COMMUNICATIONS
FROM THE
KONKOLY OBSERVATORY
OF THE
HUNGARIAN ACADEMY OF SCIENCES

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST — SZABADSÁGHEGY

No. 91.
(Vol. 10, Part 5)

UBV OBSERVATIONS OF THE RS CVn BINARY HK LACERTAE BETWEEN 1978-1985

KATALIN OLÁH
(Konkoly Observatory of the Hungarian Academy of Sciences)
DOUGLAS S. HALL
(Dyer Observatory, Vanderbilt University, Nashville, Tenn., USA)

BUDAPEST, 1988

ISBN 963 8361 28 X
HU ISSN 0328 — 2091

Felelős kiadó: Szeidl Béla

Hozott anyagról sokszorosítva

8818070 MTA Sokszorosító, Budapest. F. v.: dr. Héczey Lászlóné

UBV OBSERVATIONS OF THE RS CVn BINARY HK LACERTAE BETWEEN 1978-1985

Abstract

We report 524 UBV observations of the RS CVn binary HK Lac made between 1978-1985. Our starspot modelling results published previously for 12 light curves (using V colour) are summarized. Three additional modelled light curves are presented which have not been published before.

Nine UBV light and colour curves obtained between 1982-85 in 16 American and 2 Hungarian observatories, are given. Light curve modelling made for the V and B light curves separately show that the resulting model parameters agree well within the error of the modelling procedure.

Introduction and Observations

We have previously published two detailed papers on HK Lac describing its light variation on the basis of starspot modelling (Olah et al., 1985, 1986, hereafter Paper I and Paper II, respectively). The observations we used were only published in part so we have compiled a complete presentation here for future use by other investigators.

The magnitudes presented here are individual values, but when performing the light curve modelling for Paper II, we formed nightly means if we had more than one value per night. The ΔV magnitudes used in Paper I are individual values and that table (Table VII in Paper I) is repeated here in full.

Observations have been secured altogether in 18 observatories in the standard UBV system, the observers and observatories are listed in Table I. No systematic differences have been found between the photometric results of the different observatories.

Table III gives UBV magnitudes of HK Lac with respect to HD 208728 (C1). The ΔV magnitudes of this table have already been published in Paper I. We repeat in Table III only those measurements which can be supplemented with the corresponding ΔB and ΔU magnitudes. In the beginning of this table UBV magni-

tudes observed by K.O. between 1976-1978 (Olah, 1979) are given.

The UBV magnitude differences (with respect to HD 210731 (C2) of Table IV have not been presented before. From this table the ΔV observations made between J.D. 2445195-2446068 were used in modelling the light curves of Paper II. Additional 100 observations gathered between J.D. 2446181-2446367 which have not been cited before in details, close Table IV.

To complete the lists of observations, Table V gives the rest of ΔV observations from Paper I.

Table I

Observer	Observatory	Telescope Aperture
Boyd, L.J.	Fairborn	10 inch
Burke, E.W. jr.	Kitt Peak	16 inch
Chambliss, C.R.	Kutztown	15 inch
Eaton, J.A.	Kitt Peak	16 inch
Fried, R.E.	Braeside	16 inch
Genet, R.M.	Fairborn	10 inch
Henry, G.W.	Dyer	24 inch
	Kitt Peak	16 inch
	Cloudcroft	48 inch
Landis, H.J.	Landis	8 inch
Lines, H.C.	Lines	20 inch
Lines, R.D.	Lines	20 inch
Louth, H.	Louth	11 inch
Miles, R.	Mouldsworth	11 inch
Nielsen, P.	Nielsen	4 inch
Olah, K.	Konkoly	24 inch
	Piszkesteto	20 inch
Renner, T.R.	Scuppernong	10 inch
Stelzer, H.J.	Stelzer	14 inch
Troeger, J.C.	Sky Lights	8 inch
Wasatonic, R.P.	Pulpit Rock	20 inch
Wasson, N.F.	Sunset Hills	8 inch

All magnitude tables (III-V) contain some sporadic observations which have never been used for starspot modelling since they did not form appropriate light curves.

Magnitude differences between HD 208728 (C1) and HD 210721 (C2), were published in the Inf. Bull. Var. Stars (Olah, 1979).

Results

Most of our starspot modelling results have already been published in Papers I and II. The main goal of those papers was, using solar analogies, to identify stable active longitudes on the surface of the star. Two different methods were used to determine the position of the corotating latitude situated about 30 degrees above and below the equator. We found complex but possible 7 year cyclic variations in the median brightness of the star.

In the present paper we show that spot models made in different colours of the same light curve give the same result within the error of the determination of the parameters. From UBV light curves observed between 1982-85 the V colour has already been fitted by two spots. Here we supplement by giving model results from the B data.

For spot modelling we used the equations developed by Budding (1977) combined with a grid-search method to find the proper parameters. As orbital inclination we found $i = 60^{o}$ (Paper I). Limb darkening coefficients were 0.75 (V), 0.85 (B), 0.91 (U), from Manduca et al. (1977). The time of 0 longitude was the time of maximum + 180 degrees. We took the flux ratios 0.4 (V), 0.36 (B), 0.33 (U) from Planck functions assuming that the spots were 2000 ^{o}K cooler than the surrounding photosphere. The 1.0 intensity was given by the local maximum. The overall light variation was considered to be produced by spotted belts around the star situated parallel to the equator. In most of the cases we fitted the light curves by two spots. For modelling details see Paper I.

Table II lists the J.D. intervals, epochs and the resulting spot parameters. When both V and B models are available, we give them separately in addition to their average values. The modelling results made separately for the V and B light curves agree reasonably well. Typical uncertainties in the parameters are as follows: +/- 2-3 degrees in longitude, +/- 5-8 degrees in

Table II

Resulting spot parameters

No.	J.D. (2440000+) interval	epoch	Period	λ_1	λ_2	β_1	β_2	γ_1	γ_2	color
1	3355-3455	3348.3	25.042	314	80	55	- 6	22.9	23.3	V
2	3634-3721	3617.6	23.385	322	72	51	- 7.5	23.0	26.0	V
3	3722-3806	3709.8	25.203	335	63	49	26	24.0	19.7	V
4	3855-4094	3812.1	24.282	317	63	48	6	26.8	30.7	V
5	4496-4561	4445.1	24.174	296	57	38	27.5	22.5	26.6	V
6	4865-4968	4840.8	24.243	310	70	40	26.5	18.6	15.9	V
				270	50	12	46	18.2	27.9	V
				276	52	3	42	17.9	25.9	B
7	5195-5279	5180.8	23.724	273	51	8	44	18.1	26.9	mean
				318	52	57	23	24.2	28.1	V
				320	54	59	25	23.6	28.0	B
8	5471-5622	5448.0	24.397	319	53	58	24	23.9	28.1	mean
				335	60	53	17	27.0	28.0	V
				335	61	50	14	26.9	28.0	B
9	5628-5687	5618.4	24.397	335	61	52	16	27.0	28.0	mean
				339	--	45	--	37.2	----	V
				337	--	52	--	41.8	----	B
10	5697-5713	5695.1	24.429	338	--	49	--	39.5	----	mean
				304	18	7	53	26.0	19.9	V
				305	2	31	58	22.4	19.0	B
11	5820-5899	5819.3	24.461	304	10	19	56	24.2	19.5	mean
				303	8	11	63	21.3	21.3	V
				315	18	27	60	21.0	22.6	B
12	5970-6028	5965.0	24.461	309	13	19	62	21.2	22.0	mean
				345	56	48	29	23.3	19.1	V
				341	59	52	52	23.1	21.1	B
13	6030-6068	6010.9	24.461	343	58	50	41	23.2	20.1	mean
				321	51	43	34	29.2	22.1	V
				325	59	45	27	29.7	21.2	B
14	6181-6282	6159.8	24.389	323	55	44	31	29.5	21.7	mean
				308	40	36	50	27.9	22.0	V
				307	41	31	45	28.0	22.0	B
15	6283-6338	6257.7	24.501	308	41	33	48	28.0	22.0	mean

