

THIRTEEN-COLOR PHOTOMETRY OF SIXTEEN VARIABLE Be STARS. I. PHOTOMETRY

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RESUMEN

Presentamos la fotometría de trece-colores de 16 estrellas Be, variables, que hemos observado en el Observatorio Astronómico Nacional en San Pedro Mártir, Baja California. Nuestros datos cubren los años de 1977 a 1979, y en nuestro trabajo hemos incluido mediciones de Johnson y Mitchell efectuadas desde 1965 hasta 1968 después de aplicar las correcciones necesarias para tener un grupo homogéneo de datos.

ABSTRACT

We present thirteen-color photometry of 16 variable Be stars observed at the Observatorio Astronómico Nacional in San Pedro Mártir in Baja California. Our data cover the years 1977 to 1979, and we include earlier measurements of Johnson and Mitchell from 1965 to 1968 that have been corrected in order to have a homogeneous set of data.

Key words: STARS Be – PHOTOMETRY – VARIABILITY

I. INTRODUCTION

Be and Shell stars have been studied both spectroscopically and photometrically for a number of years. However, there have been only a few systematic programs to determine their general observational characteristics. Hubert-Delplace and Hubert (1979) have published a spectroscopic atlas of 148 stars in the O8 to A2 range, covering the years 1953 to 1976. Feinstein and collaborators (1968, 1970, 1975, 1979) and Ferrer, Jaschek and co-workers (1971), have done a photometric survey of many southern Be and Shell stars, covering independently the UV and the IR parts of the spectrum. The photometric catalogues of Nicolet (1978) and Morel and Magnenat (1978) contain *UBVRI*... values reported in the literature for many Be stars. More recently, Jaschek *et al.* (1980) have done a classification of Be stars, including the best known data on spectroscopy, photometry, polarization, etc.

In 1977, we started a 13-color photometric survey of a list of 86 Be and Shell stars (Hubert-Delplace 1976). These stars are spectroscopically variable, and some show large changes both in their magnitudes and colors. We present in this paper photometry for the ones that show photometric changes larger than 0.15 mag.

II. OBSERVATIONAL TECHNIQUES

Our program was planned to observe 'simultaneously' from the near ultraviolet (3300 Å) to the near infrared (1.1 microns) with a photometric system well suited

to study early-type stars (Borgman 1960; Borgman and Blaauw 1964; Mitchell and Johnson 1969; Schuster 1981). The 13-color photometric system (Johnson and Mitchell 1975), makes use of two photometers, and 8C one (UV, blue, and visual colors) and a 6RC photometer (visual, red, and near infrared), and we are using simultaneously the 84 cm and 150 cm telescopes of the San Pedro Mártir observatory to obtain full 13-C photometry nightly for the Be stars. This allows us to detect and to correlate photometric changes that occur in the UV and in the near-IR.

We have been using the DC equipment (amplifiers No. 1 and No 4), observing techniques and reduction procedures as outlined by Schuster (1982). We have made a calibration during each observing run. From 1977 to 1979 the original filters and photomultipliers which defined the 13-C system were employed in all our observations, and so no problems have been encountered in transforming our data into the standard 13-C system. We have observed, when possible, the bluer 13-C standard stars, such as BS 1855 (B0 V) and BS 8622 (O9 V), to check our transformations.

III. RESULTS

Jaschek *et al.* (1980) have classified a sample of 140 representative Be and Shell stars in five physically significant groups on the basis of their spectral characteristics, photometry, polarization, rotational velocities, UV spectral types and spectroscopic variability. Through 1979, 69 (80%) of the 86 stars observed in our program

are common to their work. We have included in our observing list a few supergiants and some Bpe stars that have been excluded from the Jaschek *et al.* paper. From our list of 86 observed stars, thirty-one showed evidence of variability in at least one color or magnitude (Alvarez and Schuster 1981). Of these stars, sixteen have photometric changes larger than 0.15 mg.; the 13-C photometry of these sixteen stars is given in Table 1.

We see that the quality of our 13-C data is very good with 8C probable errors at unit air mass of ± 0.004 to ± 0.013 for bright O- and B-type stars and 6RC probable errors of ± 0.004 to ± 0.016 (except for 58-110 color which may have errors as large as ± 0.038). (Schuster 1981, Table 4. See also Mitchell and Johnson 1969, Table 3). Our criterion of 0.15 magnitude includes all Be stars which are surely variable.

The data of Table 1 is arranged as follows: The first three lines contain some general characteristics of the stars, such as its identification, starting with the BS (Hoffleit 1964), HD, and MWC (Merrill and Burwell 1933, 1943, 1949) numbers and its name. Then we have the group classification according to Jaschek *et al.* (1980). From this work we include the $V \sin i$, the V magnitude and the MK, Q and UV spectral types of the star. (UND) comes from the work of Underhill *et al.* (1979). (SP.TY.) comes from Hubert-Delplace and Hubert (1979). From this work we include a short description of its spectral properties. For BS 1209 (Table 1), the spectral type has been determined by M. Jaschek (O9.5 V) from the Morgan-Keenan classification criteria and by R. Herman (O9-B0) following the Rojas and Herman (1955) criteria. The first column gives the Julian Day of the observation (minus 2 400 000); column 2 gives the 52 mag (5183 Å effective wavelength); columns 3 to 9, show the colors corresponding to the 8C system; column 10 gives the 58 magnitude (5827 Å effective wavelength), which is common to both systems and is used for tying together the observations; columns 11 to 15 show the colors of the 6RC system; and the last column gives the individual air masses.

