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Four-colour Photometry of Eclipsing Binaries. II

RZ Cha, Light Curves, Photometric Elements and Determination of Helium Content

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Summary. Photometric elements are derived for the eclipsing binary RZ Cha. Combined with spectroscopic elements the absolute dimensions are derived. A comparison with new stellar model calculations was carried out and the helium content of RZ Cha was found to be $Y=0.21\pm0.05$.

Key words: eclipsing binary – light curves – photometric elements and helium content

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1. Introduction

RZ Cha (HD 93486 = CoD − 81° 391 = BV 473, $m_V=$ 8.1–8.5, Sp F5 IV − V) was mentioned as double-lined spectroscopic binary by Popper (1966) and recommended by Batten (1971) to be observed photometrically. Spectroscopic observations have been obtained by Andersen *et al.* (1975) who derive $M_1 \sin^3 i$ and $M_2 \sin^3 i$ to an accuracy of 1.7%. The masses are equally large to this accuracy. The components seem to be somewhat evolved according to the spectral classes, and the masses also seem a bit high for the spectral type. The period is $2^d\!.8$ and the light curve seems uncomplicated, see Strohmeier *et al.* (1964). One should therefore expect that fundamental parameters for this binary could be derived with good accuracy and that a comparison with stellar evolution calculation could be made and helium content derived.

2. The Observations

The observations were carried out at the European Southern Observatory, La Silla, Chile on 23 nights during the period March 1972–June 1973. The observations on the last two nights were made by Grønbech. All observations were done using the 50 cm reflecting telescope belonging to the Copenhagen Observatory. The Strömgren four channel photometer was used to give observations simultaneously in the four colour *uvby* system. Two comparison stars were selected in order to check these stars for variability. Altogether 775 observations of RZ Cha were obtained in each of the four colours. The scatter in the magnitude difference of the comparison stars is found to be $\sigma(\Delta u)=0.007$, $\sigma(\Delta v)=0.005$, $\sigma(\Delta b)=0.005$ and $\sigma(\Delta y)=0.007$ which is very nearly the same as for the comparison stars of HS Hya discussed by Gyldenkerne *et al.* (1975). The magnitude difference between the two comparison stars was plotted night by night and no variation was found. The light curves of RZ Cha in the instrumental system are given in Table 1 and Fig. 1, where HR 4312 has been used as comparison star. For further details of methods we refer to Gyldenkerne *et al.* (1975).

The following times of minimum (Table 2) are derived using the method described by Kwee and van Woerden (1956). The period is not well determined from the times of minimum and instead we have developed a computer program which derives the scatter around the mean light curve for an assumed period. A scan through periods were made and the period giving the smallest scatter around the mean curve was accepted. This method includes branches of minima with high weight even if only one branch is observed on a particular night. We find

$$\text{Pr. Min} = 2441401.7711 + \text{E} \times 2^d\!.832084 \qquad (1)$$

from which the $O-C$ values are computed for the primary minima. The $O-C$ values for the secondary minima are determined assuming phase 0.5 exactly. Obviously the secondary minima fall very precisely at phase 0.5 and we assume that the system has circular orbits, in agreement with the spectroscopic evidence.

3. Photometric Element Determination

First we used the rectification procedure described more in detail for HS Hya by Gyldenkerne *et al.* (1975). The rectification constants are given in Table 3.

From the further discussion and the results by Andersen (1975) we derive the mean dynamical ellipticity $z=0.019$

TABLE 1. RZ CHA – HR 4312 IN THE INSTRUMENTAL SYSTEM.