latitude and +/- 0.5 degree in radius. The latitude parameter is the most uncertain one of all the fitted parameters. In two cases (model 11 and 13) one can find larger discrepancies in one of the latitude and the corresponding radius results obtained from the V and B light curves. Except model 10 (see below) these two light curves had far the smallest number of observations: 18 (model 11) and 15 (model 13) data points were fitted. This shows, obviously, that more observational data give less uncertain parameters.

The last 9 light curves are displayed in Figures 1-9, together with the colour curves. The U measurements were not modelled, the curve is drawn with the resulted average parameters (determined by B and V light curves) and using the above mentioned limb darkening coefficient and flux ratio.

The models of No. 10, 14 and 15 from Table V have not been published before, but the model parameters were used in a recent paper (Olah et al., 1988). Model No. 10 (Figure 4), is very uncertain because of the few observational points, but is the only light curve of the star which could be fitted by one single spot.

Interesting new results about starspot proper motion on HK Lac, and also a figure of the positions of the activity centers on the star, were given in the above mentioned paper (Olah et al., 1988).

Budapest - Szabadsághegy, 1988. April 8.

References:

Budding, E., 1977, Astrophys. Space Sci. 48.207
Manduca, A., Bell, R.A., Gustaffson, B., 1977, Astron. Astrophys. 61.809
Olah, K., 1979, Inf. Bull. Var. Stars No. 1717
Olah, K., Eaton, J.A., Hall, D.S., Henry, G.W., Burke, E.W. jr., Chambliss, C.R., Fried, R.E., Landis, H.J., Louth, H., Renner, T.R., Stelzer, H.J., Wasatonic, R.P., 1985, Astrophys. Space Sci. 108.137 (Paper I)
Olah, K., Gesztelyi, L., Holl, A., 1988, Proc. Xth European Regional Astr. Meeting (in press)
Olah, K., Hall, D.S., Boyd, L.J., Genet, R.M., Fried, R.E., Lines, R.D., Lines, H.C., Louth, H., Miles, R., Nielsen, P., Stelzer, H.J., Troeger, J.C., Wasson, N.F., 1986, Astrophys. Letters 25.133 (Paper II)

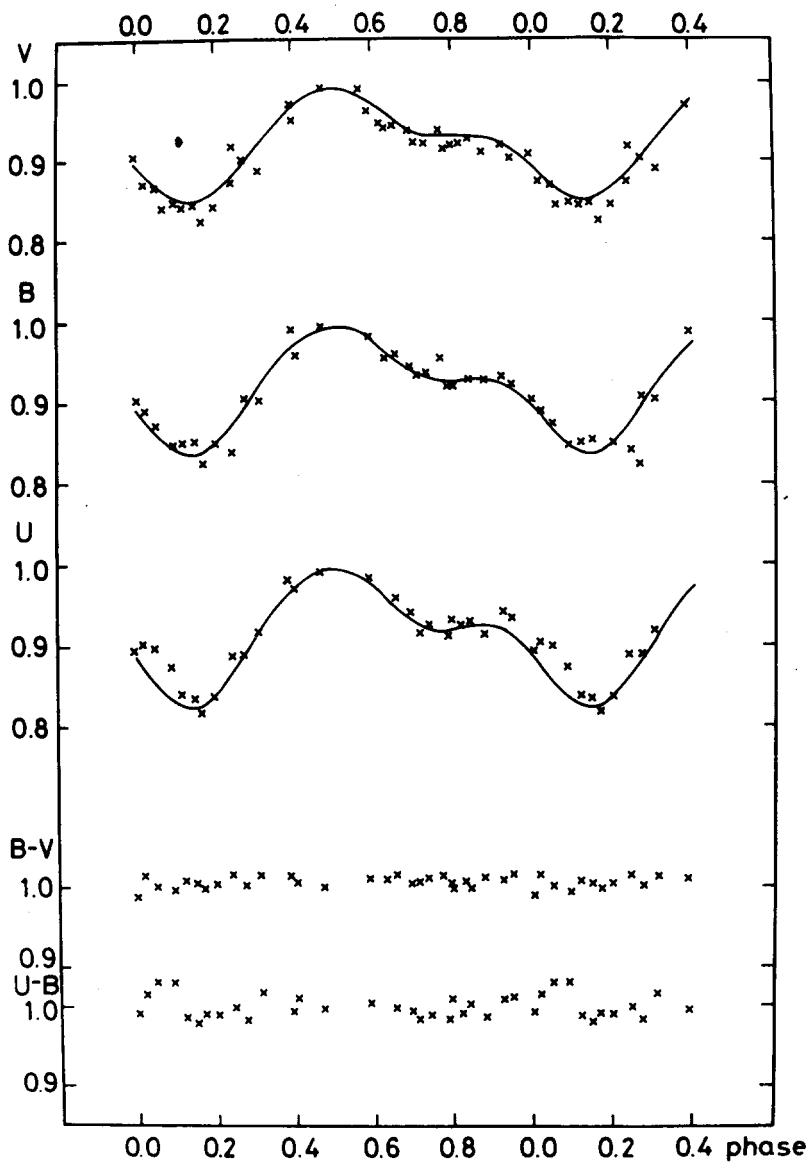

Figure 1: Light and colour curves of HK Lac (model 7)

