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Search for Evolutionary Period Changes in the Double-mode Cepheid V367 Sct

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For both periods of the bimodal Cepheid V367 Sct, O–C diagrams spanning a 113-year time interval are constructed. The O–C diagrams have the form of parabolas, allowing quadratic ephemerides and evolutionary period change rates to be determined for the first time, $dP_{\rm Fu}/dt = +0.233$ (±0.020) s/yr and $dP_{\rm 1O}/dt = +0.244$ (±0.025) s/yr, for the fundamental tone and first overtone of V367 Sct, respectively, which are consistent with the results of theoretical computations for the third crossing of the instability strip. The test for stability of pulsations proposed by Lombard and Koen confirmed the reality of the evolutionary change of the periods.

It follows from the computations performed by Eggenberger et al. (2021), Nguyen et al. (2022), and Yusof et al. (2022) that the evolutionary tracks of short-period Cepheids with periods shorter than 5 days (masses less than $5M_\odot$) either have no blue loop after the first crossing of the instability strip or this loop does not reach the instability strip, which means that the second and third crossings do not occur. This means that all short-period Cepheids are observed at the first crossing.

According to the theory, the periods of Cepheids during the first crossing increase so rapidly that the O–C diagrams should be parabolas with steep upward branches. However, no steep parabolas, i.e. rapid evolutionary period changes, have been found in the O–C diagrams for 41 short-period Cepheids (hereafter referred to simply as Cepheids) studied over a time interval of more than a hundred years (Csoernyei et al., 2022). The O–C diagrams of such Cepheids look like small-amplitude semi-regular oscillations, which are sometimes superimposed onto a slight trend; if this trend is interpreted as a result of evolutionary period changes, then the rate of these changes formally corresponds to the second or third crossing of the instability strip (Turner et al., 2006).

As of now, rapid evolutionary period changes have been found only for three Cepheids. These are two normal Cepheids, V1033 Cyg and OGLE-LMC-CEP-2132 with the periods of $P = 4\overset{\rm d}{.}946$ and $P = 4\overset{\rm d}{.}685$, respectively (Berdnikov et al., 2019, 2023) and one bimodal Cepheid, V371 Per, pulsating both in the fundamental tone and first overtone with the periods of $P_{\rm Fu} = 1\overset{\rm d}{.}738$ and $P_{\rm 1O} = 1\overset{\rm d}{.}270$, respectively (Berdnikov et al., 2023). In order to understand how these three Cepheids differ from the others, first of all, it is necessary to increase the sample size, that is, to investigate period changes in unexplored Cepheids.

One of such objects is the bimodal Cepheid V367 Sct, and the aim of this study is to search for evolutionary changes of its pulsation periods.

1 LIGHT CURVES FOR BOTH OSCILLATIONS OF V367 Sct

From July 16 to October 10, 2021, we acquired 379 $BVg'r'$-band CCD frames for the bimodal Cepheid V367 Sct with the 60-cm telescope of the Caucasian Mountain Observatory of Sternberg Astronomical Institute of M.V.Lomonosov Moscow State University (Berdnikov et al., 2021). The method of constructing light curves (Fig. 1) for the fundamental mode ($P_{\rm Fu} = 6\overset{\rm d}{.}293$) and the first overtone ($P_{\rm 1O} = 4\overset{\rm d}{.}385$) is described by Berdnikov et al. (2021).

Table 1 lists the $BVg'r'$-band light-curve parameters for both oscillations of V367 Sct: magnitude at maximum light, amplitude, and intensity-mean magnitude. Table 2 lists the Fourier coefficients (for the cosine expansion). The Fourier coefficients for $P_{\rm Fu}$ fall within the domains of classical (DCEP) Cepheids and those for $P_{\rm O1}$, within the domain of low-amplitude Cepheids (DCEPS), which pulsate in the first overtone (Udalski et al., 2018).

2 TECHNIQUE OF STUDYING PERIOD CHANGES AND OBSERVATIONAL DATA USED

We investigate changes in Cepheid pulsation periods using the standard technique of the analysis of O–C diagram. The O–C residuals can be most accurately determined using the Hertzsprung method (Hertzsprung, 1919) whose computer implementation is described by Berdnikov (1992f). We use the method described by Lombard & Koen (1993) to confirm the reality of the period changes found.

To study the periods of V367 Sct, we compiled published photographic, photoelectric, CCD observations. We supplemented these data with our own eye estimates of the star's magnitudes on photographic plates of the Sternberg Astronomical Institute plate archive and with ASAS-3 (Pojmanski, 2002) and ASAS-SN (Jayasinghe et al., 2019) survey photometry.

Table 3 summarizes information about the number of observations used. These observations span a 113-year time interval.

3 RESULTS AND DISCUSSION

We use the method described by Berdnikov et al. (2021) to extract the light curves corresponding to the fundamental mode and first overtone from observations of V367 Sct (Fig. 1). We computed seasonal light curves based on the data obtained; Table 4 summarizes the results of their analysis performed using the Hertzsprung method. The first and second columns of this table give the times of maximum light and their errors; the third column gives the type of observations; the fourth and fifth columns present the epoch number E and the O–C residual, respectively; the sixth and seventh columns are the number of observations N and the source of data, respectively. The data from Table 4 are shown in the O–C diagrams (Figs. 2 and 3 for the fundamental mode and first overtone, respectively) as squares for photographic observations and small filled circles for other observations, with vertical error bars of O–C residuals.

The O–C diagrams have the form of parabolas. Based on the times of maximum light from Table 4, we inferred the quadratic ephemerides listed in Table 5, which we use to draw the parabolas in the top panels of Figs. 2 and‘3. The bottom panels of these figures show the residuals from these parabolas. We use the linear parts of these ephemerides to compute the O–C residuals in the fifth column of Table 4.

We use the data from Table 4 to compute the differences between the times of maximum light in the B band (and also in photographic, pg, magnitudes whose photometric system is close to that of the B band), and g' and r' bands relative to the V band; the corresponding corrections are listed in Table 6. We used these corrections when drawing Figs. 2 and 3 and computing the ephemerides (Table 5), which therefore apply to the V-band variations.