HJD–2440000	Δu	Δv	Δb	Δy
1380.53403	2.307	2.731	2.473	2.227
1380.54169	2.343	2.732	2.474	2.243
1380.54630	2.319	2.721	2.466	2.223
1380.55348	2.332	2.711	2.457	2.227
1380.56037	2.293	2.691	2.430	2.205
1380.57287	2.246	2.651	2.401	2.158
1380.57774	2.233	2.632	2.374	2.150
1380.58462	2.203	2.609	2.355	2.127
1380.59162	2.181	2.583	2.329	2.097
1380.59649	2.173	2.560	2.304	2.075
1380.60274	2.133	2.534	2.277	2.048
1380.61162	2.102	2.512	2.251	2.032
1380.61718	2.093	2.482	2.225	2.003
1380.62899	2.054	2.450	2.196	1.971
1380.64489	1.993	2.397	2.154	1.914
1380.65114	1.994	2.391	2.134	1.902
1386.55875	1.918	2.327	2.075	1.844
1386.56737	1.923	2.331	2.072	1.839
1386.59466	1.930	2.319	2.063	1.843
1386.60195	1.930	2.324	2.070	1.834
1386.62794	1.930	2.328	2.070	1.847
1386.63349	1.917	2.328	2.069	1.856
1386.65746	1.938	2.323	2.074	1.844
1386.66279	1.926	2.327	2.069	1.845
1386.68824	1.927	2.330	2.072	1.862
1386.75112	1.929	2.326	2.068	1.847
1386.75629	1.926	2.327	2.067	1.845
1386.77959	1.914	2.318	2.061	1.843
1386.78667	1.916	2.320	2.064	1.839
1386.81089	1.916	2.315	2.062	1.835
1386.81891	1.925	2.327	2.071	1.850
1386.84211	1.922	2.321	2.064	1.830
1386.84847	1.923	2.323	2.070	1.842
1386.87498	1.918	2.326	2.072	1.832
1386.87985	1.916	2.325	2.065	1.827
1387.77167	1.939	2.330	2.078	1.850
1387.77566	1.930	2.336	2.080	1.850
1387.77867	1.929	2.327	2.079	1.845
1387.78318	1.927	2.336	2.078	1.858
1387.78700	1.933	2.335	2.079	1.853
1387.79175	1.930	2.331	2.076	1.858
1387.79586	1.937	2.332	2.076	1.850
1387.80025	1.943	2.336	2.087	1.857
1387.80454	1.947	2.335	2.080	1.847
1387.80853	1.947	2.335	2.070	1.858
1387.81189	1.939	2.334	2.078	1.852
1387.81617	1.934	2.335	2.077	1.864
1387.81958	1.938	2.331	2.076	1.860
1387.82305	1.939	2.332	2.081	1.857
1387.82682	1.942	2.331	2.081	1.857
1387.83087	1.935	2.333	2.078	1.837
1387.83561	1.936	2.333	2.072	1.843
1387.83926	1.935	2.333	2.075	1.842
1387.84389	1.935	2.332	2.078	1.847
1387.84881	1.940	2.336	2.078	1.853
1387.85355	1.936	2.336	2.077	1.848
1387.85691	1.927	2.331	2.075	1.851
1387.86038	1.937	2.338	2.080	1.852
1387.86420	1.937	2.334	2.080	1.860
1387.86767	1.934	2.336	2.081	1.846
1387.87149	1.936	2.336	2.079	1.851
1387.87560	1.924	2.328	2.072	1.849
1387.87965	1.953	2.335	2.074	1.845
1387.88399	1.934	2.328	2.075	1.841
1387.88775	1.929	2.329	2.075	1.852
1387.89256	1.942	2.339	2.074	1.853
1387.89603	1.927	2.334	2.082	1.849
1388.82300	1.926	2.329	2.067	1.857
1388.82977	1.934	2.330	2.072	1.848
1388.84329	1.940	2.330	2.078	1.840
1388.84713	1.930	2.331	2.074	1.855
1388.86267	1.946	2.336	2.079	1.863
1388.87870	1.936	2.342	2.089	1.859
1388.88249	1.963	2.349	2.094	1.868
1389.71890	1.930	2.333	2.076	1.853
1389.72232	1.923	2.322	2.066	1.840
1389.74500	1.926	2.323	2.072	1.843
1389.74865	1.923	2.321	2.067	1.840
1389.76827	1.917	2.317	2.064	1.852
1389.77197	1.922	2.323	2.060	1.857
1389.78927	1.928	2.316	2.067	1.824
1389.79344	1.921	2.322	2.064	1.840
1389.80935	1.937	2.323	2.068	1.822
1389.81346	1.931	2.325	2.069	1.836
1389.83372	1.918	2.322	2.059	1.825
1389.83817	1.908	2.329	2.061	1.852
1389.85461	1.927	2.323	2.060	1.835
1389.85872	1.923	2.324	2.064	1.841
1389.87585	1.926	2.319	2.062	1.840
1389.87932	1.922	2.319	2.065	1.826
1389.89610	1.919	2.326	2.068	1.837
1389.90010	1.922	2.326	2.076	1.854
1391.83881	2.316	2.719	2.455	2.234
1391.84455	2.323	2.729	2.461	2.256
1391.84975	2.339	2.732	2.469	2.242
1391.85526	2.324	2.725	2.477	2.257
1393.61286	1.931	2.332	2.078	1.851
1393.61714	1.935	2.323	2.068	1.845
1393.62134	1.926	2.327	2.071	1.842
1393.62567	1.924	2.326	2.074	1.852
1393.63087	1.930	2.334	2.083	1.849
1393.63524	1.920	2.325	2.073	1.846
1393.64037	1.938	2.330	2.080	1.844
1393.65117	1.920	2.306	2.054	1.835
1393.65567	1.910	2.324	2.064	1.841
1393.66002	1.919	2.319	2.064	1.841
1393.81752	1.931	2.319	2.071	1.855
1393.82151	1.937	2.322	2.068	1.848
1393.82701	1.916	2.319	2.064	1.853
1393.83659	1.924	2.320	2.069	1.850
1393.84115	1.910	2.315	2.064	1.843
1393.84584	1.907	2.313	2.057	1.833
1393.85036	1.925	2.311	2.058	1.826
1394.57911	1.990	2.394	2.151	1.915
1394.58362	2.018	2.415	2.168	1.926
1394.58923	2.033	2.431	2.182	1.946
1394.59259	2.058	2.442	2.193	1.954
1394.59606	2.045	2.456	2.212	1.967
1394.60191	2.077	2.478	2.219	1.996
1394.60579	2.080	2.494	2.243	2.011
1394.60903	2.106	2.496	2.253	2.030
1394.61243	2.116	2.514	2.265	2.049
1394.61771	2.129	2.530	2.272	2.051
1394.62101	2.144	2.541	2.289	2.073
1394.62552	2.168	2.561	2.302	2.083
1394.62950	2.178	2.572	2.308	2.089
1394.63297	2.198	2.594	2.333	2.126
1394.64489	2.237	2.629	2.377	2.140
1394.64987	2.249	2.653	2.405	2.167
1394.65363	2.269	2.660	2.406	2.179
1394.65786	2.271	2.676	2.426	2.184
1394.66156	2.306	2.694	2.439	2.204
1394.66492	2.306	2.705	2.443	2.217
1394.66833	2.296	2.705	2.445	2.223
1394.67157	2.301	2.714	2.455	2.233
1394.67510	2.312	2.731	2.463	2.228
1394.67892	2.314	2.728	2.472	2.231
1394.68239	2.328	2.728	2.479	2.246
1394.68639	2.307	2.729	2.476	2.264
1394.69003	2.321	2.739	2.476	2.257
1394.69333	2.326	2.732	2.472	2.256
1394.69633	2.325	2.736	2.481	2.244
1394.70080	2.324	2.739	2.467	2.239
1394.70421	2.312	2.724	2.461	2.249
1394.70768	2.302	2.715	2.459	2.231
1394.71133	2.308	2.716	2.458	2.230
1394.71451	2.314	2.706	2.446	2.232
1394.71787	2.297	2.691	2.434	2.219
1394.72186	2.286	2.689	2.433	2.193
1394.72528	2.274	2.672	2.419	2.193
1394.72892	2.259	2.660	2.412	2.178
1394.73170	2.258	2.642	2.397	2.175
1394.73506	2.256	2.643	2.384	2.153
1394.73969	2.221	2.619	2.366	2.139
1394.74333	2.224	2.607	2.349	2.121
1394.74692	2.194	2.590	2.346	2.117
1394.75057	2.186	2.581	2.337	2.104
1394.75664	2.162	2.562	2.312	2.075
1394.76058	2.150	2.541	2.287	2.074
1394.77134	2.113	2.507	2.250	2.028
1394.77476	2.094	2.495	2.243	2.024
1394.77892	2.093	2.476	2.224	2.016
1394.78234	2.079	2.470	2.216	1.978
1394.78598	2.058	2.459	2.212	1.981
1394.78928	2.053	2.443	2.189	1.962
1394.79837	2.036	2.426	2.177	1.939
1394.80265	2.014	2.416	2.161	1.929
1394.80629	1.997	2.400	2.146	1.924
1394.80971	1.990	2.392	2.141	1.927
1394.81440	1.971	2.385	2.129	1.902
1394.81775	1.984	2.375	2.120	1.892
1394.82261	1.973	2.364	2.109	1.891
1394.82724	1.961	2.365	2.110	1.878
1394.83095	1.956	2.359	2.097	1.871
1394.83506	1.943	2.350	2.096	1.871
1394.83893	1.942	2.345	2.093	1.850
1394.84923	1.939	2.347	2.093	1.879
1394.85311	1.937	2.342	2.090	1.852
1394.85768	1.931	2.338	2.083	1.869
1394.86226	1.935	2.340	2.082	1.864
1394.86619	1.943	2.331	2.080	1.853
1394.87042	1.956	2.340	2.082	1.852
1394.87400	1.940	2.335	2.081	1.856
1394.87713	1.942	2.343	2.086	1.853
1394.88060	1.952	2.339	2.079	1.853
1394.88500	1.939	2.334	2.086	1.858
1394.89460	1.931	2.339	2.079	1.861
1394.89773	1.932	2.338	2.080	1.875
1394.90143	1.926	2.340	2.078	1.864
1394.90473	1.929	2.334	2.078	1.851
1398.57413	1.916	2.321	2.065	1.836
1398.57990	1.918	2.326	2.072	1.846
1398.61436	1.927	2.324	2.067	1.836