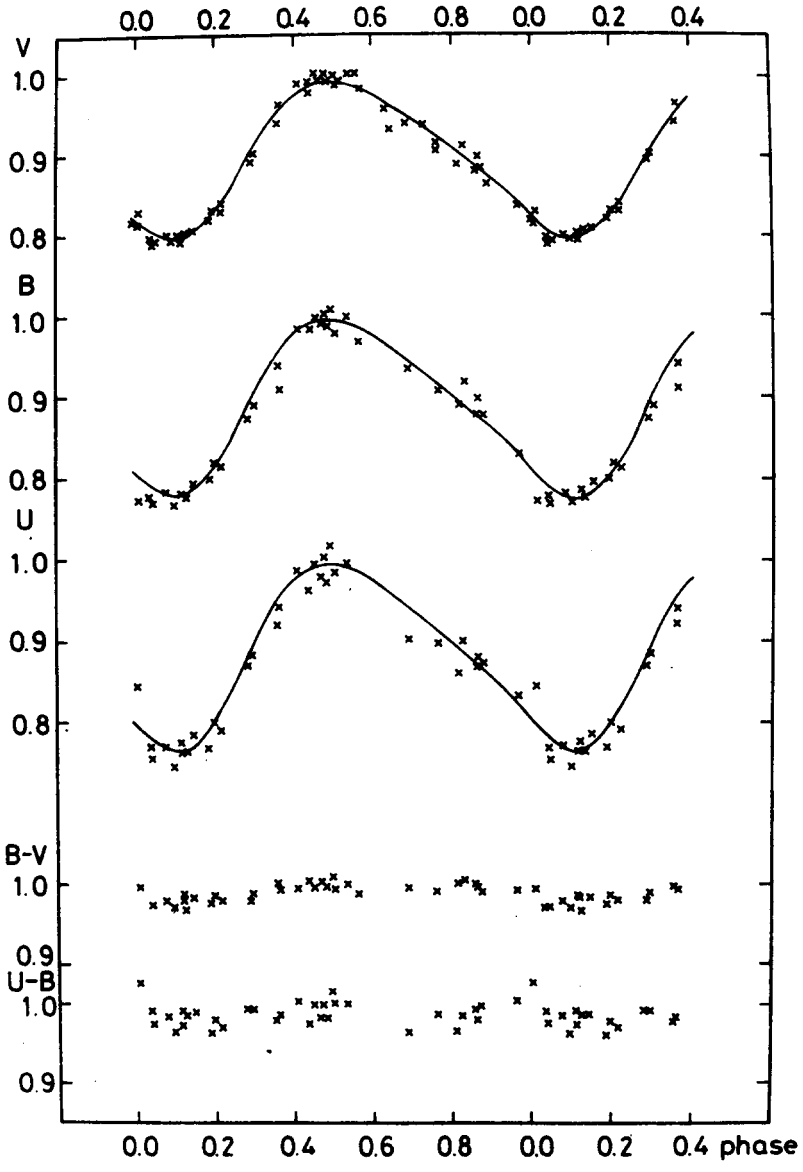

Figure 2: Light and colour curves of HK Lac (model 8)

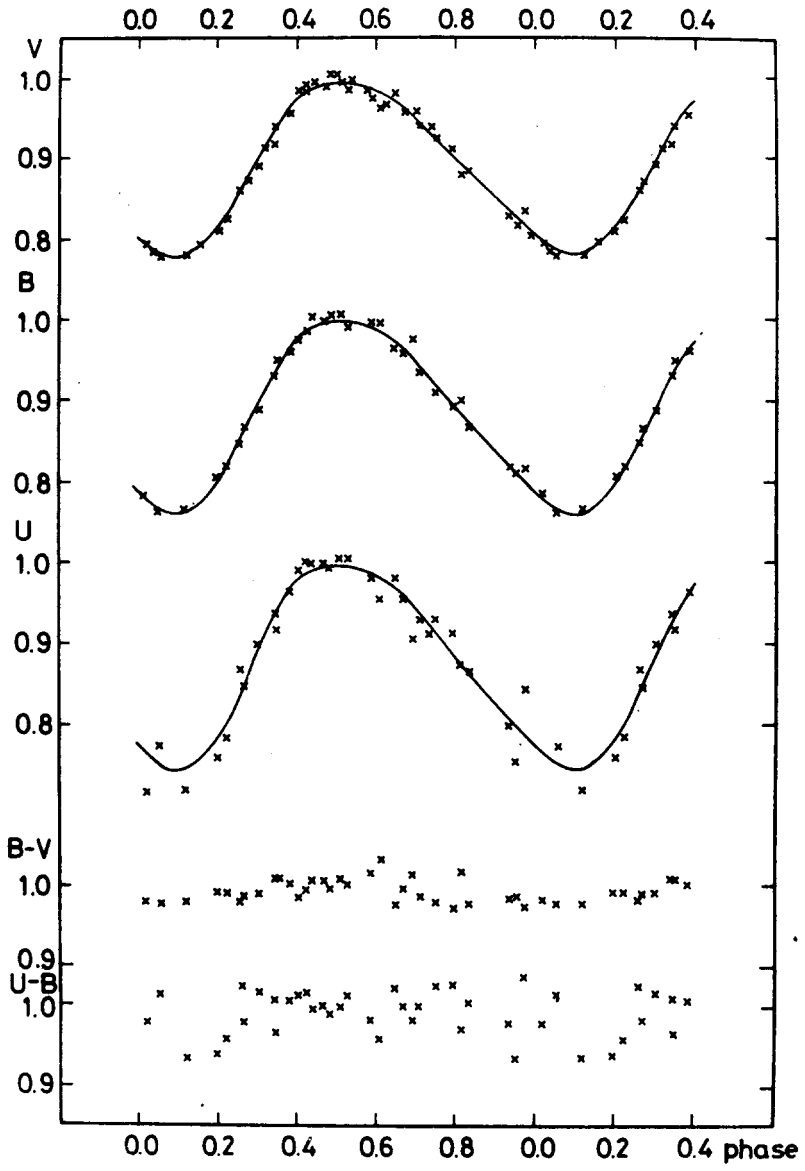

Figure 3: Light and colour curves of HK Lac (model 9)

