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FOUR RR LYRAE STARS WITH VARIABLE PERIODS IN OPHIUCHUS

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The discovery of the variability of these stars has been reported by Hoffmeister (1966, 1967). No ephemeris is known for V1089 Oph until today and, in the other cases, the published elements were outdated because of strong period variations. Photographic plates of a field centered around 67 Oph, taken with the Sonneberg Observatory 40cm Astrograph during three intervals spread over the years from 1938-1994, were used to check the behaviour of these objects (see Table 1). The elements listed below were obtained by means of least-squares solutions. Published times of maximum for V1083 Oph, V1093 Oph and V1095 Oph (Savin 1988a,b and Surikov 1982) were included in this analysis.

Photographic amplitudes were derived with respect to magnitudes of the comparison stars given in Table 2. Individual data are available upon request.

Remarks:

V1083 Oph

The ephemeris published by Savin (1988a) has been found in need of improvement. Now, the elements listed in Table 1 are valid for J.D. 2429100-2441200 and J.D. 2444000-2449500 resp. A supplementary quadratic solution is given because this represents the given minima timings in a comparable way like the linear ones. This set of elements is valid over the whole interval.

V1089 Oph

Elements valid (1982) for J.D. 2429700-2449500. Due to a apparent companion the minimal magnitudes are somewhat uncertain. Unfortunately there were not enough older plates available to determine the date of the period change as well as the value of the period acting in the time before the interval mentioned above.

V1093 Oph

First elements were derived by Savin (1988b); the GCVS lists an E0 according to Hoffmeister(1966) and an erroneous period of 4.03 days. Our elements given below are at least valid for an interval of JD 2438200-2449500. The same problem as described in the case of V1089 Oph appeared for the period change. Only the observations from J.D. 2438258-2449488 were displayed in the light curve (Fig. 5) because of the uncertainties concerning the set of elements valid prior to this date.

V1095 Oph

First elements were derived by Surikov. According to our observations the period turned out to be variable. Elements are valid for J.D. 2425400-2430000 and J.D. 2439000-2449500 resp. A quadratic fit was applied for the same reasons like in V1083 Oph.

Table 1. Summary of this paper

Star	Type	Epoch 2400000+	Period (day)	Quad. Term $*10^{-10}$	Max.	Min.	M−m	No. of Plates
V1083 Oph (1)	RRab	38258.418 ±15	0.5522898 ±7		$15^m.3$	$16^m.7$	$0^p.20$	88
V1083 Oph (2)		47418.375 ±14	0.5523085 ±25					40
V1083 Oph (3)		47418.380 ±12	0.5523132 ±20	5.0 ±6				128
V1089 Oph	RRab	49475.521 ±5	0.6045402 ±5		$13^m.9$	$14^m.9$:	$0^p.16$	260
V1093 Oph	RRab	48830.443 ±10	0.4488517 ±8		$15^m.2$	$16^m.5$	$0^p.18$	82
V1095 Oph (1)	RRab	25864.342 ±7	0.4587875 ±12		$14^m.2$	$15^m.8$	$0^p.23$	32
V1095 Oph (2)		47390.485 ±5	0.4587798 ±6					195
V1095 Oph (3)		47390.485 ±5	0.4587778 ±7	-1.8 ±2				227

Table 2. Comparison stars and cross references

	V1083 Oph S 9276 USNO 0900-11201195		V1089 Oph S 9862 USNO 0900-11607658	
Comp. No.	USNO	m*	USNO	m*
1	0900-11206973	$14^m.8$	0900-11599684	$14^m.0$
2	0900-11199346	$16^m.2$	0900-11610001	$14^m.7$
3	0900-11197315	$16^m.4$	0900-11600524	$14^m.7$
4			0900-11604592	$15^m.2$

	V1093 Oph S 9295 USNO 0900-11721789		V1095 Oph S 9868 USNO 0900-11914415	
Comp. No.	USNO	m*	USNO	m*
1	0900-11718573	$15^m.4$	0900-11926326	$14^m.1$
2	0900-11722387	$16^m.0$	0900-11919647	$14^m.4$
3	0900-11725709	$16^m.5$	0900-11909524	$15^m.3$
4			0900-11909673	$15^m.5$

* Magnitudes refer to the B values of the USNO−A2.0 catalogue

This research made use of the SIMBAD data base, operated by the CDS at Strasbourg, France.