1398.61955	1.923	2.324	2.067	1.830
1398.62385	1.923	2.323	2.062	1.840
1398.62799	1.925	2.326	2.067	1.836
1398.64151	1.918	2.311	2.067	1.848
1398.64634	1.919	2.318	2.067	1.825
1398.65048	1.935	2.325	2.076	1.861
1398.65545	1.942	2.327	2.076	1.830
1398.69027	1.942	2.337	2.075	1.850
1398.69428	1.935	2.326	2.073	1.839
1398.70181	1.935	2.327	2.065	1.831
1398.70646	1.923	2.328	2.069	1.848
1398.76720	1.925	2.335	2.071	1.851
1398.77227	1.938	2.332	2.075	1.846
1398.77707	1.937	2.332	2.077	1.845
1398.78117	1.945	2.338	2.070	1.850
1398.82756	2.022	2.424	2.164	1.933
1398.83225	2.046	2.438	2.184	1.966
1398.83631	2.048	2.440	2.195	1.966
1398.84092	2.044	2.466	2.208	1.991
1398.84581	2.096	2.475	2.215	1.987
1398.85032	2.090	2.489	2.230	1.992
1398.87600	2.177	2.590	2.327	2.093
1398.88146	2.189	2.598	2.349	2.121
1399.55971	1.925	2.322	2.070	1.850
1399.56521	1.918	2.324	2.068	1.851
1399.56914	1.930	2.323	2.066	1.850
1399.57380	1.916	2.324	2.065	1.840
1399.60405	1.931	2.335	2.065	1.855
1399.60868	1.931	2.326	2.073	1.851
1399.61262	1.922	2.327	2.072	1.846
1399.61695	1.931	2.337	2.074	1.852
1399.65615	1.929	2.319	2.064	1.836
1399.66041	1.920	2.323	2.064	1.827
1399.66504	1.926	2.324	2.070	1.840
1399.67001	1.921	2.318	2.068	1.844
1399.70109	1.913	2.326	2.066	1.853
1399.70510	1.927	2.325	2.070	1.850
1399.70892	1.914	2.328	2.067	1.850
1399.71344	1.921	2.322	2.067	1.854
1399.74571	1.917	2.322	2.071	1.854
1399.75064	1.925	2.321	2.065	1.842
1399.75506	1.913	2.323	2.065	1.842
1401.55575	1.935	2.345	2.081	1.863
1401.56152	1.941	2.337	2.074	1.862
1401.56640	1.931	2.339	2.077	1.859
1401.57303	1.941	2.326	2.081	1.871
1401.57856	1.937	2.337	2.081	1.862
1401.58359	1.934	2.330	2.074	1.857
1401.58988	1.945	2.338	2.079	1.859
1401.59608	1.934	2.335	2.076	1.858
1401.60069	1.931	2.336	2.074	1.863
1401.60464	1.944	2.335	2.080	1.838
1401.60906	1.941	2.335	2.082	1.855
1401.61304	1.930	2.329	2.075	1.847
1401.61846	1.941	2.335	2.078	1.847
1401.62269	1.942	2.335	2.082	1.869
1401.62685	1.947	2.345	2.089	1.859
1401.63080	1.941	2.345	2.090	1.876
1401.63490	1.964	2.355	2.105	1.886
1401.63906	1.968	2.364	2.113	1.894
1401.64343	1.981	2.375	2.119	1.905
1401.64722	1.987	2.379	2.125	1.906
1401.65142	1.991	2.388	2.132	1.902
1401.65593	2.009	2.404	2.151	1.920
1401.66904	2.054	2.445	2.190	1.967
1401.67297	2.053	2.454	2.199	1.983
1401.67650	2.075	2.478	2.221	2.000
1401.68125	2.092	2.485	2.234	2.001
1401.68466	2.095	2.502	2.248	2.016
1401.69005	2.124	2.526	2.275	2.038
1401.69390	2.124	2.546	2.282	2.057
1401.69833	2.137	2.545	2.290	2.060
1401.70234	2.164	2.575	2.309	2.096
1401.70726	2.178	2.584	2.328	2.102
1401.71278	2.201	2.607	2.346	2.125
1401.71745	2.215	2.613	2.363	2.137
1401.72153	2.238	2.637	2.383	2.157
1401.72613	2.255	2.656	2.390	2.175
1401.73049	2.264	2.668	2.408	2.182
1401.73608	2.292	2.684	2.425	2.201
1401.74035	2.308	2.699	2.447	2.217
1401.75637	2.345	2.743	2.492	2.269
1401.76050	2.337	2.747	2.486	2.257
1401.76484	2.348	2.755	2.503	2.278
1401.76826	2.359	2.766	2.501	2.269
1401.77219	2.362	2.765	2.502	2.276
1401.77646	2.336	2.758	2.489	2.262
1401.78185	2.355	2.745	2.495	2.278
1401.78605	2.350	2.737	2.489	2.258
1401.79015	2.330	2.757	2.474	2.236
1401.79380	2.325	2.715	2.466	2.254
1401.79861	2.312	2.715	2.448	2.220
1401.80428	2.307	2.706	2.439	2.203
1401.80937	2.280	2.691	2.426	2.202
1401.81372	2.267	2.669	2.412	2.182
1401.81782	2.244	2.648	2.380	2.147
1401.82156	2.228	2.642	2.379	2.143
1401.82604	2.220	2.619	2.363	2.140
1401.83010	2.190	2.596	2.350	2.112
1401.83485	2.175	2.573	2.329	2.104
1401.83964	2.162	2.555	2.305	2.091
1401.85251	2.137	2.511	2.262	2.034
1401.85610	2.105	2.505	2.255	2.021
1401.86571	2.061	2.464	2.211	1.967
1401.88198	2.017	2.422	2.170	1.955
1401.88582	2.005	2.407	2.158	1.920
1401.89047	1.997	2.394	2.137	1.923
1401.89497	1.980	2.378	2.123	1.896
1401.90041	1.964	2.367	2.113	1.884
1401.90483	1.966	2.367	2.110	1.892
1401.90833	1.949	2.358	2.102	1.873
1402.54433	1.925	2.324	2.069	1.849
1402.54934	1.921	2.327	2.069	1.838
1402.55403	1.931	2.326	2.068	1.843
1402.55870	1.933	2.331	2.067	1.849
1402.58612	1.926	2.323	2.073	1.837
1402.59132	1.910	2.330	2.072	1.847
1402.59566	1.925	2.324	2.074	1.836
1402.59917	1.927	2.322	2.067	1.847
1402.62558	1.927	2.327	2.079	1.855
1402.63036	1.930	2.323	2.072	1.842
1402.63415	1.929	2.328	2.073	1.840
1402.63904	1.928	2.328	2.071	1.844
1402.66132	1.930	2.335	2.078	1.835
1402.66543	1.923	2.329	2.075	1.840
1402.66936	1.924	2.333	2.073	1.827
1402.67359	1.923	2.327	2.070	1.843
1402.69360	1.931	2.333	2.067	1.843
1402.69766	1.923	2.321	2.067	1.847
1402.70214	1.936	2.334	2.070	1.856
1402.70680	1.938	2.334	2.077	1.866
1402.72463	1.924	2.325	2.068	1.840
1402.72995	1.922	2.324	2.073	1.856
1402.73418	1.923	2.327	2.074	1.859
1402.73829	1.922	2.328	2.075	1.846
1402.75553	1.922	2.330	2.072	1.841
1402.75871	1.926	2.331	2.072	1.855
1402.76253	1.920	2.326	2.076	1.845
1402.76664	1.929	2.334	2.075	1.851
1402.78973	1.923	2.326	2.078	1.848
1402.79419	1.928	2.334	2.069	1.857
1402.79980	1.921	2.337	2.077	1.848
1402.80489	1.932	2.334	2.073	1.847
1402.82966	1.923	2.329	2.073	1.848
1402.83395	1.932	2.331	2.074	1.848
1402.83858	1.928	2.332	2.072	1.877
1402.84326	1.934	2.337	2.074	1.859
1402.86074	1.923	2.325	2.062	1.840
1402.86427	1.920	2.330	2.071	1.838
1402.86878	1.925	2.323	2.064	1.849
1402.87220	1.935	2.320	2.071	1.865
1402.88863	1.927	2.326	2.069	1.847
1402.89182	1.932	2.332	2.073	1.850
1402.89662	1.928	2.329	2.072	1.844
1402.90119	1.917	2.328	2.072	1.846
1403.77379	1.930	2.319	2.073	1.839
1403.77866	1.922	2.311	2.072	1.819
1403.78369	1.930	2.320	2.067	1.845
1403.79087	1.930	2.318	2.066	1.846
1403.79798	1.915	2.313	2.063	1.837
1403.80348	1.914	2.322	2.064	1.843
1403.81205	1.912	2.316	2.065	1.835
1403.81639	1.928	2.317	2.067	1.849
1403.82246	1.922	2.320	2.062	1.840
1403.82646	1.899	2.316	2.055	1.839
1403.83143	1.914	2.321	2.063	1.848
1403.83508	1.919	2.327	2.068	1.846
1403.84278	1.926	2.321	2.064	1.839
1403.84671	1.917	2.324	2.065	1.852
1403.85146	1.916	2.326	2.077	1.836
1403.85528	1.916	2.328	2.073	1.835
1403.85979	1.927	2.317	2.065	1.839
1403.86407	1.910	2.319	2.067	1.837
1403.86824	1.904	2.313	2.063	1.843
1403.87437	1.925	2.314	2.059	1.836
1403.87889	1.914	2.314	2.067	1.835
1404.52282	2.121	2.529	2.260	2.038
1404.52746	2.151	2.546	2.284	2.068
1404.53246	2.164	2.558	2.301	2.079
1404.53745	2.181	2.580	2.313	2.087
1404.54288	2.202	2.607	2.345	2.116
1404.54669	2.225	2.617	2.355	2.143
1404.55122	2.228	2.629	2.368	2.150
1404.55548	2.255	2.649	2.384	2.160
1404.55950	2.259	2.663	2.401	2.168
1404.56794	2.309	2.692	2.443	2.197
1404.57238	2.319	2.713	2.449	2.202
1404.57730	2.327	2.725	2.468	2.234
1404.58135	2.330	2.738	2.470	2.231
1404.58713	2.332	2.743	2.481	2.254
1404.59121	2.351	2.752	2.488	2.274
1404.60134	2.354	2.758	2.490	2.280
1404.60595	2.361	2.762	2.501	2.277
1404.61129	2.350	2.749	2.491	2.256