We use the method published by Lombard and Koen (1993) to confirm the reality of the changes in the pulsation period. To this end, we compute the differences $\Delta(\mathrm{O}-\mathrm{C})_i$ of consecutive O–C residuals from Table 4, $\Delta(\mathrm{O}-\mathrm{C})_i = (\mathrm{O}-\mathrm{C})_{i+1} - (\mathrm{O}-\mathrm{C})_i$, and plot the dependences of $P'_i = \Delta(\mathrm{O}-\mathrm{C})_i/(E_{i+1} - E_i)$ on $E'_i = (E_i + E_{i+1})/2$ for both oscillations of V367 Sct (Figs. 4 and 5). The P'_i values, which have the meaning of average period in the epoch interval $E_i - E_{i+1}$, correspond to the behavior of the O–C residuals in Figs. 2 and 3, and hence the period increases found are real.

The quadratic terms (Table 5) allow us to compute the rates of evolutionary period increase for the fundamental tone and first overtone of V367 Sct, which are listed in the fifth column of Table 5. These period increase rates are consistent with theoretical computations for the third crossing of the instability strip (Turner et al., 2006; Fadeyev, 2014).

4 Conclusions

To study the period changes of the bimodal Cepheid V367 Sct, we acquired 379 CCD frames in $BVg'r'$ filters with the 60-cm telescope of Caucasian Mountain Observatory and made 282 magnitude estimates on photographic plates of Sternberg Astronomical Institute (Moscow); in addition, we compiled 4329 published photometric observations. We used the Hertzsprung method to determine 203 times of maximum light for both oscillations, which allowed us to construct O–C diagrams spanning a 113-year time interval. The O–C diagrams have the form of parabolas, which allowed us, for the first time, to determine the quadratic ephemerides and to compute the rates of evolutionary period changes: $dP_{\mathrm{Fu}}/dt = +0.233$ (± 0.020) s/year and $dP_{1\mathrm{O}}/dt = +0.244$ (± 0.025) s/yr for the fundamental tone and the first overtone of V367 Sct, respectively, which is consistent with the theoretical results for the third crossing of the instability strip. The pulsation stability test proposed by Lombard & Koen (1993) confirmed that the increase of periods was real.

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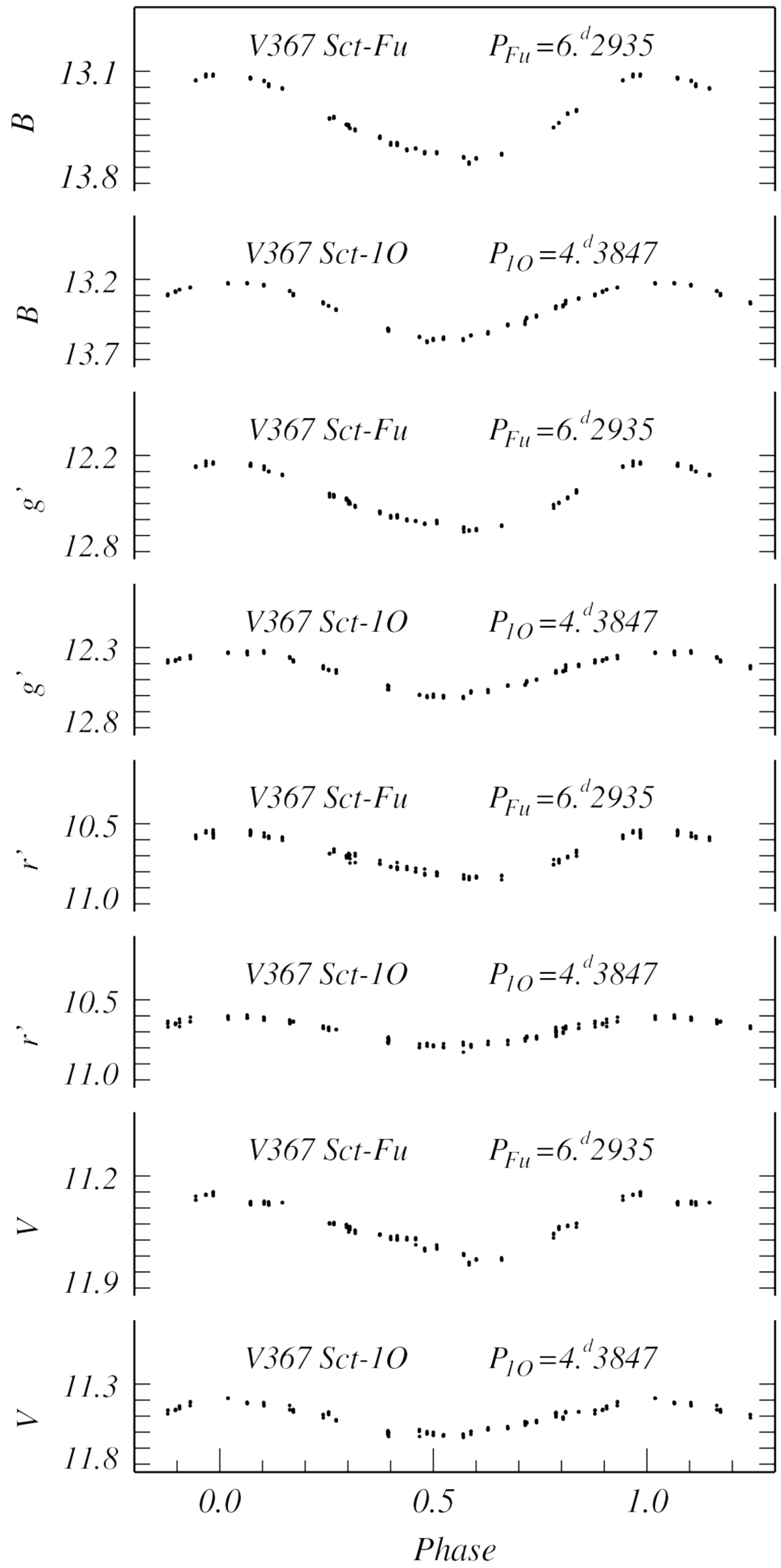

Figure 1: Phased B, V, g', and r' light curves for both oscillations of V367 Sct.