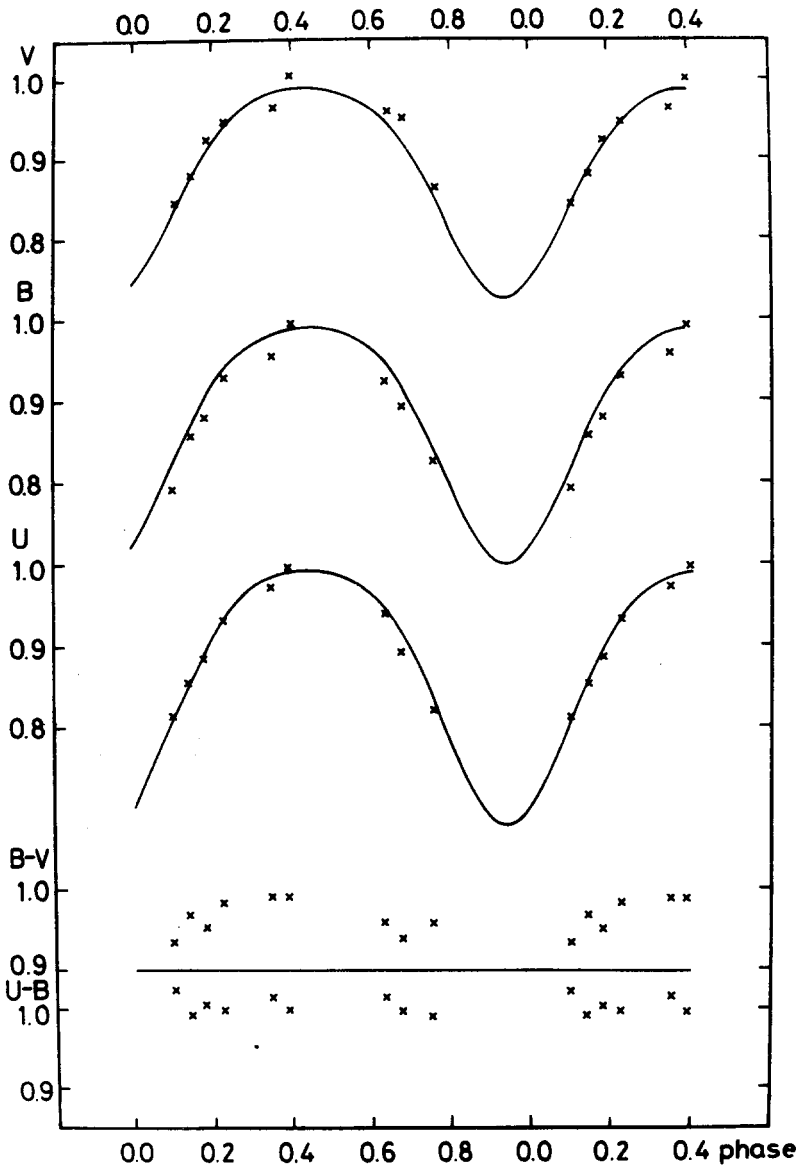

Figure 4: Light and colour curves of HK Lac (model 10)

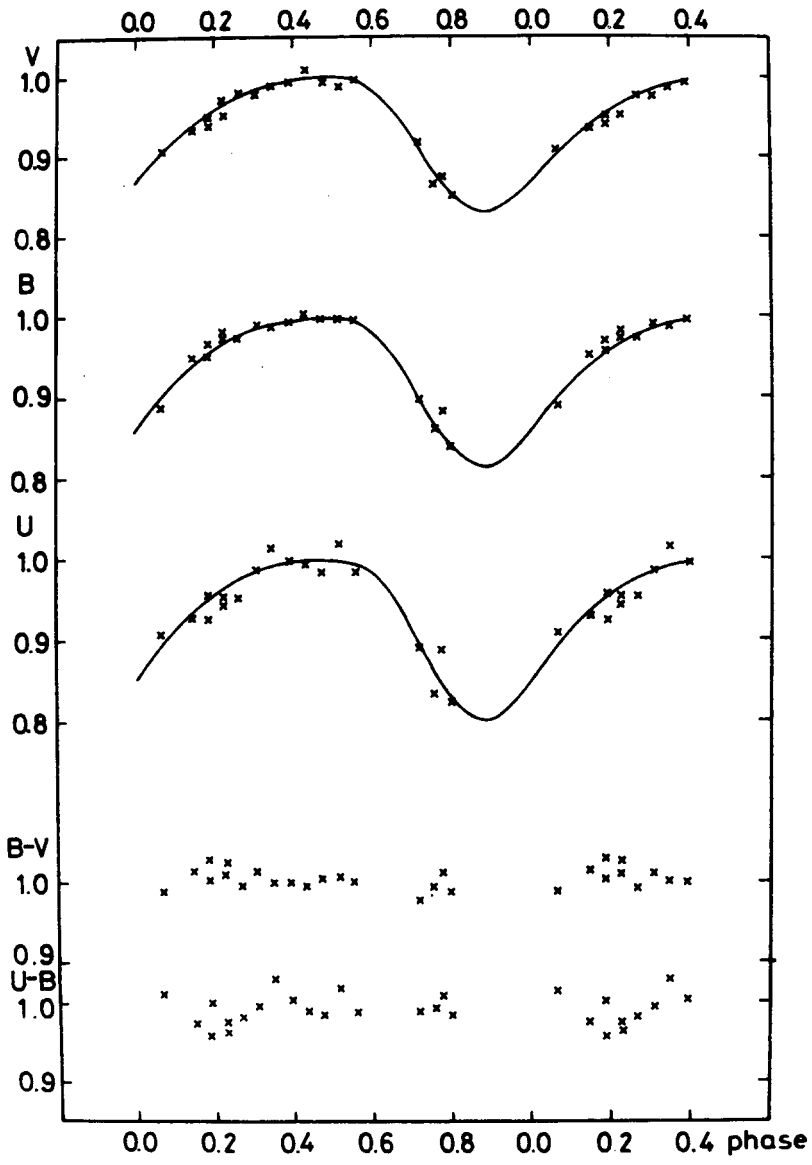

Figure 5: Light and colour curves of HK Lac (model 11)

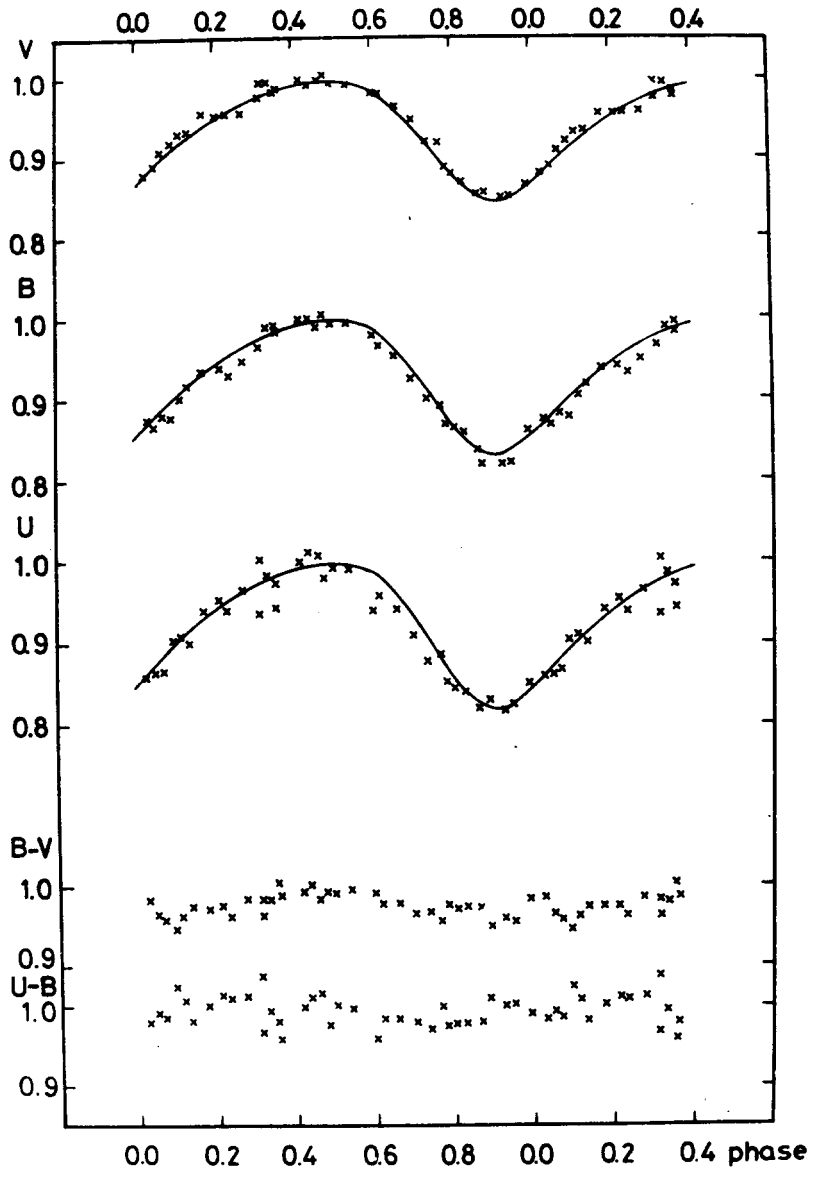

Figure 6: Light and colour curves of HK Lac (model 12)

