RS CVn-BINARY RW COM: A POSSIBLE THREE-BODY SYSTEM

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Abstract. A first detailed period study of the eclipsing RS CVn-binary system RW Com is presented. A new period (P = 0^d.2373455) based on 223 minima is given. The O–C diagrams of RW Com have been presented for the first time. Types of ten minima have been corrected judging the period trend. Period changes in different portions of the O–C diagram (Figure 2) have been estimated. The total change in period ($\Delta P/P$) ranges from 5.5×10^{-7} to 6.4×10^{-6}. Thus, ΔP ranges from 1.3×10^{-7} d to 1.5×10^{-6} d. Numerous minima are available in the time interval 1967 to 1986. This part of the O–C diagram (Figure 2) shows a sinusoidal variation, thus, it is suspected that RW Com could be a three-body system. The period of variation due to third body appears to be nearly 16 years.

1. Introduction

The eclipsing binary RW Coma Berenices (= RW Com = 33.1923) was discovered to be an eclipsing variable by Jordan (1923). Epochs and periods of the system have been given by various authors (Table I). Diethelm (1974) collected minima of the system but did not present its O–C diagram and details. Milone *et al.* (1980) attempted its period study and found – 0.40 dex (– 10) day per day. However, Milone *et al.* (1980) also did not present any O–C diagram and details of his investigation. Thus, it is apparent that this system has remained neglected for period study. Since its light curve shows unusual changes year to year, hence, it is possible that the detection of primary and secondary

TABLE I

Epochs and periods of RW Com

Sl. No.	Author	Epoch and period
1	Prager (cf. Beliawski, 1924)	J.D. 2419127.234 + 0^d.2373476
2	E.O. (cf. Beliawski, 1924)	J.D. 2419127.234 + 0^d.237350
3	E.O. (cf. Beliawski, 1924)	J.D. 2419127.234 + 0^d.237350
4	Beliawski (1924)	J.D. 2419921.404 + 0^d.237350
5	E.O. (cf. Beliawski, 1924)	J.D. 2420212.638 + 0^d.237350
6	Jacchia (1931)	J.D. 2425760.380 + –
7	Pagaczewski (1949)	J.D. 2433040.4 + 0^d.2373405
8	Pagaczewski (cf. Koch *et al.*, 1963)	J.D. 2433040.406 + 0^d.2373405
9	Diethelm (cf. Wood *et al.*, 1980)	J.D. 2439637.439 + 0^d.2373459
10	Kukarkin *et al.* (1971)	J.D. 2440022.416 + 0^d.23734610
11	Milone *et al.* (1980)	J.D. 2440022.4163 + 0^d.2373459
12	Lelaŕko (1987)	J.D. 2446175.357 + 0^d.237342
13	Srivastava (present work)	J.D. 2419127.234 + 0^d.2373455

E.O.: earlier observations (1911, 1913, and 1914).

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minima are confused. In this communication we have collected 231 times of minima from the literature and attempted its detailed period study for the first time.

2. Epoch, Period, and New Period

As mentioned above many observers presented epochs and periods of the system, which are listed in Table I. There appears no systematic trend in the period changes.

Out of 231 minima, 19 are photographic and the rest are visual. Few photoelectric minima were given by Milone *et al.* (1980), but they were not included in the discussion as they gave unusual O–C values, which did not fit in the regular trend of the period. Probably, these minima (Table 6 of Milone *et al.*, 1980) are in a different form than adopted by us for the period study. These minima have also been tried considering their fraction of J.D. in phase yet they did not show any conformity with the period trend. Out of 231 minima, 103 are secondary, while the rest are primary. From all these minima, a new period of RW Com has been obtained after trials employing the method of least squares, the new (corrected) period comes out to be $0^d.2373455$, using the initial epoch.