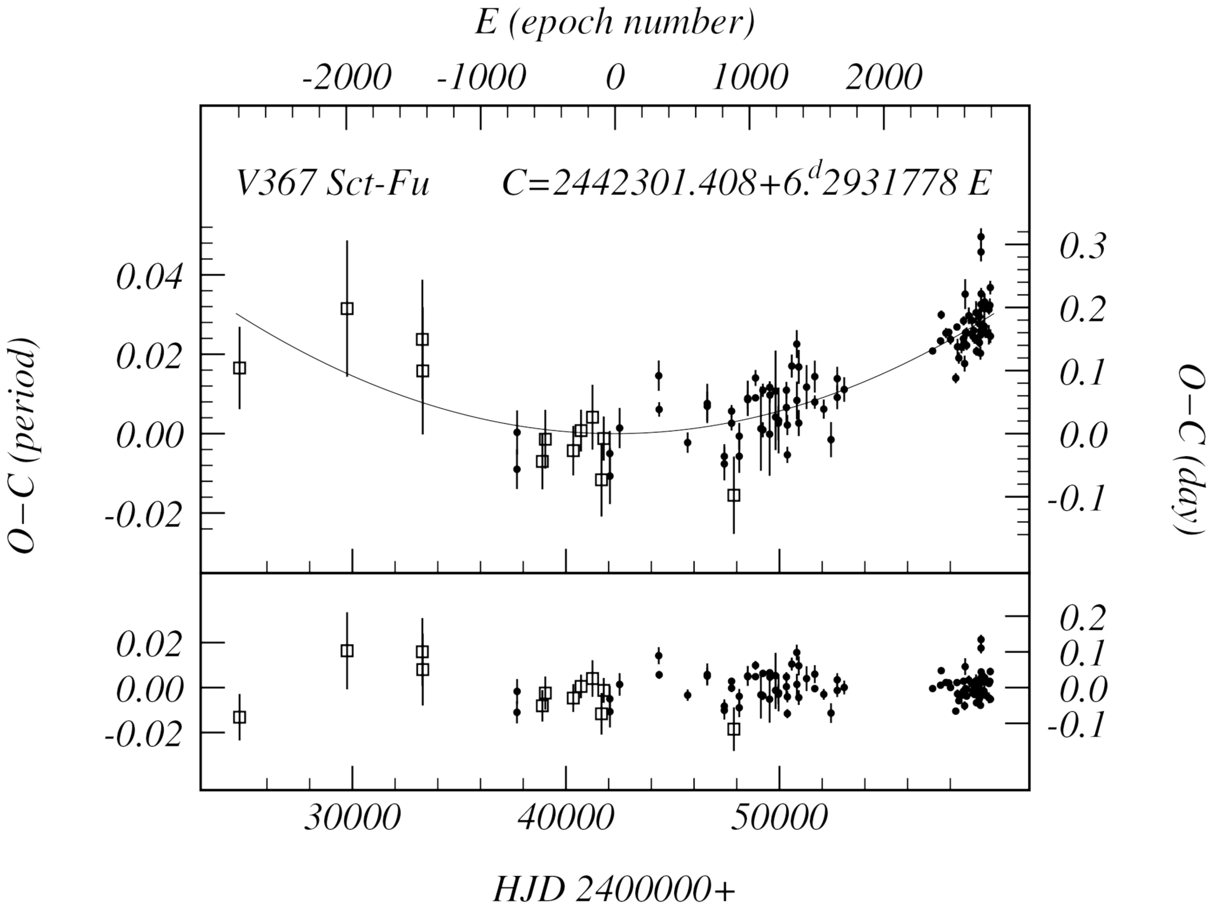

Figure 2: The O–C diagram for V367 Sct for linear (top panel) and quadratic (bottom panel) ephemeris of the fundamental tone (Table 5). The curve shows the parabola corresponding to the ephemeris (Table 5). Symbols are explained in the text.