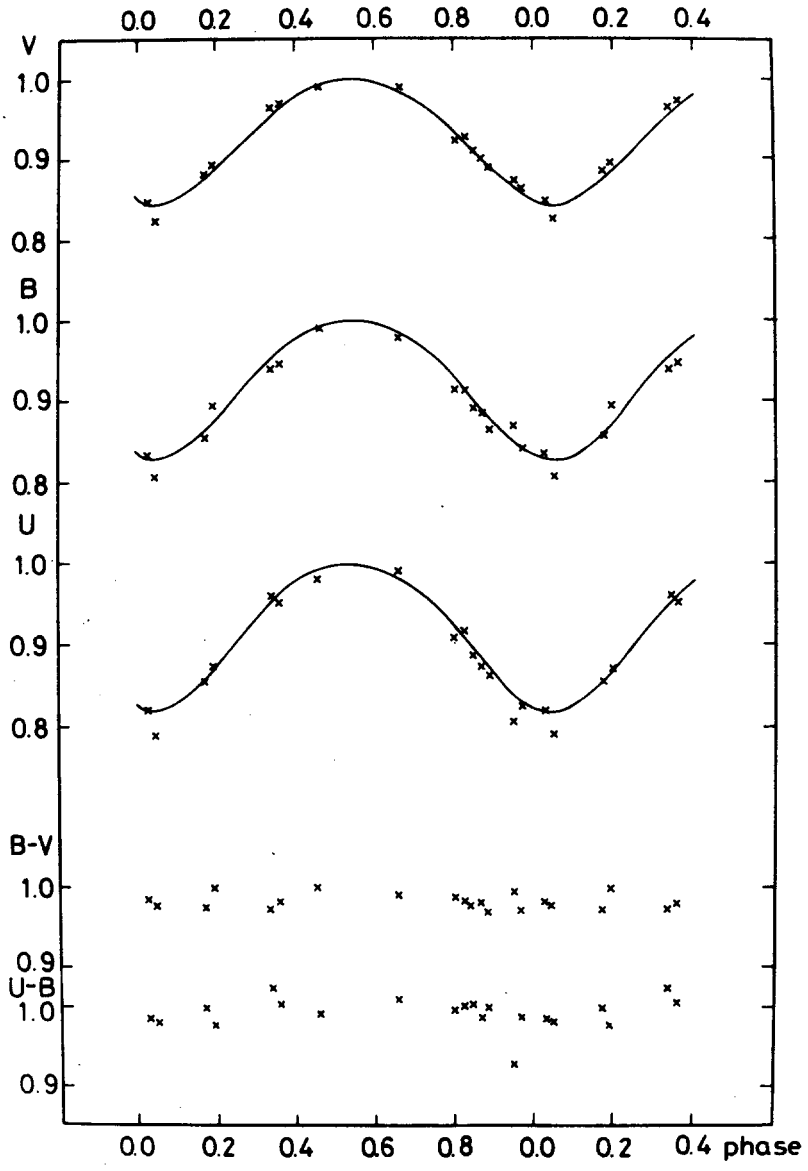

Figure 7: Light and colour curves of HK Lac (model 13)

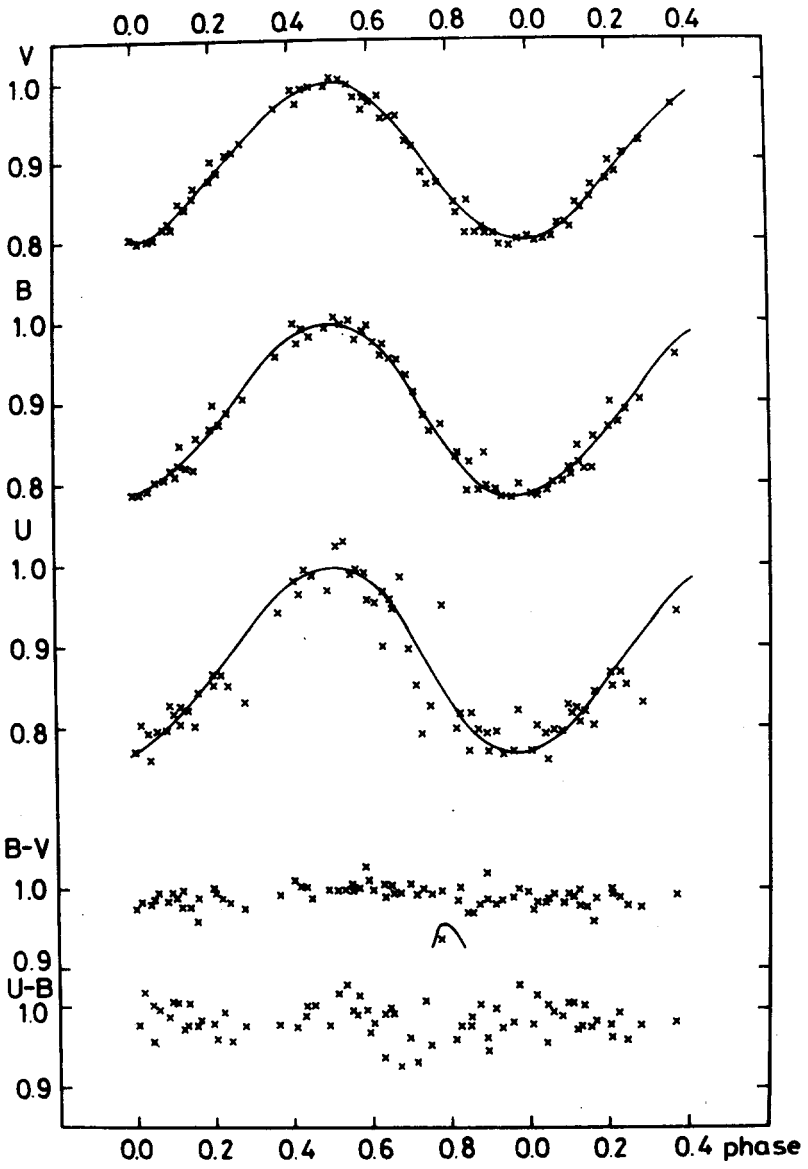

Figure 8: Light and colour curves of HK Lac (model 14)