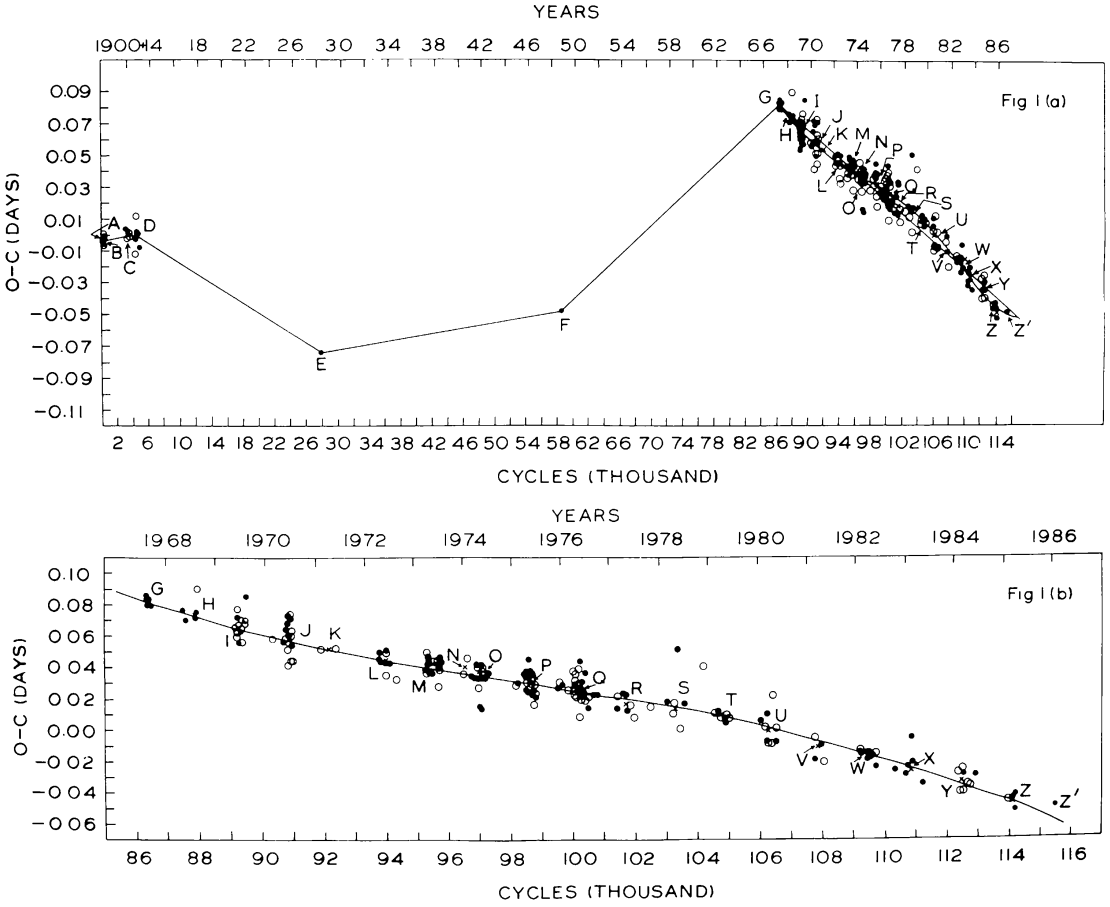

Fig. 1a. O–C diagram of RW Com based on the period quoted by Prager (cf. Beliawski, 1924). Solid lines represent the period trends while the solid curve represent the sinusoidal variation.

Fig. 1b. Part of the O–C diagram (Figure 1(a)) in the time interval 1967 to 1986 in a magnified form. The solid curve represents the sinusoidal variation.

3. O–C Diagrams and Period Changes

In all 231 minima, which are observed in the time interval 1910 to 1986, have been listed in Table II. Out of these 8 minima have not been used in the present study as they have appeared to be wrong. Thus, nearly equal number of primary and secondary minima are available, O–C diagram (Figure 1) is based on the ephemeris:

$$\text{Primary Minimum} = \text{J.D. } 2419127.234 + 0^{d}.237350E$$

[Prager (cf. Beliawski, 1924)]

This diagram shows erratic period changes before 1967. Since 1967, the period appears to have settled down, and shows a continuous declining trend till 1986 at rate of 1 min per year. On this continuous declining trend, a sinusoidal variation is apparent, which suggests the presence of a third body in the system.

The second O–C diagram (Figure 2) has been constructed from the following ephemeris:

$$\text{Primary Minimum} = \text{J.D. } 2419127.234 + 0^{d}.2373455E\,.$$

[Prager (cf. Beliawski, 1924)] (corrected)