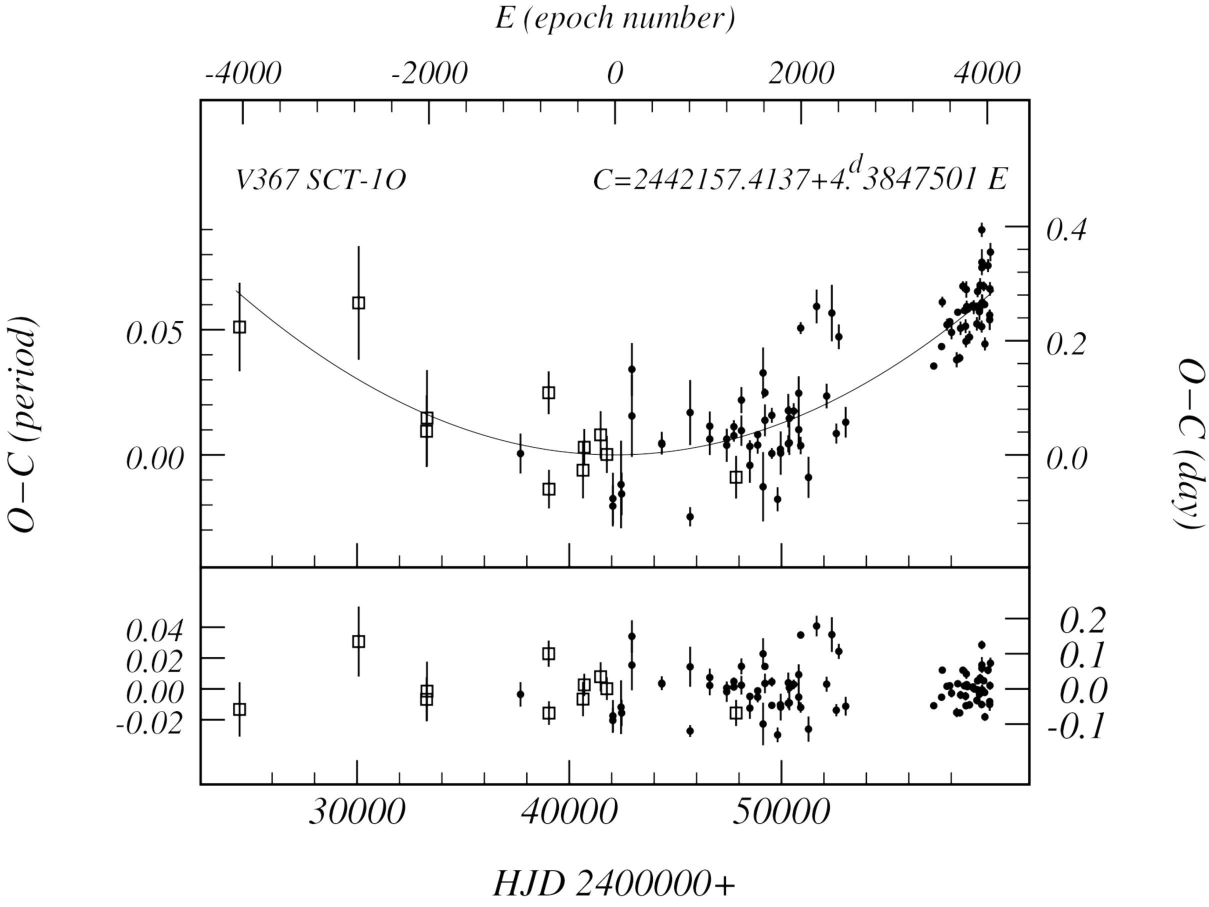

Figure 3: The O–C diagram for V367 Sct for linear (top panel) and quadratic (bottom panel) ephemeris of the first overtone (Table 5). The curve shows the parabola corresponding to the ephemeris (Table 5). Symbols are explained in the text.

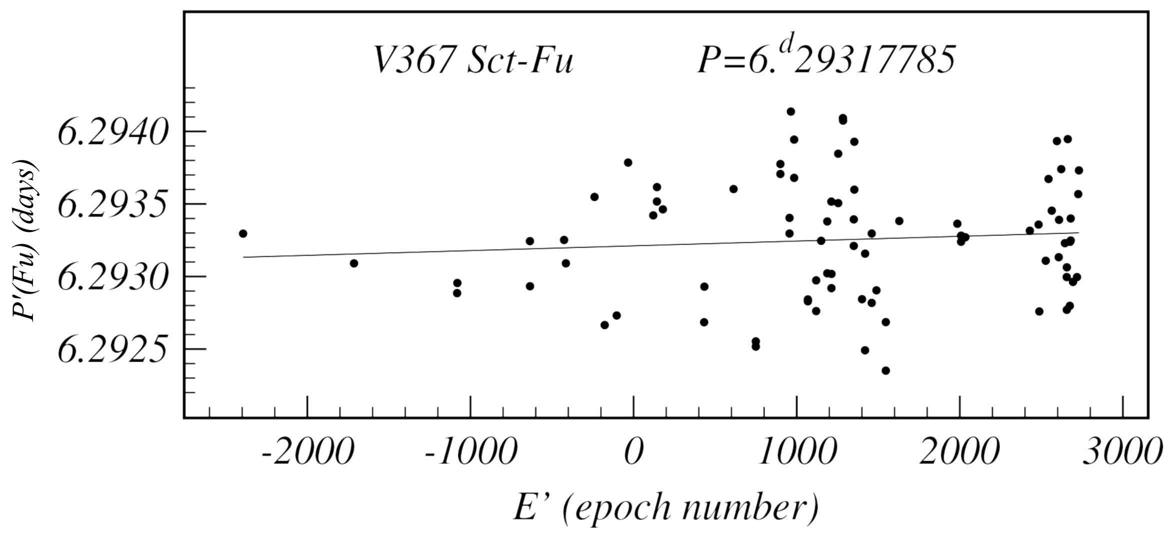

Figure 4: The dependence of $P'_i(\mathrm{Fu}) = ((\mathrm{O-C})_{i+1} - (\mathrm{O-C})_i)/(E_{i+1} - E_i)$ on $E'_i = (E_i + E_{i+1})/2$ for the fundamental tone. The line corresponds to the behavior of $O - C$ residuals in Fig. 2.

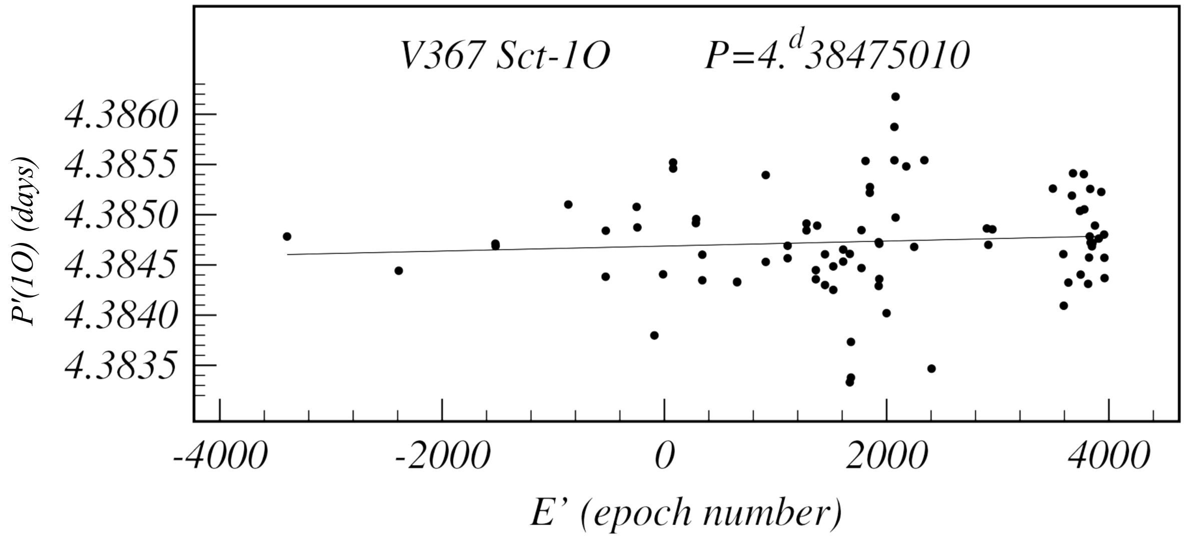

Figure 5: The dependence of $P'_i(1O) = ((O-C)_{i+1} - (O-C)_i)/(E_{i+1} - E_i)$ on $E'_i = (E_i + E_{i+1})/2$ for the first overtone. The line corresponds to the behavior of O–C residuals in Fig. 3.