1404.61556	2.335	2.753	2.487	2.265
1404.61966	2.341	2.743	2.485	2.259
1404.62414	2.339	2.742	2.474	2.239
1404.62967	2.331	2.720	2.465	2.238
1404.63387	2.301	2.713	2.450	2.217
1404.63801	2.304	2.703	2.437	2.217
1404.64173	2.290	2.679	2.424	2.191
1404.64593	2.283	2.679	2.416	2.166
1404.65270	2.247	2.639	2.388	2.156
1404.65739	2.232	2.623	2.354	2.142
1404.66902	2.177	2.578	2.319	2.092
1404.67232	2.147	2.568	2.307	2.081
1404.67580	2.141	2.557	2.289	2.090
1404.67967	2.139	2.539	2.273	2.068
1404.68438	2.119	2.518	2.255	2.032
1404.68789	2.106	2.504	2.241	2.027
1404.69602	2.083	2.481	2.229	1.998
1404.69987	2.077	2.467	2.207	1.976
1404.70427	2.055	2.455	2.198	1.983
1404.70820	2.052	2.441	2.180	1.957
1404.71218	2.017	2.422	2.171	1.950
1404.71639	2.009	2.413	2.156	1.930
1404.72155	2.011	2.398	2.140	1.917
1404.72707	1.976	2.379	2.131	1.906
1404.73861	1.969	2.362	2.105	1.886
1404.74297	1.967	2.351	2.108	1.856
1404.74883	1.948	2.352	2.090	1.868
1404.75479	1.937	2.338	2.084	1.855
1404.76905	1.938	2.338	2.082	1.865
1404.77441	1.941	2.341	2.081	1.851
1404.77929	1.948	2.337	2.082	1.851
1404.78343	1.938	2.334	2.083	1.854
1404.78768	1.951	2.333	2.083	1.864
1404.79316	1.942	2.333	2.076	1.862
1404.79787	1.941	2.338	2.081	1.850
1404.80282	1.939	2.335	2.080	1.843
1404.80755	1.945	2.335	2.083	1.852
1404.81318	1.939	2.335	2.080	1.858
1404.82831	1.934	2.331	2.076	1.844
1404.83243	1.934	2.332	2.085	1.843
1404.84759	1.928	2.337	2.076	1.850
1404.85213	1.935	2.329	2.081	1.846
1404.87224	1.928	2.325	2.064	1.834
1404.87788	1.932	2.337	2.074	1.852
1404.88347	1.937	2.333	2.069	1.860
1404.88787	1.910	2.326	2.071	1.853
1405.55968	1.931	2.322	2.071	1.846
1405.56368	1.927	2.322	2.066	1.850
1405.56958	1.919	2.323	2.070	1.836
1405.57276	1.921	2.318	2.063	1.843
1405.58347	1.920	2.315	2.064	1.831
1405.58682	1.925	2.324	2.069	1.844
1405.59059	1.915	2.322	2.065	1.837
1405.59406	1.936	2.331	2.073	1.847
1405.59753	1.921	2.327	2.069	1.838
1405.60164	1.935	2.331	2.066	1.837
1405.60494	1.925	2.327	2.069	1.831
1405.60858	1.919	2.321	2.066	1.847
1405.61269	1.933	2.335	2.077	1.863
1405.61946	1.926	2.323	2.075	1.845
1405.63324	1.941	2.329	2.077	1.866
1405.63729	1.927	2.322	2.069	1.857
1405.64076	1.940	2.331	2.075	1.857
1405.64545	1.934	2.330	2.070	1.851
1405.64938	1.932	2.330	2.076	1.859
1405.65291	1.933	2.329	2.076	1.851
1405.66391	1.929	2.328	2.074	1.838
1405.66738	1.934	2.329	2.078	1.851
1405.67366	1.929	2.331	2.077	1.837
1405.68152	1.933	2.329	2.077	1.850
1405.68517	1.933	2.332	2.078	1.851
1405.68943	1.929	2.335	2.079	1.849
1405.69319	1.940	2.331	2.072	1.852
1405.69684	1.932	2.335	2.075	1.856
1405.70013	1.936	2.332	2.072	1.855
1405.70355	1.934	2.325	2.074	1.861
1405.71043	1.928	2.330	2.081	1.842
1405.71373	1.927	2.327	2.081	1.849
1405.71819	1.929	2.330	2.073	1.854
1405.72178	1.927	2.333	2.079	1.846
1405.74284	1.918	2.325	2.069	1.845
1405.74649	1.913	2.328	2.065	1.850
1405.75042	1.930	2.334	2.073	1.833
1405.75418	1.928	2.341	2.075	1.857
1405.75864	1.940	2.334	2.074	1.833
1405.78468	1.933	2.333	2.082	1.854
1405.78908	1.933	2.334	2.079	1.846
1405.79388	1.942	2.329	2.079	1.861
1405.79736	1.933	2.326	2.080	1.868
1405.80123	1.916	2.330	2.074	1.860
1405.80482	1.949	2.326	2.074	1.853
1405.80916	1.933	2.328	2.082	1.862
1405.81263	1.930	2.332	2.071	1.867
1405.81657	1.937	2.332	2.082	1.856
1405.82016	1.940	2.337	2.078	1.847
1405.82380	1.944	2.341	2.078	1.859
1405.82791	1.938	2.333	2.081	1.868
1405.83156	1.942	2.332	2.075	1.857
1407.55033	2.016	2.409	2.152	1.930
1407.55498	1.998	2.392	2.137	1.920
1407.56060	1.980	2.385	2.129	1.909
1407.57040	1.972	2.359	2.107	1.891
1407.61614	1.935	2.327	2.072	1.864
1407.62254	1.932	2.328	2.081	1.854
1407.62607	1.939	2.336	2.079	1.861
1407.63058	1.934	2.331	2.085	1.856
1407.65159	1.937	2.335	2.074	1.856
1407.65496	1.933	2.333	2.082	1.852
1407.67256	1.936	2.333	2.083	1.852
1407.68161	1.938	2.331	2.086	1.854
1407.68499	1.920	2.330	2.077	1.841
1407.70784	1.941	2.332	2.074	1.861
1407.71200	1.941	2.328	2.070	1.855
1407.71733	1.944	2.329	2.066	1.835
1407.72184	1.934	2.332	2.066	1.853
1407.75923	1.943	2.320	2.069	1.837
1407.76258	1.925	2.325	2.068	1.844
1407.77231	1.926	2.328	2.077	1.867
1407.77713	1.920	2.324	2.066	1.850
1407.78116	1.925	2.330	2.069	1.853
1407.78530	1.929	2.328	2.076	1.852
1408.65133	1.939	2.330	2.083	1.854
1408.65521	1.936	2.337	2.076	1.850
1408.67523	1.936	2.337	2.078	1.849
1408.67909	1.932	2.343	2.081	1.840
1408.68937	1.941	2.337	2.072	1.849
1408.69400	1.937	2.335	2.080	1.850
1408.69834	1.950	2.338	2.080	1.849
1408.70278	1.938	2.339	2.086	1.862
1408.70918	1.962	2.353	2.093	1.872
1408.71355	1.958	2.362	2.107	1.891
1408.71731	1.969	2.364	2.111	1.885
1408.72077	1.970	2.368	2.110	1.897
1408.72471	1.965	2.375	2.124	1.896
1408.72801	1.976	2.376	2.123	1.907
1408.73825	2.021	2.408	2.156	1.921
1408.74237	2.021	2.422	2.160	1.942
1408.74648	2.021	2.428	2.175	1.950
1408.74963	2.041	2.441	2.188	1.966
1408.75317	2.066	2.452	2.200	1.980
1408.75746	2.075	2.465	2.213	1.976
1408.76089	2.078	2.470	2.223	1.998
1408.76507	2.081	2.491	2.235	2.011
1408.76869	2.107	2.506	2.249	2.022
1408.77312	2.113	2.515	2.263	2.029
1408.77691	2.134	2.536	2.276	2.049
1408.78104	2.152	2.550	2.293	2.062
1408.78547	2.164	2.558	2.303	2.079
1408.78909	2.162	2.578	2.319	2.111
1408.79296	2.189	2.588	2.334	2.123
1408.79778	2.206	2.609	2.351	2.125
1408.80142	2.218	2.609	2.361	2.132
1408.80538	2.232	2.633	2.378	2.142
1408.81044	2.251	2.654	2.394	2.174
1408.81419	2.268	2.659	2.412	2.189
1408.81797	2.287	2.687	2.426	2.207
1408.82159	2.297	2.692	2.438	2.210
1408.82575	2.304	2.706	2.449	2.215
1408.82948	2.295	2.711	2.451	2.244
1408.84167	2.333	2.734	2.481	2.256
1408.84554	2.324	2.737	2.487	2.251
1408.84994	2.344	2.738	2.481	2.251
1408.85498	2.315	2.729	2.477	2.255
1409.50108	1.918	2.322	2.058	1.834
1409.50559	1.928	2.327	2.062	1.833
1409.50930	1.927	2.319	2.063	1.835
1409.51377	1.927	2.322	2.061	1.838
1409.54610	1.940	2.322	2.065	1.846
1409.55007	1.924	2.317	2.061	1.843
1409.57500	1.927	2.332	2.074	1.846
1409.57935	1.930	2.324	2.072	1.839
1409.60935	1.925	2.323	2.069	1.838
1409.61375	1.922	2.323	2.062	1.848
1409.63600	1.927	2.322	2.062	1.831
1409.64071	1.937	2.324	2.066	1.839
1409.66945	1.920	2.325	2.067	1.835
1409.67304	1.922	2.322	2.064	1.828
1410.50985	1.935	2.331	2.078	1.859
1410.51333	1.934	2.334	2.077	1.843
1410.51672	1.927	2.334	2.073	1.847
1410.52047	1.933	2.329	2.076	1.845
1410.54960	1.937	2.340	2.079	1.856
1410.55534	1.925	2.337	2.084	1.863
1410.56921	1.925	2.332	2.077	1.860
1410.57319	1.932	2.327	2.077	1.846
1410.57687	1.928	2.331	2.070	1.851
1410.59100	1.936	2.329	2.075	1.849
1410.59535	1.938	2.332	2.072	1.853
1410.59896	1.929	2.325	2.067	1.844
1410.61505	1.925	2.330	2.072	1.852
1410.61843	1.928	2.331	2.075	1.852
1410.64262	1.930	2.323	2.067	1.848
1410.64607	1.934	2.327	2.074	1.841
1410.64937	1.931	2.327	2.075	1.842