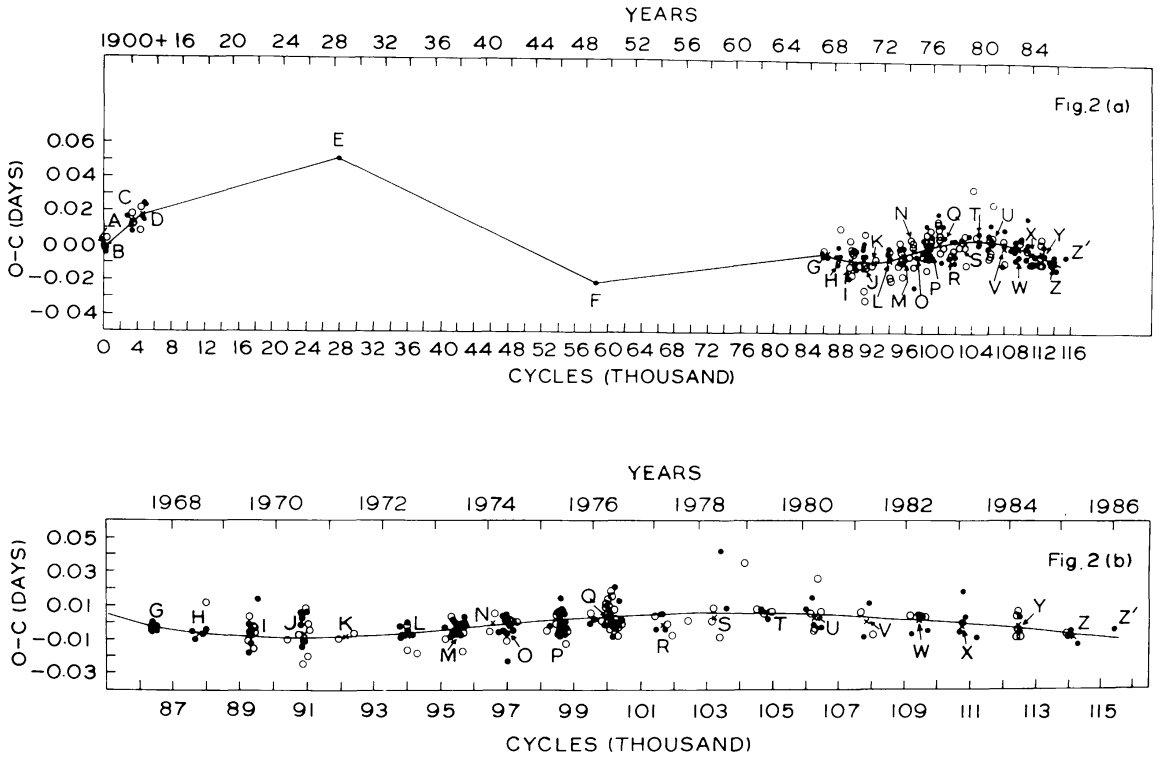

Fig. 2a. O–C diagram based on the corrected (present) period. The solid lines represent the period trends while the solid curve represents the sinusoidal variation.

Fig. 2b. Part of the O–C diagram (Figure 2(a)) in the time interval 1967 to 1986 in a magnified form. The solid curve represent the sinusoidal variation.

TABLE II

Minima of RW Com

J.D.$_\odot$	Type of obs.	Min.	Based on $P = 0^d.237350$				Based on corrected $P = 0^d.2373455$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2419127.234	pg	I	0		$0^d.000$		0		$0^d.000$		Pr (cf. Be)	*AN* **221**, 139, 1924
2419183.364	pg	II	236.5		−0.004		236.5		−0.003		Be	*AN* **221**, 139, 1924
2419188.348	pg	II	257.5		−0.004		257.5		−0.003		Be	*AN* **221**, 139, 1924
2419207.334	pg	II	337.5	311.4	−0.006	$-0^d.003$	337.5	311.4	−0.004	$-0^d.002$	Be	*AN* **221**, 139, 1924
2419209.353	pg	I	346		−0.004		346		−0.003		Be	*AN* **221**, 139, 1924
2419217.310	pg	II	379.5		+0.001		379.5		+0.003		Be	*AN* **221**, 139, 1924
2419921.403	pg	I	3346		−0.004		3346		+0.011		Be	*AN* **221**, 139, 1924
2419921.404	pg	I	3346		−0.003		3346		+0.012		Be	*AN* **221**, 139, 1924
				3418.5		−0.002		3418.5		+0.014		
2419953.353	pg	II	3480.5		+0.002		3480.5		+0.018		Be	*AN* **221**, 139, 1924
2419958.313	pg	II	3501.5		−0.002		3501.5		+0.013		Be	*AN* **221**, 139, 1924
2420187.346	pg	II	4466.5		−0.012		4466.5		+0.008		Be	*AN* **221**, 139, 1924
2420188.308	pg	II	4470.5		0.000		4470.5		+0.021		Be	*AN* **221**, 139, 1924
2420212.633	pg	I	4573	4609.5	−0.003	−0.003	4573	4609.5	+0.018	+0.018	Be	*AN* **221**, 139, 1924
2420212.638	pg	I	4573		+0.002		4573		+0.023		Be	*AN* **221**, 139, 1924
2420248.476	pg	I	4724		+0.001		4724		+0.022		Be	*AN* **221**, 139, 1924
2420278.374	pg	I	4850		−0.008		4850		+0.014		Be	*AN* **221**, 139, 1924
2425760.380	V	I	27947		−0.074		27947		+0.051		Ja	*AN* **241**, 385, 1931
2433040.406	V	I	58619		−0.048		58620		−0.021		Pg	*Circ. Astron. Obs. Warsaw* **24**, 1949
2439637.439	V	I	86413		+0.079		86415		−0.006		cf. W.	*PPEN* **XII**, 148, 1980
2439637.445	V	I	86413		+0.085		86415		0.000		KL	*BBS* **15**, 3, 1974
2439638.392	V	I	86417	86466	+0.083	+0.082	86419	86468	−0.003	−0.004	KL	*BBS* **15**, 3, 1974
2439646.461	V	I	86451		+0.133 (?)		86453		+0.046 (?)		KL	*BBS* **15**, 3, 1974
2439666.399	V	I	86535		+0.083		86537		−0.003		KL	*BBS* **15**, 3, 1974
2439670.430	V	I	86552		+0.079		86554		−0.006		KL	*BBS* **15**, 3, 1974