We report the individual observations ordered by date and as mentioned earlier, frequently our data cover the whole 13-C range within one night or within only a few nights. We include also some earlier 13-C measurements reported by Johnson, Mitchell and Latham (1967), and

Mitchell and Johnson (1969), after applying the corrections indicated by them (Mitchell and Johnson 1969). Their data correspond to Julian Days less than 2 443 000 days. In this way, the whole set of 13-C photometry becomes homogeneous and can be inter-compared directly.

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TABLE 1
OBSERVATIONS

J.D.	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	53	58-72	58-80	58-86	58-99	58-110	AIR
BS 1180															
39052.8575	5.003	-0.670	-0.641	-0.446	-0.110	0.013	-0.010	0.011	5.013	-	-	-	-	-	1.030
39377.9792	5.010	-0.709	-0.683	-0.483	-0.135	-0.024	0.005	0.032	5.005	-	-	-	-	-	1.020
39409.8902	5.008	-0.705	-0.641	-0.461	-0.123	-0.006	-0.011	0.042	5.019	-	-	-	-	-	1.020
39487.6525	-	-0.699	-0.626	-0.458	-0.125	0.002	-0.012	-0.025	-	-	-	-	-	-	1.040
39802.7484	-	-	-	-	-	-	-	-	5.046	0.005	-0.009	-0.014	-0.068	-0.011	1.130
39835.7135	-	-	-	-	-	-	-	-	5.049	-0.034	0.008	-0.043	-0.092	-0.057	1.020
39877.6382	-	-	-	-	-	-	-	-	5.045	-0.010	-0.015	-0.015	-0.072	-0.032	1.010
44194.9138	5.274	0.057	-0.008	-0.286	-0.103	0.003	0.017	0.033	5.260	-	-	-	-	-	1.148
44195.9215	5.233	0.100	0.032	-0.291	-0.093	0.011	0.023	0.036	5.211	-	-	-	-	-	1.187
44196.8734	5.249	0.071	-0.011	-0.292	-0.110	0.013	0.046	0.042	5.201	-	-	-	-	-	1.057
BS 1209															
43387.9990	-	-	-	-	-	-	-	-	6.403	0.273	0.427	0.405	0.350	0.423	1.022
43415.0284	6.528	-1.024	-1.020	-0.485	0.165	0.209	0.102	0.262	6.424	-	-	-	-	-	1.065
43416.0135	-	-	-	-	-	-	-	-	6.409	0.275	0.411	0.400	0.339	0.416	1.042
43416.0171	6.528	-1.066	-1.043	-0.512	0.158	0.201	0.134	0.275	6.394	-	-	-	-	-	1.048
43417.0001	6.604	-1.073	-1.048	-0.522	0.154	0.199	0.147	0.298	6.458	-	-	-	-	-	1.026
43473.8644	6.448	-1.050	-1.026	-0.476	0.175	0.211	0.158	0.303	6.291	-	-	-	-	-	1.059
43790.9575	6.631	-1.006	-0.972	-0.446	0.192	0.190	0.082	0.211	6.555	-	-	-	-	-	1.008
43791.9355	-	-	-	-	-	-	-	-	6.568	0.231	0.358	0.354	0.327	0.412	1.000
43793.9308	-	-	-	-	-	-	-	-	6.542	0.230	0.338	0.338	0.275	0.389	1.000
43793.9989	6.622	-1.052	-1.024	-0.511	0.126	0.175	0.121	0.252	6.509	-	-	-	-	-	1.083
43796.9043	-	-	-	-	-	-	-	-	6.559	0.236	0.335	0.338	0.280	0.376	1.003
43796.9867	6.643	-1.063	-1.049	-0.502	0.111	0.166	0.117	0.241	6.535	-	-	-	-	-	1.073
44194.9253	6.734	-1.103	-1.086	-0.507	0.083	0.155	0.084	0.175	6.671	-	-	-	-	-	1.153
44196.9071	6.698	-1.057	-1.035	-0.535	0.097	0.173	0.074	0.161	6.628	-	-	-	-	-	1.113
44211.8557	-	-	-	-	-	-	-	-	6.618	0.185	0.268	0.277	0.207	0.270	1.085
44214.8332	-	-	-	-	-	-	-	-	6.632	0.178	0.265	0.272	0.195	0.301	1.054
BS 1789															
39054.9375	4.918	-1.507	-1.376	-0.933	-0.305	-0.079	-0.071	-0.117	4.989	-	-	-	-	-	1.160
39501.6807	4.950	-1.448	-1.345	-0.896	-0.280	-0.047	-0.053	-0.102	5.003	-	-	-	-	-	1.210
39833.8800	-	-	-	-	-	-	-	-	5.065	-0.077	-0.100	-0.158	-0.306	-0.352	1.250
39875.6504	-	-	-	-	-	-	-	-	5.017	-0.114	-0.137	-0.201	-0.351	-0.367	1.220
43473.9080	4.947	-1.478	-1.361	-0.894	-0.282	-0.059	-0.062	-0.105	5.010	-	-	-	-	-	1.189
43559.7092	4.915	-1.476	-1.366	-0.899	-0.293	-0.065	-0.064	-0.107	4.982	-	-	-	-	-	1.303
43559.7109	-	-	-	-	-	-	-	-	4.980	-0.111	-0.160	-0.204	-0.349	-0.391	1.310
43560.6468	-	-	-	-	-	-	-	-	5.023	-0.114	-0.158	-0.208	-0.356	-0.396	1.155