Table 1. Parameters of B-, V-, g'-, and r'-band light curves of both oscillations of V367 Sct

Oscillation mode	Filter	Magnitude at maximum light	Amplitude	Intensity-mean magnitude
Fundamental mode	B	13.117	0.531	13.385
Fundamental mode	V	11.433	0.379	11.618
Fundamental mode	g'	12.292	0.438	12.505
Fundamental mode	r'	10.551	0.303	10.704
First overtone	B	13.225	0.352	13.385
First overtone	V	11.486	0.244	11.618
First overtone	g'	12.346	0.288	12.505
First overtone	r'	10.607	0.201	10.704

Table 2. Fourier coefficients (cosine expansion) of the B-, V-, g'-, and r'-band light curves of the fundamental mode ($P_{\mathrm{F}u} = 6\overset{\mathrm{d}}{.}2866$) and first overtone ($P_{1\mathrm{O}} = 4\overset{\mathrm{d}}{.}3863$) of V367 Sct.

Oscillation mode	Filter	R_{21} Error	R_{31} Error	R_{41} Error	ϕ_{21} Error	ϕ_{31} Error	ϕ_{41} Error
Fundamental mode	B	0.11100	0.02040	0.01350	4.27050	2.29911	4.09857
		±0.00081	±0.00081	±0.00031	±0.00194	±0.02297	±0.05099
Fundamental mode	g'	0.15596	0.03487	0.01320	4.48043	2.36722	6.24081
		±0.00053	±0.00053	±0.00053	±0.00356	±0.01529	±0.04022
Fundamental mode	r'	0.16781	0.00839	0.02262	4.22781	1.72122	0.12706
		±0.00002	±0.00002	±0.00002	±0.00012	±0.00232	±0.00086
First overtone	B	0.03281	0.00873	0.00002	5.40537	3.85542	2.34633
		±0.00002	±0.00002	±0.00002	±0.00056	±0.00212	±0.95915
First overtone	V	0.12838	0.00423	0.00188	3.74491	1.48809	1.90353
		±0.00060	±0.00060	±0.00060	±0.00486	±0.14274	±0.32162
First overtone	g'	0.08753	0.00652	0.00015	3.66465	3.60980	2.29634
		±0.00002	±0.00002	±0.00002	±0.00023	±0.00308	±0.13095
First overtone	r'	0.03161	0.01210	0.02313	0.61989	2.03573	3.30126
		±0.00003	±0.00003	±0.00003	±0.00093	±0.00243	±0.00128

Table 3. Observational data for V367 Sct.

Data source	Number of observations	Type of observations	JD interval
Caucasian Mountain Observatory (this paper)	379	CCD, $BVg'r'$	2459403–2459438
Sternberg Astronomical Institute (this paper)	282	Photographic, pg	2432826–2448179
Published	314	Photographic, pg	2418529–2441926
Published	860	Photoelectric, BV	2437549–2453118
ASAS-3	223	CCD, V	2452135–2453228
ASAS-SN	2932	CCD, Vg'	2457061–2460044

