953 (Walker and Herbig 1954) show no trace of the 1-minute periodic fluctuations found in DQ Her; the variations in UX UMa appear to be completely random.

The colors of the two stars are also very similar. According to Harris (1955), provisional values of the average colors of UX UMa between $0.2P$ and $0.7P$ are: $B-V = +0.11$ mag., $U-B = -0.81$. The color variations throughout the 4-hour cycle are also somewhat similar. If one allows for the effect of light from the nebula around DQ Her, then both systems become redder during the minimum near $0.7P$ relative to their colors between phases $0.2P$ and $0.4P$. However, owing in all probability to the effect of light from the shell, DQ Her becomes bluer during primary eclipse, while UX UMa, whose light-curve is less obviously affected by extraneous radiation, becomes redder. The shape of the light-curves of DQ Her suggests the type of curve found by Johnson, Perkins, and Hiltner (1954) for UX UMa on May 29, 1952. Their curve for this date also appears to show the anomalous brightness of the system in blue light at $0.86P$ found in DQ Her. DQ Her does not show the anomalous brightness in the ultraviolet between phases $0.03P$ and $0.09P$ displayed by UX UMa (Walker and Herbig 1954); this feature may possibly be obscured in DQ Her by the effect of the nebular light upon the ultraviolet light-curve.

Linnell (1950) obtained densities for the components of UX UMa which are somewhat higher than those we have found for DQ Her. Assuming equal masses, Linnell obtained densities of 19 and 48 $\rho_{\odot}$ for the bright and faint components, respectively. We cannot accurately compare the luminosities or the values of the radii and masses of the two systems. No accurate value of the distance modulus is available for UX UMa. Moreover, the amplitude of the velocity-curve given by Struve (1948) has very low weight, since the spectroscopic observations of Walker and Herbig (1954) indicate that, at least at times, the observed velocities do not refer to the motions of the stars themselves.

In view of the similarities between the light-curves of the two systems, we are led to ask whether UX UMa could also be an old nova or a prenova. While we cannot answer this question at the present time, it appears likely that the features of the light-curve of DQ Her may be explained by the same sort of model that has been proposed by Walker and Herbig (1954) to account for the peculiarities of UX UMa—that is, that there exists a detached cloud of luminous material in the system which is occulted by the faint star during the asymmetric portion of the eclipse-curve. From the phase of the asymmetry, the material must lie about $1\frac{1}{2}$ radii above the surface of the nova component. From the duration of the shoulder following eclipse, the luminous region must lie nearly at right angles to the line of centers of the stars. The diminution of light beginning at $0.5P$ could then be interpreted, as in UX UMa, as the result of absorption by a thin, dark extension of this luminous region which is seen projected against the disk of the nova. On this picture, the luminosity of the system ought to be greatest at $0.7P$, when the bright cloud is most favorably presented to view. To avoid this difficulty, we might suppose either that the cloud, though luminous, is cooler than the star and appears dark when seen projected against its surface or that the material is relatively opaque and that only the inner side next to the old nova is luminous. A complete spectroscopic and photometric analysis of the system will be required to determine whether either of these interpretations is possible.

It has been shown in connection with UX UMa (Walker and Herbig 1954) that if the foregoing model is correct, there should be a correlation between the bright shoulders and the asymmetry of the eclipse-curve, in that the asymmetry should never occur unless the bright shoulders are present, but that the converse might not always be true. Although only a small amount of material is available, there is some indication that this correlation occurs in DQ Her. This model does not account for the 1-minute periodic variations between $0.11P$ and $0.32P$.

It has been pointed out elsewhere (Walker 1954) that the binary nature of DQ Her raises several interesting questions regarding the evolution of a nova. Did a single star undergo fission during the nova stage in 1934, or has the present binary system existed since the initial formation of the stars? The fission hypothesis does not appear very plausible; the small fraction of the star's mass blown off in the nova explosion suggests that the phenomenon involves only the outer layers of the star. On the other hand, according to our present ideas of stellar evolution, a star which is now in the nova or post-nova stage must at one time have been a red giant. Thus, if the binary system has existed since the formation of the stars, we encounter the difficulty that during the time that the nova component was a red giant the secondary star, being very close to the primary, would have had to revolve deep within the expanded photosphere of the nova. Is it possible that somehow this star escaped going through the red giant stage in its evolution? Or was the system at one time more widely separated and the secondary, revolving in the resisting medium of the atmosphere of the red giant, slowed down by just the right amount to produce the close binary which we observe today? A theoretical investigation of these questions would be highly desirable.

Some of the answers to these problems might be provided by a thorough study of all the plates showing DQ Her taken before the 1934 explosion. It is to be noted that no perceptible light-variation was found by Boyd (1934), who examined the 19 pre-outburst plates of DQ Her in the Harvard collection; by Van Biesbroeck (1934), who examined two Yerkes plates; or by Morgenroth (1935), who examined 74 Sonnenberg plates taken between August 1, 1930, and November 3, 1934. However, it is impossible at this time to say how much significance should be attached to these results, since the dates and lengths of exposures are not given and since we do not yet have a sufficiently accurate value of the period to be able to predict when the minima should have occurred prior to the outburst. It will clearly be of great importance to obtain accurate times of minimum light for this system, both to investigate the question of eclipses prior to 1934 and to determine whether the length of the period is changing as a result of continued loss of mass since the nova stage.

The binary nature of DQ Her also raises the question whether all novae are binaries, the nova phenomenon resulting in some manner from the binary nature of the systems. The composite spectrum of T CrB shows that it is double, and Joy's (1954) recent spectroscopic study of the nova-like variable AE Aqr shows that it, too, is a spectroscopic binary. In addition, SS Cyg is known to have a variable radial velocity (Joy 1943) and may also be a spectroscopic binary. However, this is no indication that all novae are binaries. Indeed, what we know concerning the evolution of stars suggests that the nova phenomenon is only one stage in the aging of any star having the proper initial configuration.

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