43560.7402	4.984	-1.463	-1.352	-0.871	-0.283	-0.053	-0.072	-0.105	5.056	-	-	-	-	-	1.505
43562.7218	-	-	-	-	-	-	-	-	4.982	-0.092	-0.134	-0.192	-0.323	-0.321	1.413
43563.7005	4.916	-1.504	-1.380	-0.901	-0.285	-0.066	-0.063	-0.098	4.981	-	-	-	-	-	1.313
44213.9461	-	-	-	-	-	-	-	-	4.777	0.018	0.036	-0.042	-0.171	-0.139	1.462
44214.9306	-	-	-	-	-	-	-	-	4.805	0.026	0.036	-0.039	-0.165	-0.138	1.379
HD 45314															
43559.7791	-	-	-	-	-	-	-	-	6.737	0.183	0.265	0.251	0.166	0.273	1.279
43560.7317	-	-	-	-	-	-	-	-	6.720	0.175	0.265	0.233	0.161	0.254	1.112
43560.8117	6.800	-1.238	-1.183	-0.620	0.046	0.134	0.073	0.186	6.725	-	-	-	-	-	1.531
43563.7969	6.796	-1.255	-1.194	-0.637	0.035	0.129	0.104	0.197	6.696	-	-	-	-	-	1.472
43796.9931	-	-	-	-	-	-	-	-	6.887	0.145	0.236	0.200	0.134	0.168	1.057
BS 4787															
38890.6593	3.852	-0.959	-0.917	-0.594	-0.169	-0.025	-0.047	-0.010	3.899	-	-	-	-	-	1.270
39150.9862	3.850	-0.960	-0.920	-0.599	-0.186	-0.018	-0.039	-0.007	3.889	-	-	-	-	-	1.260
39201.8456	3.847	-0.973	-0.920	-0.621	-0.191	-0.044	-0.020	0.013	3.867	-	-	-	-	-	1.260
39875.9697	-	-	-	-	-	-	-	-	3.908	-0.000	0.030	-0.006	-0.114	-0.179	1.260
39906.9127	-	-	-	-	-	-	-	-	3.995	-0.021	0.001	-0.050	-0.144	-0.086	1.260
39964.7510	-	-	-	-	-	-	-	-	3.849	-0.089	-0.067	-0.121	-0.244	-0.332	1.260
43268.8132	3.906	-0.847	-0.761	-0.562	-0.172	-0.026	-0.068	-0.064	3.973	-	-	-	-	-	1.363
43687.7284	-	-	-	-	-	-	-	-	3.969	-0.048	-0.079	-0.092	-0.175	-0.194	1.525
43688.7302	-	-	-	-	-	-	-	-	3.966	-0.059	-0.078	-0.106	-0.175	-0.185	1.541
43689.7365	-	-	-	-	-	-	-	-	3.971	-0.048	-0.076	-0.092	-0.158	-0.199	1.575
BS 5941															
38916.7409	4.892	-0.339	-0.329	-0.452	-0.157	0.029	-0.018	-0.013	4.910	-	-	-	-	-	1.480
39231.8855	4.946	-0.394	-0.289	-0.496	-0.119	0.024	-0.032	0.014	4.978	-	-	-	-	-	1.470
39941.8998	-	-	-	-	-	-	-	-	-	-0.036	-0.030	0.018	0.002	-0.035	1.580
39970.8379	-	-	-	-	-	-	-	-	4.886	-0.014	-0.005	0.033	0.003	0.009	1.510
39993.7994	-	-	-	-	-	-	-	-	4.893	-0.012	-0.002	0.039	-0.018	-0.038	1.460
43268.8971	-	-	-	-	-	-	-	-	4.744	-0.028	-0.020	0.004	-0.053	-0.055	1.453
43268.9956	4.784	-0.880	-0.779	-0.655	-0.170	-0.013	-0.008	0.046	4.792	-	-	-	-	-	2.262
43269.8963	4.726	-0.809	-0.725	-0.585	-0.136	-0.013	-0.059	-0.022	4.785	-	-	-	-	-	1.457
43269.8985	-	-	-	-	-	-	-	-	4.751	-0.032	-0.035	-0.013	-0.067	-0.080	1.462
43270.8787	-	-	-	-	-	-	-	-	4.730	-0.044	-0.041	-0.025	-0.094	-0.066	1.431
43303.7841	4.719	-0.839	-0.772	-0.594	-0.146	-0.009	-0.043	-0.018	4.765	-	-	-	-	-	1.426
43304.7723	4.723	-0.852	-0.763	-0.602	-0.157	-0.016	-0.035	-0.033	4.762	-	-	-	-	-	1.420
43304.8168	-	-	-	-	-	-	-	-	4.750	-0.063	-0.075	-0.009	-0.081	-0.044	1.505
43686.8274	4.748	-0.827	-0.757	-0.597	-0.138	-0.002	-0.034	0.015	4.783	-	-	-	-	-	1.897
43686.8325	-	-	-	-	-	-	-	-	4.775	-0.008	-0.007	0.008	-0.034	-0.004	1.959
43687.7329	4.776	-0.850	-0.775	-0.592	-0.147	-0.007	-0.026	0.020	4.803	-	-	-	-	-	1.425
43687.7708	-	-	-	-	-	-	-	-	4.814	-0.006	0.008	0.032	-0.036	-0.009	1.514
43688.7577	-	-	-	-	-	-	-	-	4.752	-0.013	-0.010	0.015	-0.034	-0.025	1.479
43689.7152	4.735	-0.837	-0.774	-0.593	-0.130	-0.012	-0.033	-0.005	4.770	-	-	-	-	-	1.419
43690.7366	4.731	-0.852	-0.775	-0.589	-0.138	-0.008	-0.030	-0.001	4.766	-	-	-	-	-	1.442
43690.7611	-	-	-	-	-	-	-	-	4.760	-0.004	-0.003	0.012	-0.040	-0.015	1.508
BS 6118															
38890.8457	4.603	-0.963	-0.959	-0.435	0.160	0.196	0.165	0.373	4.438	-	-	-	-	-	1.590
38929.7323	4.573	-0.939	-0.963	-0.423	0.162	0.191	0.135	0.367	4.438	-	-	-	-	-	1.590
39970.9192	-	-	-	-	-	-	-	-	4.486	0.276	0.439	0.414	0.396	0.475	1.590 →