1410.67246	1.933	2.330	2.079	1.857
1410.67533	1.923	2.334	2.073	1.855
1410.67948	1.925	2.331	2.075	1.850
1410.68351	1.928	2.327	2.073	1.843
1410.68698	1.931	2.323	2.073	1.842
1410.69046	1.936	2.331	2.068	1.838
1410.69401	1.928	2.321	2.070	1.850
1410.69792	1.921	2.327	2.071	1.838
1410.70151	1.933	2.323	2.069	1.839
1410.70571	1.921	2.330	2.074	1.858
1410.70943	1.920	2.325	2.085	1.846
1410.72775	1.928	2.324	2.073	1.853
1410.73165	1.920	2.325	2.071	1.835
1410.73513	1.920	2.324	2.063	1.846
1410.73932	1.914	2.321	2.067	1.841
1410.76347	1.934	2.328	2.072	1.844
1410.76704	1.940	2.324	2.066	1.849
1410.77472	1.929	2.328	2.075	1.843
1410.77825	1.922	2.329	2.072	1.840
1410.78189	1.920	2.319	2.069	1.845
1410.78579	1.918	2.321	2.065	1.841
1410.78999	1.916	2.318	2.065	1.844
1410.79335	1.928	2.317	2.069	1.843
1410.80938	1.921	2.326	2.067	1.842
1410.81334	1.915	2.322	2.060	1.843
1410.81794	1.922	2.323	2.070	1.851
1410.82171	1.922	2.328	2.065	1.848
1410.83417	1.921	2.327	2.072	1.840
1410.83932	1.920	2.330	2.070	1.852
1410.84306	1.915	2.320	2.065	1.848
1410.86169	1.913	2.312	2.060	1.834
1410.86575	1.913	2.313	2.061	1.842
1410.86933	1.916	2.313	2.064	1.833
1410.87391	1.929	2.326	2.064	1.857
1410.87744	1.922	2.316	2.062	1.846
1410.88206	1.937	2.319	2.062	1.844
1410.88580	1.914	2.316	2.060	1.834
1410.89042	1.926	2.324	2.064	1.835
1410.89613	1.923	2.319	2.058	1.834
1410.90339	1.920	2.317	2.065	1.844
1410.90602	1.937	2.324	2.067	1.836
1410.90999	1.916	2.320	2.064	1.838
1411.49485	1.939	2.333	2.081	1.857
1411.49905	1.940	2.337	2.082	1.842
1411.51418	1.939	2.331	2.068	1.848
1411.51896	1.933	2.333	2.076	1.865
1411.52471	1.916	2.330	2.072	1.858
1411.52926	1.932	2.335	2.081	1.855
1411.53337	1.931	2.336	2.078	1.858
1411.53782	1.941	2.343	2.087	1.867
1411.54179	1.949	2.347	2.087	1.865
1411.54668	1.959	2.350	2.098	1.880
1411.55009	1.953	2.364	2.107	1.881
1411.55434	1.972	2.361	2.115	1.883
1411.55816	1.974	2.373	2.121	1.900
1411.56178	1.987	2.383	2.124	1.907
1411.56630	1.987	2.392	2.139	1.938
1411.57063	2.009	2.402	2.147	1.926
1411.57428	2.016	2.413	2.160	1.941
1411.57764	2.031	2.433	2.175	1.960
1411.58239	2.046	2.438	2.185	1.970
1411.58684	2.065	2.453	2.196	1.979
1411.59072	2.067	2.466	2.212	1.993
1411.60446	2.103	2.517	2.261	2.045
1411.60816	2.116	2.530	2.271	2.061
1411.61345	2.144	2.545	2.290	2.066
1411.61789	2.158	2.563	2.307	2.094
1411.62182	2.183	2.574	2.317	2.097
1411.62625	2.196	2.589	2.337	2.109
1411.63066	2.215	2.618	2.361	2.134
1411.64095	2.242	2.647	2.394	2.162
1411.64468	2.270	2.655	2.406	2.192
1411.65544	2.296	2.701	2.439	2.205
1411.65910	2.298	2.709	2.454	2.230
1411.66262	2.303	2.710	2.454	2.225
1411.66624	2.311	2.717	2.467	2.241
1411.66997	2.327	2.724	2.463	2.233
1411.67345	2.325	2.735	2.474	2.258
1411.67683	2.343	2.731	2.476	2.246
1411.68017	2.344	2.731	2.476	2.241
1411.68377	2.319	2.731	2.478	2.242
1411.68713	2.335	2.731	2.480	2.250
1411.69134	2.327	2.725	2.469	2.233
1411.69615	2.331	2.728	2.468	2.250
1411.70029	2.317	2.724	2.465	2.234
1411.70468	2.308	2.710	2.460	2.244
1411.70873	2.302	2.705	2.440	2.215
1411.71288	2.293	2.687	2.433	2.201
1411.72759	2.237	2.640	2.378	2.143
1411.73142	2.241	2.633	2.371	2.142
1411.73487	2.212	2.620	2.366	2.141
1411.73859	2.200	2.608	2.353	2.121
1411.74447	2.183	2.581	2.323	2.105
1411.76078	2.118	2.522	2.266	2.035
1411.76426	2.103	2.505	2.254	2.032
1411.76801	2.088	2.498	2.247	2.015
1411.77359	2.069	2.476	2.222	2.001
1411.77758	2.054	2.466	2.209	1.992
1411.78154	2.050	2.450	2.196	1.976
1411.78561	2.048	2.435	2.185	1.950
1411.78936	2.039	2.427	2.177	1.960
1411.79434	2.022	2.416	2.163	1.936
1411.79810	1.993	2.401	2.148	1.919
1411.80223	1.984	2.391	2.143	1.916
1411.80671	1.962	2.383	2.123	1.912
1411.81094	1.963	2.371	2.125	1.899
1411.81476	1.970	2.367	2.117	1.895
1411.81888	1.959	2.357	2.107	1.892
1411.82311	1.957	2.347	2.098	1.881
1411.83456	1.934	2.339	2.085	1.874
1411.83829	1.930	2.342	2.091	1.867
1411.84223	1.937	2.330	2.080	1.857
1411.84668	1.938	2.336	2.085	1.855
1411.85079	1.934	2.336	2.076	1.855
1411.85647	1.938	2.338	2.079	1.855
1411.86288	1.890	2.338	2.091	1.858
1411.86682	1.930	2.326	2.068	1.866
1414.50458	2.307	2.720	2.469	2.246
1414.50771	2.314	2.733	2.471	2.249
1414.51124	2.329	2.729	2.476	2.248
1414.51500	2.319	2.728	2.477	2.257
1414.51934	2.323	2.734	2.475	2.240
1414.52339	2.321	2.725	2.469	2.228
1414.52738	2.320	2.723	2.468	2.239
1414.53074	2.322	2.728	2.464	2.246
1414.53404	2.317	2.711	2.456	2.214
1414.53705	2.308	2.711	2.451	2.216
1414.54046	2.306	2.698	2.439	2.203
1414.54393	2.285	2.683	2.428	2.218
1414.54752	2.291	2.673	2.419	2.197
1414.55117	2.259	2.666	2.410	2.184
1414.55487	2.246	2.660	2.395	2.171
1414.55886	2.241	2.652	2.389	2.158
1414.56234	2.228	2.627	2.368	2.142
1414.56610	2.214	2.616	2.361	2.133
1414.57125	2.198	2.595	2.339	2.128
1414.57455	2.182	2.585	2.331	2.101
1414.58132	2.165	2.551	2.296	2.079
1414.61268	2.043	2.443	2.192	1.963
1414.61639	2.043	2.436	2.184	1.967
1414.61974	2.026	2.419	2.173	1.954
1414.62310	2.015	2.419	2.160	1.944
1414.63277	1.983	2.395	2.139	1.917
1414.63722	1.974	2.377	2.133	1.918
1414.64011	1.970	2.377	2.124	1.901
1728.55781	1.927	2.325	2.081	1.856
1728.56517	1.937	2.324	2.073	1.842
1728.57046	1.929	2.323	2.072	1.844
1728.57447	1.933	2.330	2.078	1.847
1728.57832	1.917	2.330	2.075	1.844
1728.60126	1.917	2.331	2.075	1.852
1728.60560	1.911	2.323	2.067	1.854
1728.60959	1.919	2.318	2.067	1.840
1728.61282	1.911	2.331	2.074	1.846
1728.63586	1.922	2.331	2.071	1.839
1728.63959	1.913	2.333	2.078	1.849
1728.64330	1.922	2.329	2.074	1.845
1728.64614	1.914	2.331	2.074	1.849
1728.66939	1.911	2.329	2.070	1.847
1728.67229	1.912	2.330	2.076	1.851
1728.67555	1.918	2.330	2.075	1.857
1728.67915	1.916	2.328	2.075	1.848
1728.70095	1.906	2.319	2.073	1.859
1728.70455	1.915	2.322	2.072	1.850
1728.70800	1.936	2.329	2.072	1.846
1728.71092	1.925	2.329	2.070	1.840
1728.73363	1.934	2.334	2.090	1.853
1728.73700	1.942	2.340	2.090	1.864
1728.74089	1.951	2.351	2.098	1.876
1728.74437	1.951	2.361	2.107	1.884
1728.74862	1.953	2.363	2.113	1.888
1728.75204	1.967	2.368	2.123	1.888
1728.77576	2.023	2.423	2.175	1.951
1728.77896	2.039	2.450	2.196	1.975
1728.78250	2.065	2.456	2.208	1.983
1728.78579	2.063	2.462	2.217	1.993
1728.81720	2.178	2.589	2.332	2.104
1728.82111	2.198	2.597	2.345	2.112
1728.82521	2.217	2.613	2.363	2.121
1728.82856	2.248	2.637	2.379	2.144
1728.85099	2.294	2.705	2.452	2.220
1728.85454	2.315	2.708	2.456	2.233
1728.86161	2.332	2.727	2.470	2.232
1728.86550	2.324	2.731	2.472	2.248
1836.46405	2.278	2.692	2.430	2.197
1836.46681	2.305	2.704	2.451	2.211
1836.48041	2.324	2.719	2.459	2.234
1836.48305	2.320	2.730	2.472	2.234
1836.49565	2.320	2.729	2.486	2.243
1836.49862	2.339	2.737	2.487	2.246
1836.51126	2.318	2.719	2.464	2.233
1836.51431	2.293	2.708	2.450	2.220
1836.52708	2.298	2.682	2.438	2.197
1836.52967	2.268	2.676	2.423	2.193