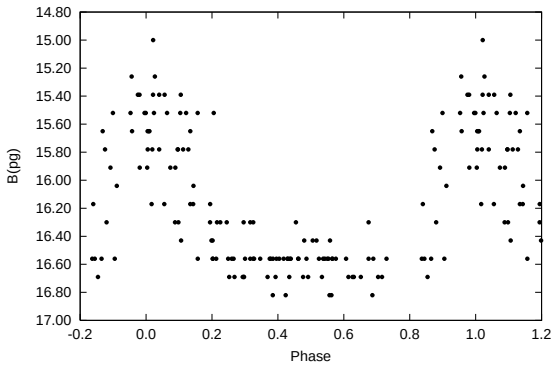

Figure 1. Composite light curve of V1083 Oph

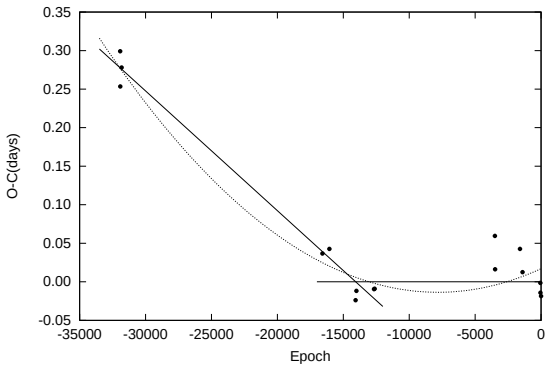

Figure 2. (O−C) diagram for V1083 Oph

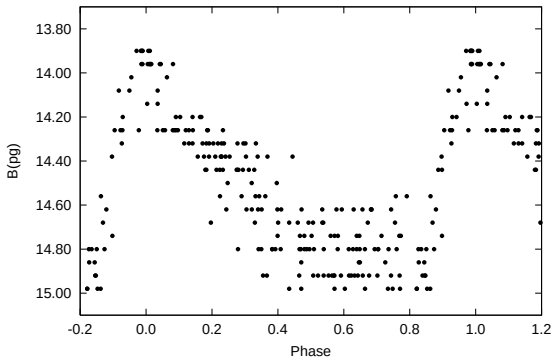

Figure 3. Composite light curve of V1089 Oph

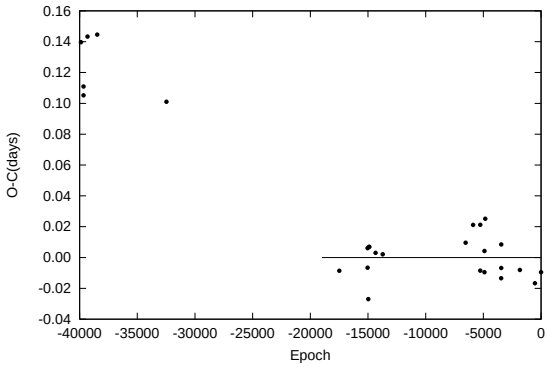

Figure 4. (O−C) diagram for V1089 Oph

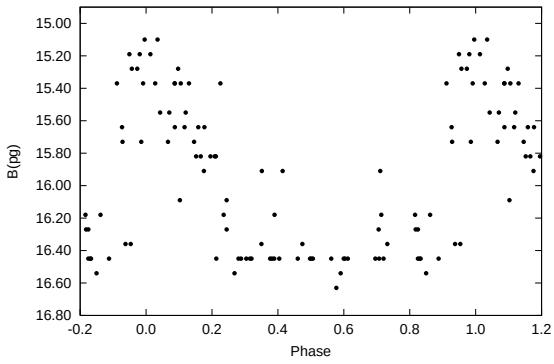

Figure 5. Light curve (J.D. 2438258 − 2449488) of V1093 Oph

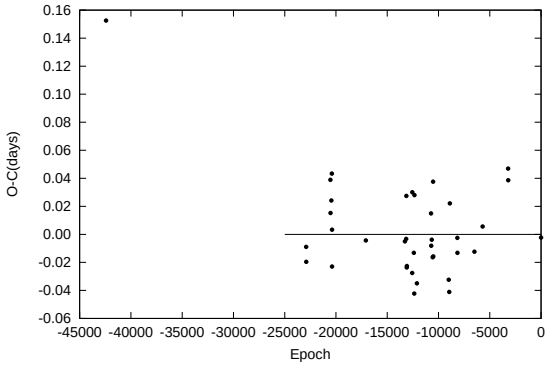

Figure 6. (O−C) diagram for V1093 Oph

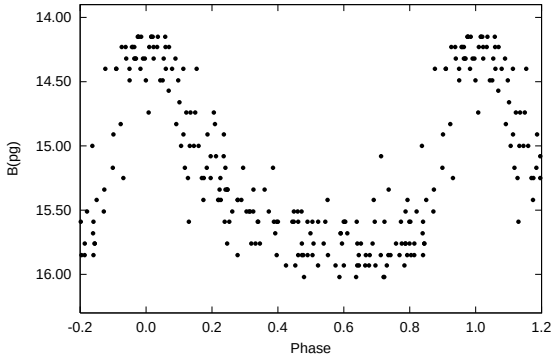

Figure 7. Composite light curve of V1095 Oph

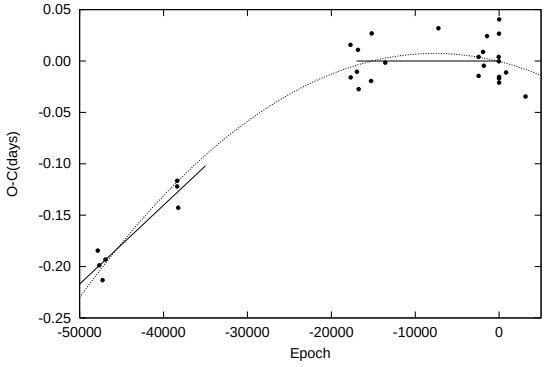

Figure 8. (O−C) diagram for V1095 Oph

Table 3. Heliocentric times of new found maxima and $O-C$ values according to the elements derived in this paper

Star	JD (max.*)	Epoch	$O-C$	Star	JD (max.*)	Epoch	$O-C$
V1083 Oph (1)	29787.418	−15338	0.022	V1093 Oph	38549.486	−22905	−0.009
	29788.477	−15336	−0.024		38553.515	−22896	−0.020
	29845.389	−15233	0.003		39611.517	−20539	0.039
	38258.415	0	−0.003		39615.533	−20530	0.015
	38549.486	527	0.012		39651.450	−20450	0.024
	39648.507	2517	−0.024		39673.463	−20401	0.043
	39684.419	2582	−0.011		39681.476	−20383	−0.023
	40418.435	3911	0.012		39682.400	−20381	0.003
	40444.394	3958	0.013		41160.461	−17088	−0.004
V1083 Oph (2)	45486.458	−3498	0.058		45912.446	−6501	−0.012
	45492.490	−3487	0.015		46272.443	−5699	0.006
	46533.612	−1602	0.035		47387.432	−3215	0.047
	46642.386	−1405	0.004		47392.361	−3204	0.039
	47387.432	−56	−0.014		48830.441	0	−0.002