TABLE 1 (CONTINUED)

J.D.	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	58	58-72	58-80	58-86	58-99	58-110	AIR
43268.9093	--	--	--	--	--	--	--	--	4.294	0.362	0.551	0.543	0.534	0.655	1.559
43269.9081	--	--	--	--	--	--	--	--	4.277	0.348	0.534	0.532	0.517	0.640	1.561
43270.8892	--	--	--	--	--	--	--	--	4.275	0.341	0.533	0.525	0.488	0.637	1.540
43303.8316	4.381	-0.889	-0.900	-0.334	0.221	0.214	0.161	0.392	4.225	--	--	--	--	--	1.605
43304.8099	4.418	-0.906	-0.913	-0.352	0.215	0.205	0.178	0.389	4.247	--	--	--	--	--	1.556
43304.8773	--	--	--	--	--	--	--	--	4.244	0.357	0.551	0.549	0.528	0.606	1.910
43686.8423	--	--	--	--	--	--	--	--	4.159	0.330	0.486	0.502	0.491	0.612	2.030
43686.8916	4.312	-0.859	-0.831	-0.309	0.222	0.200	0.147	0.359	4.171	--	--	--	--	--	3.170
43687.7785	--	--	--	--	--	--	--	--	4.166	0.333	0.497	0.504	0.498	0.620	1.599
43687.7973	4.339	-0.834	-0.826	-0.313	0.224	0.204	0.157	0.373	4.182	--	--	--	--	--	1.677
43688.7680	--	--	--	--	--	--	--	--	4.164	0.331	0.507	0.512	0.517	0.622	1.575
43688.7774	4.281	-0.832	-0.834	-0.309	0.234	0.197	0.149	0.375	4.132	--	--	--	--	--	1.604
43690.7450	4.224	-0.832	-0.822	-0.313	0.224	0.206	0.152	0.358	4.077	--	--	--	--	--	1.544
HD 162428															
43268.9766	--	--	--	--	--	--	--	--	7.208	-0.003	0.018	0.006	-0.044	-0.122	1.025
43269.9708	--	--	--	--	--	--	--	--	7.198	-0.003	0.015	-0.002	-0.041	-0.154	1.021
43270.9732	--	--	--	--	--	--	--	--	7.202	-0.012	-0.002	0.000	-0.054	-0.041	1.027
43303.9081	7.139	-0.471	-0.446	-0.415	-0.106	-0.009	-0.004	0.016	7.146	--	--	--	--	--	1.067
43304.8941	7.145	-0.463	-0.458	-0.413	-0.119	-0.014	-0.004	0.010	7.153	--	--	--	--	--	1.046
43686.9189	7.110	-0.822	-0.786	-0.490	-0.106	-0.008	0.000	0.050	7.112	--	--	--	--	--	1.279
43686.9215	--	--	--	--	--	--	--	--	7.121	0.022	0.064	0.039	-0.029	0.020	1.294
43687.8503	--	--	--	--	--	--	--	--	7.165	0.051	0.079	0.076	-0.019	-0.002	1.054
43689.7522	7.113	-0.793	-0.759	-0.456	-0.104	-0.005	-0.009	0.020	7.124	--	--	--	--	--	1.031
BS 6664															
43268.9645	--	--	--	--	--	--	--	--	6.776	-0.067	-0.096	-0.114	-0.167	-0.378	1.053
43269.9596	--	--	--	--	--	--	--	--	6.793	-0.052	-0.078	-0.080	-0.175	-0.165	1.052
43270.9426	--	--	--	--	--	--	--	--	6.775	-0.075	-0.106	-0.101	-0.202	-0.204	1.048
43303.8714	6.629	-0.815	-0.762	-0.553	-0.169	-0.038	-0.029	-0.036	6.661	--	--	--	--	--	1.054
43304.8825	6.641	-0.821	-0.762	-0.557	-0.185	-0.039	-0.018	-0.043	6.664	--	--	--	--	--	1.065
43382.7345	6.830	-0.799	-0.741	-0.560	-0.171	-0.023	-0.027	-0.036	6.860	--	--	--	--	--	1.190
43384.7199	--	--	--	--	--	--	--	--	6.849	-0.034	-0.062	-0.059	-0.113	-0.181	1.164
43686.9060	--	--	--	--	--	--	--	--	6.891	-0.044	-0.072	-0.048	-0.118	-0.102	1.203
43686.9080	6.853	-0.668	-0.619	-0.527	-0.155	-0.024	-0.018	-0.015	6.872	--	--	--	--	--	1.209
43687.8240	6.855	-0.658	-0.624	-0.521	-0.159	-0.023	-0.012	-0.015	6.867	--	--	--	--	--	1.057
43687.8383	--	--	--	--	--	--	--	--	6.925	-0.046	-0.074	-0.067	-0.108	-0.114	1.069
43689.7435	6.867	-0.638	-0.604	-0.496	-0.170	-0.027	-0.031	-0.032	6.900	--	--	--	--	--	1.076
43689.8034	--	--	--	--	--	--	--	--	6.907	-0.029	-0.066	-0.054	-0.114	-0.101	1.050
43690.7767	6.866	-0.662	-0.616	-0.520	-0.162	-0.023	-0.023	-0.033	6.892	--	--	--	--	--	1.049
43690.7867	--	--	--	--	--	--	--	--	6.904	-0.040	-0.082	-0.063	-0.129	-0.221	1.048
HD 173371															
43303.9416	6.888	-0.477	-0.434	-0.364	-0.047	0.031	0.005	0.035	6.885	--	--	--	--	--	1.238
43304.9419	6.866	-0.474	-0.460	-0.371	-0.068	0.012	0.022	0.057	6.847	--	--	--	--	--	1.247
43382.8151	6.914	-0.512	-0.443	-0.386	-0.075	0.020	0.017	0.028	6.899	--	--	--	--	--	1.900