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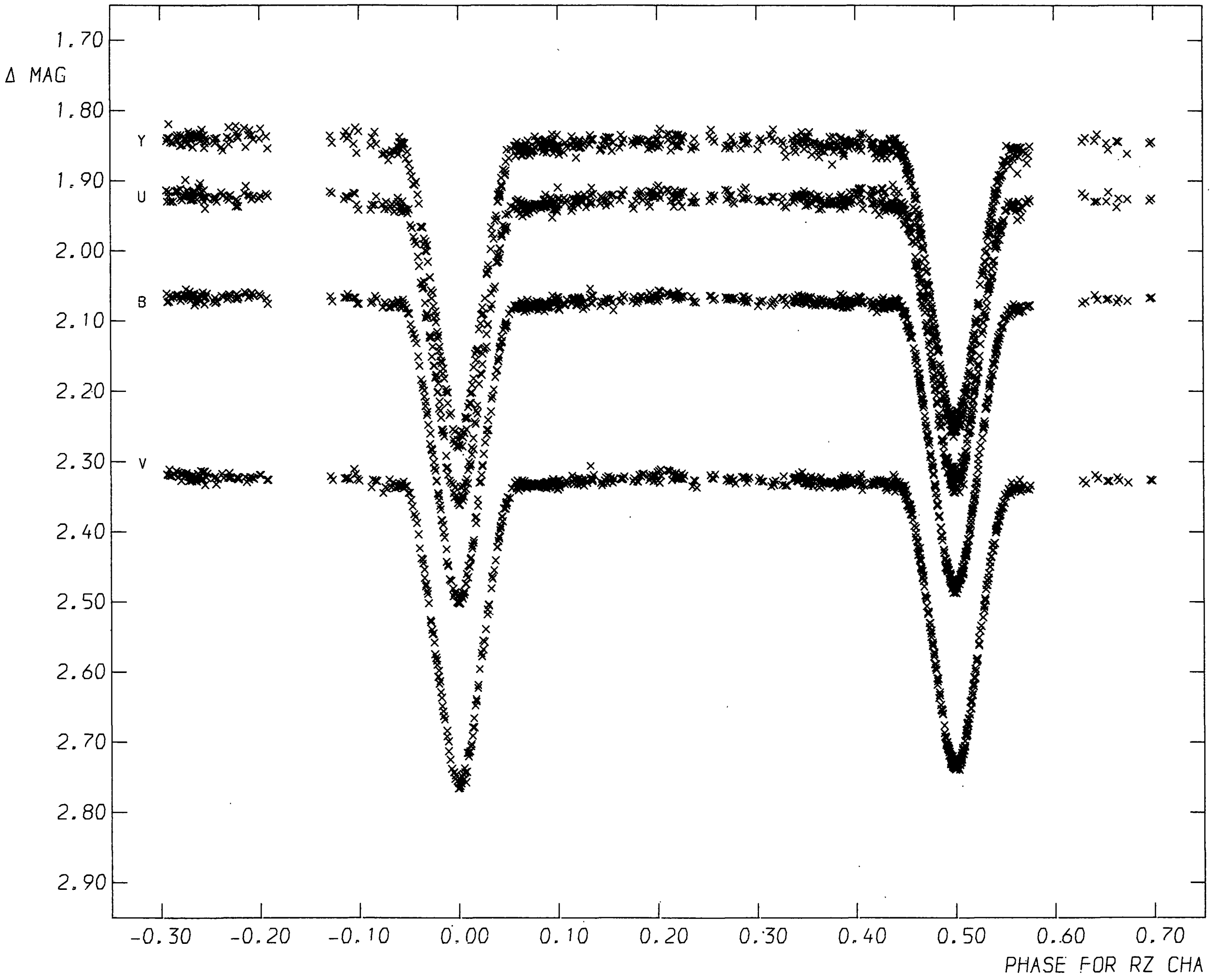