Table 4. Times of maximum light for V367 Sct

Maximum, HJD	Error, days	Filter	E	O−C, days	N	Reference
			V367 Sct–Fu			
2424718.3580	0.0656	pg	−2794	0.1022	58	Efremov, Kholopov (1975)
2429752.9944	0.1084	pg	−1994	0.1966	35	Efremov, Kholopov (1975)
2433277.1252	0.0949	pg	−1434	0.1479	22	Sternberg Astronomical Institute
2433295.9548	0.1011	pg	−1431	0.0980	22	Efremov, Kholopov (1975)
2437707.3317	0.0315	*V*	−730	−0.0578	25	Roslund, Pretorius (1962)
2437713.6682	0.0351	*B*	−729	0.0007	24	Roslund, Pretorius (1962)
2438896.7396	0.0446	pg	−541	−0.0453	57	Efremov, Kholopov (1975)
2439035.2246	0.0469	pg	−519	−0.0101	78	Sternberg Astronomical Institute
2440344.1875	0.0396	pg	−311	−0.0282	75	Efremov, Kholopov (1975)
2440709.2236	0.0334	pg	−253	+0.0036	71	Sternberg Astronomical Institute
2441244.1650	0.0518	pg	−168	+0.0249	45	Efremov, Kholopov (1975)
2441665.7087	0.0586	pg	−101	−0.0743	35	Efremov, Kholopov (1975)
2441772.7581	0.0353	pg	−84	−0.0089	81	Sternberg Astronomical Institute
2442055.9425	0.0362	*V*	−39	−0.0327	37	Madore, van den Bergh (1975)
2442062.1848	0.0447	*B*	−38	−0.0684	36	Madore, van den Bergh (1975)
2442515.3697	0.0322	*B*	34	+0.0078	54	Madore et al. (1978)
2444346.7675	0.0243	*B*	325	+0.0908	124	Moffett, Barnes (1984)
2444365.6087	0.0118	*V*	328	+0.0373	44	Moffett, Barnes (1984)
2445699.7099	0.0165	*V*	540	−0.0151	50	Berdnikov (1986)
2446618.5607	0.0315	*B*	686	+0.0470	27	Berdnikov (1992a)
2446618.5714	0.0234	*V*	686	+0.0424	27	Berdnikov (1992a)
2447417.7103	0.0196	*B*	813	−0.0369	30	Berdnikov (1992b)
2447417.7136	0.0264	*V*	813	−0.0488	30	Berdnikov (1992b)
2447757.5945	0.0118	*B*	867	+0.0156	41	Berdnikov (1992c)
2447757.6289	0.0101	*V*	867	+0.0348	41	Berdnikov (1992c)
2447864.4644	0.0617	pg	884	−0.0985	30	Sternberg Astronomical Institute
2448116.2532	0.0267	*B*	924	−0.0368	38	Berdnikov (1992d)
2448116.3004	0.0212	*V*	924	−0.0049	19	Berdnikov (1992d)
2448512.8153	0.0284	*B*	987	+0.0552	31	Berdnikov (1992e)
2448512.8284	0.0137	*V*	987	+0.0530	62	Berdnikov (1992e)
2448877.8204	0.0052	*B*	1045	+0.0559	824	Berdnikov, Ibragimov (1994a)
2448877.8671	0.0130	*V*	1045	+0.0875	83	Berdnikov, Ibragimov (1994a)
2449129.5138	0.0670	*V*	1085	+0.0070	45	Arellano Ferro et al. (1998)
2449223.9098	0.0123	*V*	1100	+0.0053	50	Berdnikov, Ibragimov (1994b)
2449223.9571	0.0108	*B*	1100	+0.0679	98	Berdnikov, Ibragimov (1994b)
2449538.5617	0.0663	*V*	1150	−0.0017	10	Berdnikov, Turner (1995a)
2449544.9139	0.0098	*B*	1151	+0.0726	164	Berdnikov et al. (1995)
2449551.2100	0.0122	*V*	1152	+0.0603	83	Berdnikov et al. (1995)
2449815.4734	0.0527	*B*	1194	+0.0255	15	Berdnikov, Turner (1995b)
2449815.5299	0.0644	*V*	1194	+0.0667	15	Berdnikov, Turner (1995b)
2449947.6206	0.0271	*B*	1215	+0.0160	56	Berdnikov et al. (1997)
2449960.2264	0.0525	*V*	1217	+0.0201	23	Berdnikov et al. (1997)
2450325.2512	0.0224	*V*	1275	+0.0407	33	Berdnikov et al. (1998)
2450325.2634	0.0136	*B*	1275	+0.0681	133	Berdnikov et al. (1998)
2450369.2132	0.0132	*B*	1282	−0.0343	28	Berdnikov, Turner (1998a)
2450369.2757	0.0162	*V*	1282	+0.0129	28	Berdnikov, Turner (1998a)
2450577.0441	0.0185	*V*	1315	+0.1064	35	Berdnikov, Turner (1998b)
2450809.9265	0.0225	*V*	1352	+0.1413	45	Ignatova, Vozyakova (2000)
2450816.1151	0.0302	*B*	1353	+0.0520	44	Ignatova, Vozyakova (2000)
2450904.1837	0.0210	*B*	1367	+0.0161	94	Berdnikov, Turner (2000)
2450904.2879	0.0271	*V*	1367	+0.1051	48	Berdnikov, Turner (2000)
2451269.2451	0.0352	*B*	1425	+0.0731	23	Berdnikov, Turner (2001)
2451653.1203	0.0108	*V*	1486	+0.0493	21	Berdnikov, Caldwell (2001)
2451653.1456	0.0256	*B*	1486	+0.0898	42	Berdnikov, Caldwell (2001)
2452074.7521	0.0155	*V*	1553	+0.0382	54	ASAS
2452414.5353	0.0282	*V*	1607	−0.0102	50	ASAS