43383.7578	6.893	-0.479	-0.461	-0.398	-0.066	0.013	0.010	0.021	6.887	--	--	--	--	--	1.380
43384.7751	6.880	-0.462	-0.434	-0.372	-0.053	0.034	0.011	0.038	6.872	--	--	--	--	--	1.513
43386.7577	--	--	--	--	--	--	--	--	6.850	-0.005	-0.002	0.013	-0.002	-0.107	1.428
43387.7307	--	--	--	--	--	--	--	--	6.845	0.023	0.062	0.049	0.064	0.099	1.302
43687.8975	6.904	-0.510	-0.485	-0.387	-0.052	0.016	0.043	0.064	6.862	--	--	--	--	--	1.260
43687.9354	--	--	--	--	--	--	--	--	6.905	0.036	0.059	0.041	0.046	0.076	1.443
43688.8373	6.877	-0.492	-0.463	-0.368	-0.057	0.019	0.034	0.057	6.842	--	--	--	--	--	1.163
43689.7707	6.841	-0.491	-0.453	-0.348	-0.049	0.022	0.017	0.033	6.826	--	--	--	--	--	1.244
43689.8751	--	--	--	--	--	--	--	--	6.889	0.047	0.063	0.065	0.062	0.048	1.213
43690.8080	6.901	-0.481	-0.451	-0.362	-0.052	0.024	0.017	0.039	6.887	--	--	--	--	--	1.170
BS 7106															
38917.8555	3.418	-0.832	-0.798	-0.582	-0.080	0.030	0.061	0.118	3.357	--	--	--	--	--	1.010
39240.9878	3.399	-0.891	-0.865	-0.607	-0.078	0.036	0.050	0.131	3.349	--	--	--	--	--	1.000
39297.7313	3.405	-0.843	-0.796	-0.576	-0.070	0.047	0.068	0.118	3.337	--	--	--	--	--	1.200
39300.7465	3.573	-0.818	-0.810	-0.567	-0.055	0.035	0.075	0.144	3.498	--	--	--	--	--	1.120
39407.6103	3.506	-0.853	-0.846	-0.591	-0.078	0.025	0.048	0.104	3.458	--	--	--	--	--	1.070
39408.6044	3.430	-0.866	-0.817	-0.590	-0.059	0.041	0.060	0.105	3.370	--	--	--	--	--	1.060
39714.7668	--	--	--	--	--	--	--	--	3.656	-0.029	0.088	0.116	0.105	0.186	1.060
39732.6265	--	--	--	--	--	--	--	--	3.387	0.076	0.093	0.072	0.039	-0.071	1.010
39732.6358	--	--	--	--	--	--	--	--	3.393	0.114	0.103	0.109	0.093	0.159	1.000
39974.8658	--	--	--	--	--	--	--	--	4.256	0.130	0.178	0.209	0.182	0.269	1.250
43303.9712	3.632	-0.788	-0.786	-0.544	-0.057	0.024	0.082	0.130	3.554	--	--	--	--	--	1.104
43304.9719	3.786	-0.775	-0.790	-0.549	-0.076	0.020	0.101	0.142	3.691	--	--	--	--	--	1.113
43382.8301	3.851	-0.774	-0.758	-0.553	-0.070	0.036	0.070	0.109	3.783	--	--	--	--	--	1.473
43383.7660	3.681	-0.777	-0.769	-0.565	-0.069	0.026	0.084	0.112	3.600	--	--	--	--	--	1.143
43383.8230	--	--	--	--	--	--	--	--	3.560	0.050	0.091	0.114	0.061	0.162	1.440
43384.7850	3.494	-0.798	-0.800	-0.548	-0.048	0.048	0.069	0.122	3.428	--	--	--	--	--	1.229
43386.7700	--	--	--	--	--	--	--	--	3.401	0.056	0.097	0.119	0.084	0.165	1.188
43387.7407	--	--	--	--	--	--	--	--	3.607	0.068	0.111	0.125	0.105	0.238	1.101
43686.9717	--	--	--	--	--	--	--	--	4.163	0.050	0.091	0.134	0.111	0.259	1.299
43687.9246	3.729	-0.728	-0.727	-0.523	-0.038	0.045	0.081	0.151	3.648	--	--	--	--	--	1.117
43687.9763	--	--	--	--	--	--	--	--	3.658	0.072	0.097	0.121	0.105	0.196	1.342
43688.8552	3.542	-0.812	-0.817	-0.543	-0.045	0.042	0.072	0.122	3.470	--	--	--	--	--	1.006
43689.7895	3.438	-0.829	-0.822	-0.544	-0.063	0.033	0.069	0.105	3.369	--	--	--	--	--	1.028
43690.8262	--	--	--	--	--	--	--	--	3.414	0.076	0.106	0.121	0.062	0.131	1.001
HD 184279															
43382.8507	6.928	-1.129	-1.051	-0.635	-0.042	0.080	0.045	0.100	6.886	--	--	--	--	--	1.827
43383.7752	6.900	-1.133	-1.081	-0.651	-0.016	0.075	0.050	0.088	6.853	--	--	--	--	--	1.256
43383.8393	--	--	--	--	--	--	--	--	6.778	0.031	0.084	0.083	0.001	0.048	1.713
43384.8320	6.913	-1.169	-1.107	-0.640	-0.040	0.079	0.065	0.106	6.852	--	--	--	--	--	1.659
43386.7841	--	--	--	--	--	--	--	--	6.833	0.070	0.122	0.108	0.068	0.118	1.332
43387.7519	--	--	--	--	--	--	--	--	6.800	0.057	0.103	0.090	0.033	0.100	1.214
43688.9398	--	--	--	--	--	--	--	--	7.030	0.066	0.100	0.114	0.078	0.180	1.256
43688.9469	7.079	-1.090	-1.029	-0.591	-0.026	0.086	0.063	0.127	7.016	--	--	--	--	--	