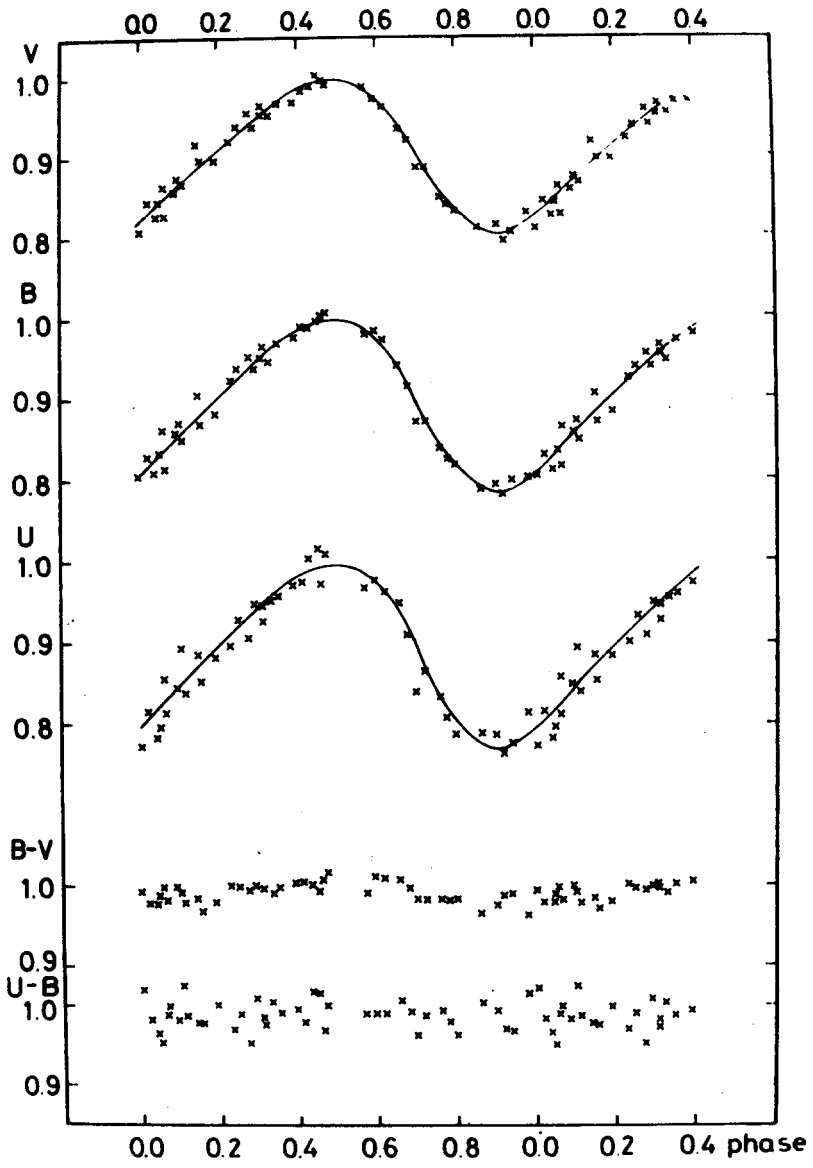

Figure 9: Light and colour curves of HK Lac (model 15)

Table III

UBV magnitudes of HK Lac with respect to HD 208728 (C1)

J.D. 2440000+	ΔU	ΔB	ΔV	J.D. 2440000+	ΔU	ΔB	ΔV
3045.437	----	-.013	.100	4045.942	----	-.097	.040
3048.522	----	-.011	.126	4048.944	----	-.073	.066
3073.303	----	.002	.107	4069.878	----	-.115	.034
3076.286	-.095	-.002	.112	4086.810	----	-.019	.125
3077.230	-.053	.018	.122	4091.849	----	-.138	-.008
3079.217	-.042	.037	.180	4172.369	-.185	-.081	.044
3108.254	-.025	.093	.192	4474.785	----	.058	.139
3368.503	-.090	.024	.130	4483.688	----	-.102	-.011
3385.525	----	-.056	.086	4497.717	----	.061	.152
3432.316	-.138	-.017	.115	4502.390	-.259	-.122	.029
3434.322	-.113	-.012	.117	4502.708	----	-.094	.009
3438.356	-.112	-.007	.113	4511.375	-.115	-.041	.085
3455.286	-.107	.014	.152	4514.350	-.092	-.004	.115
3482.276	-.137	-.024	.124	4533.439	-.206	-.078	.050
3514.222	-.188	-.029	.088	4541.244	-.082	.004	.109
3713.473	-.002	.096	.199	4561.250	-.108	-.015	.082
3727.547	-.167	-.034	.078	4605.265	-.247	-.118	-.017
3739.464	-.025	.065	.177	4613.257	-.150	-.039	.067
3740.412	-.077	.059	.162	4621.344	----	.022	.114
3742.456	-.038	.009	.111	4628.246	-.247	-.144	-.013
3747.497	----	-.101	.039	4633.242	----	-.073	.048
3766.378	-.063	.016	.122	4635.231	-.130	-.038	.074
3777.461	-.152	-.048	.077	4638.246	-.153	-.049	.085
3797.304	-.225	-.113	.022	4783.522	-.127	-.024	.084
3879.209	----	-.011	.091	4787.536	-.004	.075	.169
3881.232	----	.039	.157	4811.464	-.056	.069	.170
4034.950	----	.092	.223	4813.422	-.042	.081	.184
4035.945	----	.063	.197	4822.412	-.172	-.043	.063
4036.937	----	.018	.158	4854.459	-.142	-.032	.067
4038.954	----	-.061	.081	4873.453	-.148	-.044	.054
4043.947	----	-.121	.018				

Table IV

UBV magnitudes of HK Lac with respect to HD 210731 (C2)

J.D. 2440000+	ΔU	ΔB	ΔV	J.D. 2440000+	ΔU	ΔB	ΔV
5195.585	----	----	-.541	5228.840	----	----	-.451
5210.509	----	----	-.509	5229.426	.678	.047	-.449
5213.855	.583	-.088	-.571	5230.449	.710	.079	-.429
5218.451	.584	-.077	-.563	5230.672	----	----	-.417
5219.479	----	-.050	-.539	5231.806	.760	.073	-.422
5221.426	.658	-.025	-.517	5234.810	.691	.009	-.488
5223.451	.645	-.009	-.509	5239.437	.572	-.096	-.596
5224.444	.645	-.018	-.518	5243.773	.608	-.056	-.538
5225.465	.662	-.018	-.501	5244.765	.632	-.039	-.532
5226.482	.630	-.024	-.510	5245.578	----	----	-.509
5228.505	.635	.014	-.471	5245.743	.649	-.026	-.516
5228.835	.715	.040	-.445	5246.499	----	-.051	-.535

Table IV (cont.)