	47392.390	−47	−0.026	V1095 Oph (1)	25440.438	−924	0.016
	47418.344	0	−0.031		25525.298	−739	0.000
V1089 Oph	25363.576	−39885	0.140		25705.584	−346	−0.017
	25495.337	−39667	0.111		25864.342	0	0.000
	25498.354	−39662	0.105		29786.522	8549	0.006
	25707.563	−39316	0.143		29787.445	8551	0.011
	26215.378	−38476	0.145		29843.390	8673	−0.016
	29844.389	−32473	0.101	V1095 Oph (2)	39259.546	−17723	0.016
	38901.500	−17491	−0.009		39270.525	−17699	−0.016
	40381.429	−15043	0.006		39615.533	−16947	−0.010
	40384.439	−15038	−0.007		39672.443	−16823	0.011
	40419.482	−14980	−0.027		39711.401	−16738	−0.027
	40453.370	−14924	0.007		40384.439	−15271	−0.019
	40473.320	−14891	0.007		40418.435	−15197	0.027
	40803.395	−14345	0.003		41163.465	−13573	−0.002
	41179.418	−13723	0.002		44069.410	−7239	0.032
	45522.442	−6539	0.010		46271.507	−2439	−0.014
	45912.382	−5894	0.021		46272.443	−2437	0.004
	46288.406	−5272	0.021		46509.637	−1920	0.009
	46291.399	−5267	−0.009		46554.584	−1822	−0.005
	46506.628	−4911	0.004		46731.243	−1437	0.024
	46509.637	−4906	−0.010		47368.468	−48	0.004
	46552.594	−4835	0.025		47380.392	−22	0.000
	47381.380	−3464	−0.013		47385.422	−11	−0.017
	47387.432	−3454	−0.007		47386.383	−9	0.027
	47390.470	−3449	0.008		47390.470	0	−0.015
	48362.554	−1841	−0.008		47391.382	2	−0.021
	49154.493	−531	−0.017		47392.361	4	0.040
	49475.511	0	−0.010		47770.344	828	−0.011
V1093 Oph	29788.511	−42424	0.153		48832.396	3143	−0.035

* Mid-exposure times of plates with brightest observations

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