TABLE 1 (CONTINUED)

J.D.	52	33-52	35-52	37-52	40-52	45-52	52-58	52-63	58	58-72	58-80	58-86	58-99	58-110	AIR
43690.8511	7.067	-1.074	-1.019	-0.584	-0.022	0.087	0.060	0.111	7.012	--	--	--	--	--	1.127
43690.8996	--	--	--	--	--	--	--	--	7.034	0.079	0.099	0.118	0.076	0.127	1.161
BS 7763															
38928.9387	4.940	-0.617	-0.624	-0.236	0.351	0.278	0.299	0.520	4.641	--	--	--	--	--	1.010
39280.9477	4.972	-0.617	-0.636	-0.237	0.339	0.287	0.296	0.539	4.676	--	--	--	--	--	1.000
39741.6716	--	--	--	--	--	--	--	--	4.684	0.283	0.400	0.450	0.578	0.826	1.000
39989.9929	--	--	--	--	--	--	--	--	4.604	0.252	0.372	0.440	0.547	0.795	1.000
43383.8178	4.978	-0.616	-0.638	-0.233	0.355	0.270	0.284	0.509	4.694	--	--	--	--	--	1.115
43383.8745	--	--	--	--	--	--	--	--	4.643	0.268	0.414	0.470	0.574	0.836	1.356
43384.8582	4.968	-0.605	-0.630	-0.207	0.364	0.277	0.286	0.501	4.686	--	--	--	--	--	1.277
43384.8841	--	--	--	--	--	--	--	--	4.656	0.275	0.402	0.467	0.569	0.785	1.438
43386.8328	--	--	--	--	--	--	--	--	4.674	0.295	0.425	0.493	0.594	0.826	1.189
43387.7767	--	--	--	--	--	--	--	--	4.672	0.286	0.415	0.488	0.586	0.849	1.050
43414.7594	--	--	--	--	--	--	--	--	4.537	0.298	0.452	0.510	0.606	0.837	1.204
43414.7691	4.865	-0.575	-0.607	-0.202	0.389	0.291	0.289	0.523	4.575	--	--	--	--	--	1.242
43415.6693	4.843	-0.560	-0.594	-0.195	0.400	0.288	0.281	0.507	4.561	--	--	--	--	--	1.016
43415.7081	--	--	--	--	--	--	--	--	4.599	0.325	0.455	0.526	0.608	0.819	1.065
43416.6811	4.950	-0.573	-0.597	-0.201	0.379	0.292	0.280	0.501	4.671	--	--	--	--	--	1.028
43666.8228	--	--	--	--	--	--	--	--	4.626	0.303	0.425	0.504	0.571	0.749	1.301
43667.8200	--	--	--	--	--	--	--	--	4.637	0.302	0.424	0.508	0.584	0.784	1.301
43688.9587	--	--	--	--	--	--	--	--	4.526	0.300	0.437	0.509	0.592	0.779	1.061
43689.9232	4.814	-0.590	-0.628	-0.179	0.388	0.286	0.303	0.544	4.507	--	--	--	--	--	1.020
43689.9495	--	--	--	--	--	--	--	--	4.528	0.317	0.457	0.527	0.602	0.798	1.050
43690.9215	4.790	-0.589	-0.629	-0.176	0.390	0.286	0.297	0.541	4.497	--	--	--	--	--	1.020
43690.9567	--	--	--	--	--	--	--	--	4.512	0.321	0.457	0.528	0.616	0.806	1.068
43790.7199	4.896	-0.576	-0.625	-0.210	0.375	0.271	0.295	0.513	4.609	--	--	--	--	--	1.166
43791.7357	--	--	--	--	--	--	--	--	4.558	0.289	0.432	0.494	0.586	0.815	1.236
43793.7258	--	--	--	--	--	--	--	--	4.663	0.295	0.436	0.510	0.588	0.823	1.217
43793.7270	4.918	-0.575	-0.603	-0.197	0.370	0.276	0.291	0.529	4.635	--	--	--	--	--	1.227
43796.6658	--	--	--	--	--	--	--	--	4.686	0.287	0.422	0.498	0.579	0.797	1.065
BS 8047															
39045.6417	4.595	-1.364	-1.296	-0.769	-0.096	0.048	0.017	0.105	4.578	--	--	--	--	--	1.040
39373.6502	4.765	-1.344	-1.249	-0.743	-0.117	0.055	-0.025	0.068	4.790	--	--	--	--	--	1.110
40019.8697	--	--	--	--	--	--	--	--	4.662	--	0.183	0.100	-0.008	0.064	1.130
40025.8883	--	--	--	--	--	--	--	--	4.639	0.201	0.246	0.189	0.046	0.135	1.060
43383.8378	5.021	-1.481	-1.376	-0.885	-0.270	-0.057	-0.067	-0.119	5.092	--	--	--	--	--	1.120
43384.9180	5.019	-1.478	-1.365	-0.854	-0.261	-0.053	-0.051	-0.093	5.076	--	--	--	--	--	1.449
43386.8561	--	--	--	--	--	--	--	--	5.093	-0.080	-0.113	-0.164	-0.282	-0.325	1.189
43387.8272	--	--	--	--	--	--	--	--	5.043	-0.078	-0.106	-0.171	-0.287	-0.347	1.121
43414.7832	--	--	--	--	--	--	--	--	5.056	-0.050	-0.093	-0.152	-0.291	-0.296	1.201
43414.8035	4.979	-1.470	-1.377	-0.876	-0.251	-0.047	-0.070	-0.070	5.046	--	--	--	--	--	1.277
43415.6935	5.048	-1.469	-1.376	-0.882	-0.249	-0.046	-0.067	-0.090	5.118	--	--	--	--	--	1.047
43415.7297	--	--	--	--	--	--	--	--	5.096	-0.081	-0.103	-0.163	-0.305	-0.338	1.083