Fig. 1. *uvby* light curves in the instrumental system for RZ Cha. HR 4312 is used as comparison star

Table 2. Times of minimum

	O–C	E	
Pr.min			
2441401.7709	−.0002	0	
1404.6033	+.0001	+ 1	
Sec. min			
2441394.6911	+.0002	− 2.5	
1411.6834	.0000	+ 3.5	
1836.4935	−.0025	+153.5	insufficiently observed

Table 3. Fourier coefficients with mean errors and rectification constants. σ_r is the r.m.s. scatter between the minima

	u	v	b	y
A_0	.9738±.0004	.9742±.0002	.9791±.0002	.9744±.0004
A_1	−.0016±.0006	.0003±.0004	.0004±.0003	.0010±.0006
A_2	−.0066±.0006	−.0061±.0004	−.0064±.0004	−.0067±.0006
C_0	.0137	.0137	.0137	.0137
C_1	.0016	−.0003	−.0004	−.0010
C_2	.0046	.0046	.0046	.0046
z	.0144	.0138	.0140	.0179
σ_r	.007	.004	.004	.007

of the two components, in fair agreement with the small geometrical ellipticity found from the light curves.

We notice that the constants are small and that the residual scatter between the minima are the same as for HS Hya, which is of similar apparent magnitude.

In order to derive the elements we tried to use the method of Kopal (1959), that is an iteration in k where k is the ratio of the radii of the components. However, we ran into precisely the same troubles as for HS Hya and no value of k could be determined in this way. For some colours the iteration did converge but if the intensities in the minima (λ_{pr}, λ_{sec}) were changed by only 0.001 a completely different value of k was obtained. Other colours gave no solution in the iterative process since the difference Δk between any starting value of k and an improved value was either positive or negative.

Instead we have used the method described for HS Hya by Gyldenkerne *et al.* (1975). For adopted values of $(k, \lambda_{pr}, \lambda_{\sec})$ we compute $p_0 = (\cos i - r_b)/r_a$ and find the fractional light losses α_0 in the two minima. The constants (C_1, C_2) in the formula

$$\sin^2\Theta = (p^2 - p_0^2)C_1 + 2(p - p_0)C_2 \qquad (2)$$

are found by the usual method and a least squares fit. The radii r_a and r_b are then found from

$$r_a = \left(p_0^2 + \frac{1}{k^2} + \frac{2p_0}{k} + \frac{1}{k \cdot C_2}\right)^{-1/2}, \qquad (3)$$

$$r_b = r_a/k, \qquad (4)$$

and finally the inclination from

$$\cos i = r_a \cdot p_0 + r_b. \qquad (5)$$

By a "best fit" method we have thus found a set of elements adopting $(k, \lambda_{pr}, \lambda_{\sec})$. Finally the light curve is computed for these elements and the residual scatter is found. By varying k we should in principle be able to find the minimum of the scatter and therefore a final set of elements. However, this procedure does not work in practice since there is no well defined minimum of the scatter and because the k giving the minimum is extremely sensitive to the adopted $(\lambda_{pr}, \lambda_{\sec})$. Also it was impossible to decide if the primary was a transit or an occultation. There was no need for a final adjustment of $(\lambda_{pr}, \lambda_{\sec})$ since the residual scatter around the computed light curves was sufficiently small. In Table 4 we give the intensities of the minima and the adopted limb-darkening coefficients from Grygar *et al.* (1972).