Table 4. Continued

Maximum, HJD	Error, days	Filter	E	O−C, days	N	Reference
			V367 Sct–Fu			
2452704.0885	0.0190	V	1653	+0.0568	66	Berdnikov et al. (2019)
2452704.1182	0.0191	V	1653	+0.0865	48	ASAS
2453031.3463	0.0198	V	1705	+0.0694	59	ASAS
2457172.3183	0.0037	V	2363	+0.1306	110	ASAS-SN
2457543.6319	0.0035	V	2422	+0.1467	99	ASAS-SN
2457575.1390	0.0072	V	2427	+0.1880	60	ASAS-SN
2457795.3714	0.0083	V	2462	+0.1591	60	ASAS-SN
2457927.5295	0.0028	V	2483	+0.1604	154	ASAS-SN
2458009.3293	0.0083	V	2496	+0.1490	60	ASAS-SN
2458254.7019	0.0083	V	2535	+0.0876	62	ASAS-SN
2458311.4215	0.0035	V	2544	+0.1687	120	ASAS-SN
2458336.4655	0.0130	g'	2548	+0.1373	60	ASAS-SN
2458399.3794	0.0093	g'	2558	+0.1194	59	ASAS-SN
2458525.2606	0.0105	g'	2578	+0.1370	55	ASAS-SN
2458613.3781	0.0112	g'	2592	+0.1501	60	ASAS-SN
2458619.6996	0.0076	g'	2593	+0.1784	70	ASAS-SN
2458625.9558	0.0110	g'	2594	+0.1414	55	ASAS-SN
2458669.9773	0.0129	g'	2601	+0.1107	74	ASAS-SN
2458695.2601	0.0240	g'	2605	+0.2208	59	ASAS-SN
2458714.0785	0.0070	g'	2608	+0.1596	60	ASAS-SN
2458764.4038	0.0078	g'	2616	+0.1395	70	ASAS-SN
2458764.4232	0.0093	g'	2616	+0.1589	54	ASAS-SN
2458865.1417	0.0135	g'	2632	+0.1866	59	ASAS-SN
2459016.1705	0.0095	g'	2656	+0.1791	69	ASAS-SN
2459060.1976	0.0094	g'	2663	+0.1539	74	ASAS-SN
2459097.9658	0.0062	g'	2669	+0.1631	70	ASAS-SN
2459135.7134	0.0098	g'	2675	+0.1516	60	ASAS-SN
2459204.9781	0.0186	g'	2686	+0.1914	58	ASAS-SN
2459223.7966	0.0075	g'	2689	+0.1303	55	ASAS-SN
2459362.2602	0.0079	g'	2711	+0.1440	69	ASAS-SN
2459362.2899	0.0085	g'	2711	+0.1737	84	ASAS-SN
2459362.3011	0.0138	g'	2711	+0.1850	60	ASAS-SN
2459412.5887	0.0106	g'	2719	+0.1271	55	ASAS-SN
2459418.9106	0.0174	g'	2720	+0.1558	60	ASAS-SN
2459425.2103	0.0121	g'	2721	+0.1624	54	ASAS-SN
2459437.8389	0.0212	g'	2723	+0.2046	93	Sternberg Astronomical Institute
2459438.0193	0.0153	V	2723	+0.2877	95	Sternberg Astronomical Institute
2459444.2310	0.0096	B	2724	+0.2214	91	Sternberg Astronomical Institute
2459569.9590	0.0125	g'	2744	+0.1680	56	ASAS-SN
2459576.2545	0.0073	g'	2745	+0.1703	70	ASAS-SN
2459595.1616	0.0216	g'	2748	+0.1979	60	ASAS-SN
2459607.7585	0.0138	g'	2750	+0.2084	66	ASAS-SN
2459645.4690	0.0089	g'	2756	+0.1599	65	ASAS-SN
2459802.7950	0.0158	g'	2781	+0.1564	57	ASAS-SN
2459809.1282	0.0082	g'	2782	+0.1965	73	ASAS-SN
2459853.1872	0.0111	g'	2789	+0.2031	68	ASAS-SN
2459872.0948	0.0111	g'	2792	+0.2312	72	ASAS-SN
2459878.3109	0.0111	g'	2793	+0.1542	61	ASAS-SN
			V367 Sct–1O			
2424465.1663	0.0778	pg	−4035	+0.1996	53	Efremov, Kholopov (1975)
2430077.6886	0.0999	pg	−2755	+0.2456	29	Efremov, Kholopov (1975)
2433278.3314	0.0630	pg	−2025	+0.0229	22	Sternberg Astronomical Institute
2433295.8936	0.0844	pg	−2021	+0.0461	22	Efremov, Kholopov (1975)
2437702.5100	0.0354	V	−1016	−0.0132	25	Roslund, Pretorius (1962)
2437742.2970	0.0297	B	−1007	+0.3159	20	Roslund, Pretorius (1962)
2439031.1910	0.0379	pg	−713	+0.0942	77	Sternberg Astronomical Institute
2439044.1764	0.0342	pg	−710	−0.0747	70	Efremov, Kholopov (1975)
2440649.0281	0.0495	pg	−344	−0.0404	71	Efremov, Kholopov (1975)
2440706.0701	0.0321	pg	−331	−0.0001	71	Sternberg Astronomical Institute
2441477.8078	0.0418	pg	−155	+0.0220	67	Efremov, Kholopov (1975)
2441771.5517	0.0328	pg	−88	−0.0121	81	Sternberg Astronomical Institute
2442052.0901	0.0361	V	−24	−0.1023	37	Madore, van den Bergh (1975)
2442056.4832	0.0456	B	−23	−0.0892	36	Madore, van den Bergh (1975)
2442442.3659	0.0771	B	65	−0.0643	54	Madore, van den Bergh (1975)
2442468.6626	0.0373	V	71	−0.0807	31	Madore et al. (1978)
2442951.1169	0.0722	B	181	+0.0561	8	Dean (1977)
2442951.2034	0.0464	V	181	+0.1378	8	Dean (1977)
2444358.5741	0.0202	B	502	+0.0094	118	Moffett, Barnes (1984)
2444362.9616	0.0135	V	503	+0.0074	44	Moffett, Barnes (1984)
2445695.7986	0.0172	V	807	−0.1186	50	Berdnikov (1986)
2445695.9764	0.0574	B	807	+0.0639	23	Berdnikov (1986)
2446621.1122	0.0283	B	1018	+0.0180	27	Berdnikov (1992a)
2446621.1396	0.0260	V	1018	+0.0407	27	Berdnikov (1992a)