43416.7525	4.984	-1.487	-1.376	-0.882	-0.265	-0.049	-0.063	-0.087	5.048	--	--	--	--	--	1.131
43744.8011	4.972	-1.506	-1.397	-0.887	-0.259	-0.047	-0.057	-0.071	5.030	--	--	--	--	--	1.053
43745.8414	4.981	-1.500	-1.411	-0.873	-0.252	-0.048	-0.051	-0.064	5.036	--	--	--	--	--	1.109
43790.7288	4.894	-1.468	-1.401	-0.831	-0.188	-0.020	-0.012	-0.014	4.914	--	--	--	--	--	1.131
43791.7453	--	--	--	--	--	--	--	--	4.908	-0.013	0.003	-0.065	-0.195	-0.176	1.182
43793.7344	--	--	--	--	--	--	--	--	4.941	0.003	0.017	-0.052	-0.189	-0.187	1.167
43793.7391	--	--	--	--	--	--	--	--	4.918	--	--	--	--	--	1.180
43796.6997	4.866	-1.457	-1.362	-0.834	-0.183	-0.010	-0.041	-0.027	4.945	-0.010	0.000	-0.067	-0.193	-0.178	1.105
43796.7019	4.863	-1.444	-1.398	-0.822	-0.183	-0.016	-0.024	-0.036	4.900	--	--	--	--	--	1.109
BS 8731															
43383.9571	--	--	--	--	--	--	--	--	5.245	0.022	0.080	0.054	-0.020	0.042	1.234
43383.9578	5.258	-1.036	-0.954	-0.669	-0.143	0.014	-0.008	0.091	5.270	--	--	--	--	--	1.236
43384.9864	5.275	-1.010	-0.939	-0.652	-0.137	0.016	0.003	0.086	5.277	--	--	--	--	--	1.375
43386.9746	--	--	--	--	--	--	--	--	5.261	0.053	0.096	0.089	0.021	0.034	1.343
43387.9533	--	--	--	--	--	--	--	--	5.306	0.053	0.103	0.091	0.034	0.094	1.260
43414.9342	5.315	-0.981	-0.920	-0.665	-0.138	0.019	-0.022	0.072	5.336	--	--	--	--	--	1.570
43415.8784	--	--	--	--	--	--	--	--	5.381	0.031	0.081	0.087	0.023	0.055	1.266
43415.8798	5.328	-0.927	-0.859	-0.659	-0.127	0.015	-0.016	0.069	5.348	--	--	--	--	--	1.272
43416.8590	5.348	-0.983	-0.924	-0.675	-0.145	0.010	-0.010	0.071	5.358	--	--	--	--	--	1.206
43744.9491	5.404	-0.559	-0.520	-0.637	-0.164	-0.003	-0.036	0.038	5.442	--	--	--	--	--	1.171
43745.9059	5.372	-0.615	-0.567	-0.641	-0.168	-0.010	-0.040	0.026	5.413	--	--	--	--	--	1.087
43790.7644	5.356	-0.561	-0.544	-0.649	-0.157	0.000	-0.049	0.011	5.407	--	--	--	--	--	1.065
43791.8027	--	--	--	--	--	--	--	--	5.372	-0.035	-0.036	0.046	0.006	0.048	1.127
43793.7878	--	--	--	--	--	--	--	--	5.428	-0.029	-0.022	0.057	0.001	0.052	1.108
43793.7983	5.375	-0.567	-0.524	-0.652	-0.153	0.005	-0.053	0.021	5.429	--	--	--	--	--	1.129
43796.7344	5.408	-0.479	-0.461	-0.621	-0.148	-0.001	-0.035	0.008	5.451	--	--	--	--	--	1.055
43796.7539	--	--	--	--	--	--	--	--	5.459	-0.033	-0.029	0.052	0.013	0.047	1.071
44213.6032	--	--	--	--	--	--	--	--	5.346	-0.044	-0.046	-0.006	-0.046	-0.007	1.062
44214.6190	--	--	--	--	--	--	--	--	5.395	-0.038	-0.044	0.001	-0.060	0.009	1.082
HD 218393															
43383.9749	7.086	-0.364	-0.367	-0.184	0.285	0.229	0.211	0.437	6.876	--	--	--	--	--	1.281
43387.9730	--	--	--	--	--	--	--	--	6.915	0.379	0.546	0.650	0.759	0.966	1.319
43414.9898	7.136	-0.218	-0.279	-0.104	0.309	0.227	0.236	0.484	6.901	--	--	--	--	--	2.091
43415.9047	--	--	--	--	--	--	--	--	6.864	0.397	0.575	0.677	0.787	0.924	1.357
43415.9265	7.078	-0.278	-0.309	-0.145	0.314	0.231	0.228	0.468	6.850	--	--	--	--	--	1.483
43416.8842	7.096	-0.224	-0.254	-0.128	0.315	0.239	0.225	0.459	6.872	--	--	--	--	--	1.278
43745.9240	7.107	-0.293	-0.338	-0.136	0.315	0.232	0.227	0.466	6.882	--	--	--	--	--	1.113
43791.8122	--	--	--	--	--	--	--	--	6.982	0.385	0.546	0.644	0.742	0.904	1.140
43793.7986	--	--	--	--	--	--	--	--	7.023	0.367	0.541	0.639	0.718	0.890	1.124
43796.7417	7.244	-0.416	-0.435	-0.175	0.285	0.204	0.203	0.425	7.040	--	--	--	--	--	1.064
43796.7629	--	--	--	--	--	--	--	--	7.054	0.380	0.553	0.644	0.751	0.905	1.082
44211.6401	--	--	--	--	--	--	--	--	6.815	0.386	0.551	0.657	0.743	0.893	1.099
44213.6590	--	--	--	--	--	--	--	--	6.813	0.405	0.579	0.669	0.770	0.941	1.144