J.D. 2440000+	ΔU	ΔB	ΔV	J.D. 2440000+	ΔU	ΔB	ΔV
5247.778	.648	-.024	-.514	5582.741	----	----	-.579
5250.824	.639	-.013	-.493	5583.726	----	----	-.574
5253.595	----	----	-.419	5583.781	----	-.080	-.572
5254.796	.754	.076	-.416	5585.716	----	----	-.514
5256.780	.752	.077	-.418	5586.705	----	----	-.523
5257.763	.690	.025	-.456	5586.846	.638	-.042	-.523
5259.415	.654	.009	-.488	5587.724	----	----	-.520
5259.547	----	----	-.461	5588.444	.626	-.014	-.502
5261.361	.591	-.049	-.533	5588.886	.657	-.008	-.494
5261.824	.603	-.062	-.541	5589.889	.691	.012	-.464
5265.563	----	----	-.590	5591.709	----	----	-.432
5270.721	.667	-.014	-.507	5595.695	----	----	-.339
5275.761	.684	.011	-.499	5596.699	----	----	-.337
5279.717	.780	.108	-.391	5596.786	.849	.167	-.342
5306.644	.760	.104	-.387	5597.364	.803	.153	-.344
5310.688	----	----	-.508	5599.695	----	----	-.403
5311.506	----	----	-.542	5601.372	.676	.029	-.464
5316.674	.594	-.067	-.544	5601.670	----	----	-.474
5319.668	.648	-.030	-.516	5603.328	.589	-.070	-.552
5322.673	.723	.008	-.477	5604.334	.539	-.098	-.580
5325.475	----	----	-.344	5605.462	.529	-.114	-.593
5471.557	.724	.087	-.399	5606.494	.502	-.125	-.595
5473.539	.834	.168	-.336	5606.710	----	----	-.587
5475.542	.815	.158	-.353	5607.418	.529	-.114	-.591
5493.489	.663	.002	-.472	5618.669	----	----	-.371
5508.471	.522	-.120	-.593	5619.627	----	----	-.352
5521.510	.708	.095	-.385	5619.718	----	----	-.334
5525.910	.812	.127	-.376	5621.629	----	----	-.347
5526.539	.780	.109	-.388	5622.392	.788	.134	-.359
5528.515	.659	.011	-.478	5628.615	----	----	-.599
5529.930	.616	-.049	-.527	5630.624	----	----	-.619
5531.944	.569	-.097	-.570	5631.621	----	----	-.610
5532.517	.533	-.112	-.585	5632.640	----	----	-.595
5532.902	.564	-.107	-.581	5633.622	----	----	-.576
5533.487	.546	-.095	-.579	5635.354	.537	-.096	-.575
5534.750	----	----	-.592	5635.627	----	----	-.557
5539.817	----	----	-.483	5636.331	.531	-.093	-.568
5541.475	.638	-.021	-.492	5636.585	----	----	-.523
5542.517	.672	.027	-.458	5641.707	.795	.106	-.395
5545.732	----	----	-.369	5642.643	----	----	-.378
5546.519	.810	.158	-.346	5643.636	----	----	-.352
5547.515	.807	.151	-.347	5645.736	.851	.164	-.345
5547.721	----	----	-.349	5646.597	----	----	-.365
5548.711	----	----	-.356	5647.746	.789	.109	-.386
5560.963	----	----	-.542	5648.323	.751	.093	-.402
5566.565	.674	.027	-.450	5649.347	.668	.033	-.460
5572.862	.818	.149	-.343	5649.637	----	----	-.471
5574.884	.765	.101	-.392	5650.608	----	----	-.515
5580.741	----	----	-.581	5651.290	.582	-.068	-.545
5581.718	----	----	-.578	5652.664	.501	-.096	-.597
5581.853	.556	-.104	-.586	5653.352	.510	-.127	-.605
5582.732	----	----	-.586	5653.627	.469	-.126	-.608

Table IV (cont.)

J.D. 2440000+	ΔU	ΔB	ΔV	J.D. 2440000+	ΔU	ΔB	ΔV
5654.632	.499	-.128	-.610	5873.944	.621	-.033	-.522
5654.652	----	----	-.628	5970.752	.598	.008	-.505
5655.664	.484	-.114	-.598	5971.724	.572	-.015	-.507
5657.660	.539	-.121	-.572	5972.752	.603	-.034	-.527
5658.587	.509	-.080	-.592	5973.774	.594	-.053	-.540
5662.710	.636	-.008	-.476	5983.769	.661	.058	-.462
5665.625	.714	.104	-.405	5984.691	.712	.086	-.417
5665.682	.748	.085	-.409	5986.710	.736	.142	-.386
5666.589	.669	.095	-.417	5987.714	.748	.145	-.373
5667.606	.763	.150	-.356	5990.735	.690	.081	-.429
5667.612	----	----	-.376	5991.767	.642	.067	-.465
5667.673	.792	.132	-.358	5992.738	.644	.022	-.479
5668.583	.766	.169	-.341	5993.737	.597	-.003	-.505
5673.616	.643	.054	-.450	5994.749	.583	-.004	-.505
5674.647	.603	.008	-.489	5997.698	.549	-.058	-.550
5675.629	.560	-.045	-.521	5999.676	.530	-.071	-.553
5676.579	.527	-.080	-.564	6000.702	.522	-.064	-.555
5677.608	.490	-.105	-.597	6001.668	.538	-.064	-.549
5678.615	.492	-.123	-.603	6002.671	.540	-.068	-.546
5679.637	.484	-.131	-.607	6004.674	.580	-.037	-.534
5681.665	.513	-.121	-.587	6005.655	.598	-.020	-.518
5683.595	.539	-.076	-.566	6006.657	.635	.013	-.497
5684.571	.569	-.045	-.547	6007.656	.676	.043	-.466
5685.571	.569	-.019	-.528	6008.656	.706	.077	-.423
5686.578	.586	.000	-.515	6009.691	.722	.095	-.406
5687.581	.644	.032	-.481	6010.648	.747	.121	-.381
5697.577	.722	.124	-.402	6012.653	.738	.139	-.382
5698.574	.671	.040	-.446	6013.757	.706	.093	-.395
5699.569	.630	.011	-.496	6014.645	.693	.071	-.417
5700.610	.575	-.050	-.522	6015.711	.687	.068	-.451
5703.582	.527	-.079	-.526	6016.713	.632	.038	-.475
5704.596	.503	-.122	-.588	6021.653	.526	-.035	-.550
5710.598	.567	-.041	-.536	6022.635	.560	-.065	-.535
5711.580	.622	-.006	-.528	6024.634	.519	-.072	-.545
5713.571	.712	.079	-.422	6025.644	.551	-.077	-.560
5820.981	.662	.060	-.450	6028.662	.598	-.048	-.532
5823.972	.611	-.004	-.500	6030.626	.634	.008	-.485
5824.965	.613	-.028	-.501	6031.633	.660	.040	-.464
5825.963	.614	-.024	-.530	6032.619	.689	.070	-.442
5826.963	.576	-.045	-.532	6034.629	.737	.100	-.411
5827.956	.544	-.041	-.541	6036.626	.788	.145	-.360
5828.955	.563	-.050	-.550	6039.676	.699	.077	-.433
5829.965	.569	-.059	-.565	6043.623	.573	-.023	-.533
5830.951	.580	-.053	-.549	6046.664	.550	-.079	-.558
5831.947	.540	-.052	-.545	6051.589	.542	-.066	-.556
5832.945	.579	-.052	-.552	6055.611	.625	.009	-.486
5836.935	.687	.061	-.463	6056.619	.679	.042	-.456
5837.930	.732	.108	-.397	6058.625	.766	-.060	-.422
5838.929	.767	.134	-.380	6060.614	.745	.108	-.390
5862.907	.686	.080	-.406	6064.608	.678	.030	-.449
5871.929	.642	.001	-.481	6068.576	.584	-.032	-.535
5872.955	.643	-.020	-.489	6181.567	.741	.083	-.383

Table IV (cont.)