Table 4. Continued

Maximum, HJD	Error, days	Filter	E	O−C, days	N	Reference
			V367 Sct–1O			
2447419.1307	0.0294	V	1200	+0.0078	30	Berdnikov (1992b)
2447419.1368	0.0166	B	1200	+0.0186	30	Berdnikov (1992b)
2447756.7685	0.0109	B	1277	+0.0248	41	Berdnikov (1992c)
2447756.7889	0.0118	V	1277	+0.0404	41	Berdnikov (1992c)
2447861.9297	0.0377	PG	1301	−0.0480	30	Sternberg Astronomical Institute
2448111.9421	0.0270	B	1358	+0.0338	38	Berdnikov (1992d)
2448112.0003	0.0232	V	1358	+0.0873	19	Berdnikov (1992d)
2448510.8983	0.0309	V	1449	−0.0266	62	Berdnikov (1992e)
2448510.9268	0.0110	B	1449	+0.0066	31	Berdnikov (1992e)
2448879.2528	0.0154	V	1533	+0.0090	83	Berdnikov, Ibragimov (1994a)
2448879.2664	0.0044	B	1533	+0.0273	823	Berdnikov, Ibragimov (1994a)
2449133.4953	0.0611	V	1591	−0.0638	47	Arellano Ferro et al. (1998)
2449133.6899	0.0450	B	1591	+0.1356	59	Arellano Ferro et al. (1998)
2449221.3067	0.0283	V	1611	+0.0526	50	Berdnikov, Ibragimov (1994b)
2449221.3502	0.0078	B	1611	+0.1009	98	Berdnikov, Ibragimov (1994b)
2449545.7154	0.0098	B	1685	−0.0052	164	Berdnikov et al. (1995)
2449545.7869	0.0135	V	1685	+0.0616	83	Berdnikov et al. (1995)
2449817.4896	0.0214	B	1747	−0.0853	15	Berdnikov, Turner (1995b)
2449949.1196	0.0066	B	1777	+0.0023	56	Berdnikov et al. (1997)
2449962.2720	0.0384	V	1780	−0.0043	23	Berdnikov et al. (1997)
2450321.8331	0.0152	B	1862	+0.0123	133	Berdnikov et al. (1998)
2450321.8959	0.0296	V	1862	+0.0703	33	Berdnikov et al. (1998)
2450370.0671	0.0217	B	1873	+0.0140	28	Berdnikov, Turner (1998a)
2450370.1146	0.0216	V	1873	+0.0568	28	Berdnikov, Turner (1998a)
2450576.2106	0.0143	V	1920	+0.0697	35	Berdnikov, Turner (1998b)
2450812.9499	0.0347	B	1974	+0.0373	45	Ignatova, Vozyakova (2000)
2450813.0184	0.0300	V	1974	+0.1011	45	Ignatova, Vozyakova (2000)
2450905.0017	0.0156	B	1995	+0.0095	94	Berdnikov, Turner (2000)
2450905.2123	0.0108	V	1995	+0.2153	48	Berdnikov, Turner (2000)
2451273.2650	0.0364	B	2079	−0.0460	23	Berdnikov, Turner (2001)
2451655.0424	0.0299	V	2166	+0.2537	21	Berdnikov, Caldwell (2001)
2451655.0956	0.0200	B	2166	+0.3116	42	Berdnikov, Caldwell (2001)
2452128.4385	0.0219	V	2274	+0.0970	71	ASAS
2452374.1251	0.0498	B	2330	+0.2426	18	Berdnikov et al. (2019)
2452584.3868	0.0179	V	2378	+0.0317	83	ASAS
2452702.9445	0.0220	V	2405	+0.2012	66	Berdnikov et al. (2019)
2453027.2664	0.0272	V	2479	+0.0518	61	ASAS
2457175.3384	0.0032	V	3425	+0.1529	110	ASAS-SN
2457543.6916	0.0046	V	3509	+0.1873	99	ASAS-SN
2457578.8474	0.0096	V	3517	+0.2653	60	ASAS-SN
2457798.0453	0.0108	V	3567	+0.2257	60	ASAS-SN
2457929.5932	0.0028	V	3597	+0.2312	154	ASAS-SN
2458012.8846	0.0125	V	3616	+0.2124	60	ASAS-SN
2458253.9979	0.0137	V	3671	+0.1646	62	ASAS-SN
2458306.6982	0.0041	V	3683	+0.2480	120	ASAS-SN
2458398.7412	0.0078	g'	3704	+0.1678	59	ASAS-SN
2458438.2560	0.0122	g'	3713	+0.2200	100	ASAS-SN
2458547.9484	0.0091	g'	3738	+0.2936	80	ASAS-SN
2458622.4468	0.0046	g'	3755	+0.2513	70	ASAS-SN
2458675.0362	0.0125	g'	3767	+0.2237	69	ASAS-SN
2458692.5485	0.0108	g'	3771	+0.1971	60	ASAS-SN
2458710.1785	0.0148	g'	3775	+0.2881	79	ASAS-SN
2458727.6876	0.0108	g'	3779	+0.2582	100	ASAS-SN
2458767.1457	0.0044	g'	3788	+0.2535	70	ASAS-SN
2458859.1765	0.0114	g'	3809	+0.2047	58	ASAS-SN
2459017.0831	0.0064	g'	3845	+0.2604	70	ASAS-SN
2459060.9275	0.0125	g'	3855	+0.2573	71	ASAS-SN
2459205.5950	0.0121	g'	3888	+0.2282	58	ASAS-SN
2459227.5498	0.0039	g'	3893	+0.2592	137	ASAS-SN
2459240.7298	0.0105	g'	3896	+0.2850	79	ASAS-SN
2459328.3894	0.0152	g'	3916	+0.2496	100	ASAS-SN
2459359.1290	0.0127	g'	3923	+0.2960	73	ASAS-SN
2459433.5973	0.0109	g'	3940	+0.2236	57	ASAS-SN
2459442.4081	0.0157	g'	3942	+0.2649	93	Sternberg Astronomical Institute
2459442.4219	0.0060	B	3942	+0.3268	91	Sternberg Astronomical Institute
2459442.4360	0.0231	V	3942	+0.3363	95	Sternberg Astronomical Institute
2459464.3326	0.0138	g'	3947	+0.2657	100	ASAS-SN
2459530.1323	0.0088	g'	3962	+0.2942	80	ASAS-SN
2459573.9479	0.0065	g'	3972	+0.2623	70	ASAS-SN
2459587.0331	0.0118	g'	3975	+0.1932	54	ASAS-SN
2459731.8671	0.0116	g'	4008	+0.3306	143	ASAS-SN
2459810.6978	0.0183	g'	4026	+0.2358	52	ASAS-SN
2459810.7060	0.0074	g'	4026	+0.2441	71	ASAS-SN
2459823.9061	0.0124	g'	4029	+0.2899	88	ASAS-SN
2459845.8942	0.0164	g'	4034	+0.3543	78	ASAS-SN

Table 5. Quadratic ephemerides in the form $MaxHJD = HJD_0 + P \cdot E + q \cdot E^2$ for the fundamental mode and first overtone of V367 Sct and period change rates dp/dt

Oscillation mode	HJD_0 Error	P, days Error	q, days Error	dp/dt, s/yr Error
Fundamental tone	2442301.4091	6.293177564	$0.23276399 \cdot 10^{-07}$	0.2334
	±0.0068	±0.000004929	$\pm 0.2039 \cdot 10^{-08}$	±0.0205
First overtone	2442157.4263	4.384747197	$0.16984058 \cdot 10^{-07}$	0.2445
	±0.0116	±0.000006137	$\pm 0.1764 \cdot 10^{-8}$	±0.0254

Table 6. Differences ΔT between the times of maximum light in the B- and g'-band filters relative to the V-band filter for the fundamental mode and first overtone of V367 Sct

Oscillation mode	ΔT_B, days Error	$\Delta T_{g'}$, days Error
Fundamental tone	+0.0152	+0.0974
	±0.0478	±0.0478
First overtone	+0.0047	−0.0434
	±0.0943	±0.0636