Microphotometer tracings of spectra of RZ Cha by Andersen *et al.* (1975) show that the spectral types and luminosities of the two components are very similar. This is confirmed by our photometry since there is no detectable variation in the colour index $b-y$ and the c_1 index. If there is any variation it is less than approximately 0.002 in these indices.

In Table 5 we give solutions for $k=0.90$ and $k=1.00$ and this interval seems to give luminosity ratios acceptable from the spectroscopic point of view. From these solutions we find that the flux in all four colours is approximately 5% higher for the hotter star which corresponds to a temperature difference of $\Delta \log T_e \approx 0.005$ or a spectral type difference of only 0.6 subclasses in agreement with no detectable difference. Comparing the b and y solutions we find that the difference in colour index between the two components is $\Delta(b-y) = -0.010$ in the sense that the bluest star is the cooler one. This is of course not acceptable but we need only a change $(\lambda_{pr}, \lambda_{\sec})$ by ~0.001 in order to make the cooler star the reddest one. The disagreement between colour differences and flux ratios is therefore no problem.

Table 4. Limb-darkening coefficients and the minimum intensities in the rectified light curves

	Limb-darkening	Minimum intensities	
	u	λ_{pr}	$\lambda_{\sec}$
u	0.73	.687	.700
v	0.82	.683	.698
b	0.73	.686	.699
y	0.61	.685	.701

4. Discussion

We have seen that the ratio of the luminosities and the radii are very close to unity and we shall therefore dis-

Table 5. Solutions for $k=0.90$ and $k=1.00$ assuming partial occultation and partial transit. $\Delta \log F = \log F_b - \log F_a$; σ_L = r.m.s. scatter

Pr. min.	k	Colour	r_a	r_b	i_r	σ_L	L_a	L_b	L_b/L_a	$\Delta\log F$
Occ. par.	0.90	u	.1763	.1959	82.84	.0064	.4590	.5410	1.1786	−.0201
		v	.1766	.1962	82.83	.0040	.4606	.5394	1.1711	−.0229
		b	.1765	.1961	82.87	.0037	.4590	.5410	1.1786	−.0201
		y	.1755	.1949	83.01	.0063	.4613	.5387	1.1678	−.0241
	1.00	u	.1864	.1864	82.78	.0064	.5106	.4894	.9585	−.0184
		v	.1864	.1864	82.78	.0042	.5121	.4879	.9527	−.0210
		b	.1861	.1861	82.82	.0037	.5106	.4894	.9585	−.0184
		y	.1849	.1849	82.97	.0063	.5130	.4870	.9493	−.0226
Tr. par.	0.90	u	.1759	.1955	82.90	.0064	.4380	.5620	1.2831	+.0167
		v	.1761	.1957	82.90	.0047	.4367	.5633	1.2899	+.0190
		b	.1761	.1956	82.93	.0041	.4381	.5619	1.2826	+.0166
		y	.1751	.1946	83.07	.0064	.4356	.5644	1.2957	+.0210
	1.00	u	.1864	.1864	82.78	.0064	.4894	.5106	1.0433	+.0184
		v	.1864	.1864	82.78	.0042	.4879	.5121	1.0496	+.0210
		b	.1861	.1861	82.82	.0037	.4894	.5106	1.0433	+.0184
		y	.1849	.1849	82.97	.0063	.4870	.5130	1.0534	+.0226

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cuss the mean component. We have

$$R=(r_a+r_b)/2=(0.1860\pm.0007)\cdot a=2.26\pm.02R_\odot$$

$$a\sin i=12.08\pm.06R_\odot \quad \text{and} \quad a=12.17\pm.06R_\odot$$

$$M=(M_1+M_2)/2=1.51\pm.02M_\odot$$

where $a\sin i$ and $M_1\sin^3 i$ and $M_2\sin^3 i$ are given by Andersen *et al.* (1975). For the surface gravity we derive

$$\log g=3.908\pm.010$$

For the indices in the standard *uvby* system we get the following values to an accuracy better than 0.002 since three standard stars were observed

$b-y=0.309$ (corresponding to $B-V=0.47$ and spectral type F6)

$$m_1=0.157\,, \qquad \Delta m_1=0.017$$

$$c_1=0.474\,, \qquad \Delta c_1=0.057\,.$$

The deviations $\Delta m_1=0.017$ and $\Delta c_1=0.057$ are found relative to the Hyades values assuming no reddening. For stars in the spectral range F5–G2 Nissen (1970) found a factor of 13 to convert Δm_1 to metal content $\left[\frac{\mathrm{Fe}}{\mathrm{H}}\right]$. Adopting $\left[\frac{\mathrm{Fe}}{\mathrm{H}}\right]_{\mathrm{Hyades}}=0.20\pm.15$ for the metallicity of the Hyades compared to the Sun we have

$$\left[\frac{\mathrm{Fe}}{H}\right]_{\mathrm{RZ\,Cha}}=-0.02\pm.15 \quad \text{or} \quad Z_{\mathrm{RZ\,Cha}}\approx Z_{\odot\,-.006}^{\,+.008}$$

$$=0.020^{+.008}_{-.006}$$

where $Z_{\mathrm{RZ\,Cha}}$ is the fraction by mass of elements heavier than hydrogen and helium. RZ Cha is then a normal population I star with solar composition. The indicated errors in $Z_{\mathrm{RZ\,Cha}}$ are those found assuming $\pm.15$ in $\left[\frac{\mathrm{Fe}}{\mathrm{H}}\right]$.

The value $\Delta c_1=+.057$ indicates that the star is evolved in agreement with the small value of the gravity found above.

Adopting the temperature scale by Morton and Adams (1968) we find the effective temperature which again gives the luminosity as we know the radius.

$$T_e=6580°, \qquad \log T_e=3.818\,,$$

$$\log\frac{L}{L_\odot}=0.937\,, \qquad M_{\mathrm{bol}}=2.41$$

(for $M_{\mathrm{bol}\odot}=4.75$).

Comparing these data for RZ Cha to a new set of stellar models by Hejlesen (unpublished) we find that the value of $\log g$ places the star above the gap at the end of the main-sequence phase and that the evolutionary phase is characterized by a thick hydrogen burning shell corresponding to subgiant stars. For the initial helium content we derive

$$Y_{\mathrm{RZ\,Cha}}=0.21\pm.05$$

Table 6. Changes in the helium content corresponding to changes in mass, content of heavy elements, effective temperature and radius

$\Delta M=+.03\,M_\odot$	$\Delta Y=-.010$
$\Delta Z=+.008$	$\Delta Y=+.040$
$\Delta T_e=+150°$	$\Delta Y=+.020$
$\Delta R=+.02\,R_\odot$	$\Delta Y=\sim.000$

where the uncertainty is estimated from Table 6, giving the changes in helium content for the indicated changes in mass, content of heavier elements, effective temperature and radius. Particularly we notice the strong influence on the accuracy of Y from the uncertainty in the content of heavier elements.

The value of the helium content is very nearly the same as the value found for HS Hya, see Gyldenkerne *et al.* (1975). The average value of the two stars is somewhat lower than the mean value for stars of spectral type early B to F found previously by Popper *et al.* (1970).

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