J.D. 2440000+	ΔU	ΔB	ΔV	J.D. 2440000+	ΔU	ΔB	ΔV
6187.977	.727	.103	-.430	6281.880	.770	.150	-.367
6190.979	.624	-.001	-.515	6282.784	.786	.139	-.367
6197.956	.494	-.088	-.577	6283.399	.736	.074	-.429
6198.954	.538	-.084	-.573	6283.784	.711	.100	-.406
6199.954	.535	-.064	-.547	6285.995	.662	.030	-.493
6204.950	.706	.096	-.426	6286.832	.623	.015	-.493
6205.938	.773	.134	-.370	6287.886	.605	-.036	-.523
6206.929	.776	.152	-.351	6288.952	.595	-.067	-.563
6207.926	.698	.132	-.358	6289.833	.568	-.067	-.560
6208.928	.728	.149	-.359	6290.782	.533	-.087	-.575
6209.916	.734	.131	-.365	6291.771	.520	-.095	-.579
6210.915	.696	.105	-.389	6292.767	.481	-.110	-.598
6211.524	.696	.068	-.422	6293.479	.519	-.125	-.607
6211.912	.697	.102	-.413	6293.771	.479	-.129	-.603
6213.533	.645	.005	-.486	6296.771	.514	-.105	-.581
6213.904	.640	.036	-.467	6298.876	.592	-.026	-.522
6218.900	.526	-.083	-.570	6299.366	.675	.025	-.482
6221.938	.500	-.103	-.596	6299.810	.645	.023	-.482
6222.889	.498	-.100	-.561	6300.761	.686	.072	-.434
6223.890	.526	-.081	-.581	6301.796	.745	.093	-.412
6224.881	.623	-.059	-.554	6304.833	.782	.142	-.362
6225.875	.664	-.012	-.509	6306.780	.699	.114	-.381
6226.872	.694	.046	-.448	6307.761	.751	.106	-.404
6228.497	.731	.087	-.420	6308.883	.669	.044	-.447
6229.865	.736	.141	-.371	6309.398	.679	.055	-.458
6230.862	.738	.140	-.371	6312.753	.567	-.053	-.544
6231.867	.770	.152	-.350	6313.753	.546	-.054	-.544
6233.895	.738	.143	-.363	6314.744	.542	-.062	-.560
6234.901	.734	.124	-.384	6316.737	.518	-.110	-.595
6235.846	.723	.098	-.415	6317.747	.473	-.117	-.613
6236.873	.673	.057	-.447	6320.743	.522	-.097	-.598
6237.892	.662	.041	-.454	6321.784	.529	-.093	-.572
6238.850	.662	.015	-.498	6322.737	.546	-.057	-.539
6241.874	.553	-.066	-.564	6325.752	.717	.086	-.422
6242.873	.513	-.111	-.591	6327.786	.745	.138	-.387
6243.878	.503	-.090	-.594	6328.825	.747	.128	-.387
6244.931	.520	-.103	-.593	6329.723	.763	.121	-.377
6245.872	.459	-.112	-.603	6330.729	.713	.119	-.409
6248.840	.549	-.059	-.554	6331.729	.708	.082	-.428
6249.916	.606	-.035	-.517	6332.754	.656	.036	-.453
6250.845	.612	.022	-.466	6333.720	.611	.028	-.467
6251.912	.546	.037	-.453	6334.784	.619	-.013	-.518
6252.932	.708	.083	-.403	6338.736	.548	-.081	-.572
6259.851	.705	.114	-.386	6356.327	.741	.087	-.426
6267.829	.495	-.102	-.588	6359.330	.659	.006	-.503
6269.848	.462	-.116	-.605	6364.314	.587	-.059	-.556
6270.828	.494	-.114	-.597	6365.367	.568	-.080	-.571
6271.827	.535	-.101	-.577	6366.354	.549	-.092	-.580
6272.793	.605	-.065	-.547	6367.330	.524	-.103	-.593
6277.948	.769	.147	-.372				

Table V

V observations of HK Lac with respect to HD 208728 (C1)

J.D. 2440000+	ΔV	J.D. 2440000+	ΔV	J.D. 2440000+	ΔV	J.D. 2440000+	ΔV
3633.960	.131	4177.620	.229	4536.619	.099	4881.564	.113
3650.807	.081	4182.547	.187	4536.644	.100	4883.536	.128
3659.834	.164	4194.563	.021	4537.638	.112	4884.664	.117
3662.871	.195	4196.541	.037	4539.652	.122	4889.519	.123
3676.842	.075	4209.669	.062	4540.721	.118	4891.534	.118
3714.820	.212	4210.566	.031	4541.640	.123	4893.535	.115
3718.762	.139	4217.676	.018	4542.610	.125	4893.544	.094
3721.775	.068	4227.667	.232	4543.640	.165	4897.514	.084
3722.786	.048	4451.840	.099	4544.658	.156	4898.512	.077
3723.777	.037	4453.818	.031	4545.632	.154	4900.564	.039
3726.783	.053	4454.868	-.004	4546.642	.163	4905.561	.086
3727.753	.093	4458.838	-.019	4547.640	.136	4905.644	.068
3747.719	.038	4459.823	-.004	4549.610	.068	4907.525	.104
3770.737	.052	4496.856	.159	4554.585	-.020	4914.691	.128
3790.727	.168	4498.730	.136	4554.668	-.025	4915.499	.132
3794.687	.081	4499.700	.109	4555.647	-.001	4916.496	.136
3795.719	.056	4500.861	.068	4816.806	.098	4917.503	.133
3806.698	.148	4501.707	.039	4828.678	.031	4918.682	.120
3834.629	.178	4503.721	-.014	4854.769	.062	4920.503	.106
3849.680	.039	4504.842	-.028	4865.544	.128	4921.496	.095
3855.623	.152	4505.706	-.030	4866.546	.110	4923.493	.061
3870.614	-.005	4506.717	-.017	4867.534	.114	4926.513	.059
3871.621	-.013	4509.804	.049	4868.543	.120	4927.538	.051
3872.607	-.005	4510.814	.072	4869.539	.110	4931.506	.119
3873.603	.009	4511.701	.084	4869.588	.093	4933.521	.144
3876.615	.068	4512.704	.100	4870.531	.106	4934.557	.146
3877.635	.087	4513.703	.107	4871.527	.098	4937.570	.142
3878.568	.103	4514.806	.110	4872.710	.087	4944.507	.133
3879.619	.130	4526.694	.030	4873.725	.076	4947.517	.085
3902.608	.112	4528.672	-.011	4874.681	.072	4954.603	.098
3903.635	.129	4529.638	-.016	4875.558	.062	4955.516	.106
3906.600	.179	4530.644	-.011	4876.557	.045	4956.607	.109
4078.769	.183	4531.650	.002	4877.548	.047	4959.634	.125
4094.771	.017	4532.652	.021	4877.703	.055	4960.603	.129
4136.641	.066	4534.639	.075	4878.520	.057	4967.647	.137
4160.618	.074	4535.646	.090	4880.558	.078	4968.607	.139
4169.576	.036	4535.666	.082	4880.616	.067		