- BS 1180 = HD 23862 = MWC 75 = 28 Tau Pleione.
GRP III, $V \sin i = 330 \text{ km s}^{-1}$, $V = 5.09$ variable. MK = B8 V, Q = B8.
Change in emission. Strong shell of H and metals developed in 1972.
- BS 1209 = HD 24534 = MWC 78 = $\times$ Per.
 $V \sin i = 150 \text{ km s}^{-1}$, $V = 6.10$ variable. Sp. Ty. = O9.5 V (1) O0-B0 (2).
Large change in emission. Weak helium shell.
- BS 1789 = HD 35439 = MWC 110 = 25 Ori.
GRP V, $V \sin i = 316 \text{ km s}^{-1}$, $V = 4.95$, MK = B1 V, Q = B1, Sp. UV = DB1, UND = B1.5 IVe.
B – Be from 1953 to 1974. In 1975 H α again in absorption.
- HD 45314 = MWC 140.
 $V = 6.64$, Sp. Ty. O9-B0?
Important changes in emission. Temporary hydrogen shell.
- BS 4787 = HD 109387 = MWC 222 = 5 K Dra.
GRP I, $V \sin i = 243 \text{ km s}^{-1}$, $V = 3.87$, MK B5 IV, Q = B5, Sp. UV = GB6, UND = B5 IVe.
Strong emission lines. Temporary shell component that changes within several days.
- BS 5941 = HD 142983 = MWC 239, 48 Lib.
GRP III, $V \sin i = 393 \text{ km s}^{-1}$, $V = 4.88$ variable. MK = B4 III, Q = B, Sp. UV = GB2.5, UND = B3 Ve.
Hydrogen and metallic variable shell showing great changes.
- BS 6118 = HD 148184 = MWC 241 = 7 Psi Oph.
GRP I, $V \sin i = 134 \text{ km s}^{-1}$, $V = 4.42$ variable. MK = B1 V, Q = O9.
Very strong emission lines decreasing in intensity from 1969 to 1975.
- HD 162428 = MWC 594.
GRP II, $V \sin i = 350 \text{ km s}^{-1}$, $V = 7.0$, MK = B7 Vn.
Changes in emission lines and a variable Hydrogen shell.
- BS 6664 = HD 162732 = MWC 88 Her.
GRP V, $V \sin i = 300 \text{ km s}^{-1}$, $V = 6.68$, MK = B7 Vn, Q = B7.
Be + Shell $\rightarrow$ B Hydrogen and metallic shell.
- HD 173371 = MWC 956.
GRP IV, $V \sin i = 350 \text{ km s}^{-1}$, $V = 6.8$, MK = B8 III, Q = B7.
Changes in the H α line, Be $\rightarrow$ B in 1974.
- BS 7106 = HD 174638 = MWC 306. β Lyra, eclipsing binary + gaseous streams.
 $V = 3.4$ variable. B8 + F?
Primary mass = $11 M_{\odot}$, secondary mass $> 20.2 M_{\odot}$.
- HD 184279 = MWC 319.
GRP V, $V \sin i = 228 \text{ km s}^{-1}$, $V = 6.94$, MK = B0.5, Q = B0.5.
B $\rightarrow$ Be + temporary shell of hydrogen, helium and Fe III.
- BS 7763 = HD 193237 = MWC 338, 34 P Cyg.
 $V = 4.90$, Sp. Ty. = B1 e, Bpe.
Shell always in expansion.
- BS 8047 = HD 200120 = MWC 359, 59 Cyg. F1 Cyg.
GRP I, $V \sin i = 374 \text{ km s}^{-1}$, $V = 4.74$ variable, MK = B1, Q = B0, Sp UV = GB1, UND = B1 IVe.
Variable emission lines + temporary shell of hydrogen, helium and ionized metals. BE $\rightarrow$ B in 1976?
- BS 8731 = HD 217050 = MWC 394, BW Lac.
GRP I, $V \sin i = 350 \text{ km s}^{-1}$, $V = 5.43$, MK = B3 III, Q = B3, Sp. UV = GB 2.5.
Strong and rapidly variable emission lines + strong shell of hydrogen and metals.
Night to night variations.
- HD 218393 = MWC 397.
Spect. Bin. P = 38 D, $V = 7.02$, Sp. Ty. = B0 IV-III.
Variable lines hydrogen shell, metallic shell lines vary with P = 38 D.

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