Table II (continued)

J.D.$_{\odot}$	Type of obs.	Min.	Based on $P = 0^d.237350$				Based on corrected $P = 0^d.2373455$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2439914.423	V	I	87580		$+0^d.076$		87582		$-0^d.005$		KL	*BBS* **15**, 3, 1974
2439935.304	V	I	87668		+0.070		87670		−0.010		KL	*BBS* **15**, 3, 1974
2439990.371	V	I	87900	87795.8	+0.072	$+0^d.073$	87902	977797.8	−0.007	$-0^d.007$	MW	*BBS* **15**, 3, 1974
2440022.416	V	I	88035		+0.075		88037		−0.004		HP	*BBS* **15**, 3, 1974
2440024.449	V	II	88043.5		+0.090(?)		88045.5		+0.011(?)		RD	*BBS* **15**, 3, 1974
2440316.362	V	II	89273.5		+0.062		89275.5		−0.011		RD	*BBS* **15**, 3, 1974
2440316.365	V	II	89273.5		+0.065		89275.5		−0.008		KL	*BBS* **15**, 3, 1974
2440317.422	V	I	98278		+0.055		89280		−0.018		RD	*BBS* **15**, 3, 1974
2440319.331	V	I	89286		+0.065		89288		−0.008		KL	*BBS* **15**, 3, 1974
2440319.338	V	I	89286		+0.072		89288		−0.001		RD	*BBS* **15**, 3, 1974
2440321.350	V	II	89294.5		+0.066		89296.5		−0.007		KL	*BBS* **15**, 3, 1974
2440321.361	V	II	89294.5		+0.077		89296.5		+0.004		RD	*BBS* **15**, 3, 1974
2440325.386	V	II	89311.5		+0.067		89313.5		−0.006		KL	*BBS* **15**, 3, 1974
				89363		+0.066		89365		−0.006		
2440330.490	V	I	89333		+0.068		89335		−0.004		KL	*BBS* **15**, 3, 1974
2440344.490	V	I	89392		+0.065		89394		−0.008		RD	*BBS* **15**, 3, 1974
2440350.548	V	II	89417.5		+0.070		89419.5		−0.002		KL	*BBS* **15**, 3, 1974
2440353.382	V	II	89429.5		+0.056		89431.5		−0.016		RD	*BBS* **15**, 3, 1974
2440353.395	V	II	89429.5		+0.069		89431.5		−0.003		KL	*BBS* **15**, 3, 1974
2440362.411	V	II	89467.5		+0.066		89469.5		−0.007		AR	*BBS* **15**, 3, 1974
2440368.586	V	II	89493.5		+0.069		89495.5		−0.003		KL	*BBS* **15**, 3, 1974
2440381.403	V	II	89547.5		+0.070		89549.5		−0.002		KL	*BBS* **15**, 3, 1974
2440382.486	V	I	89552		+0.085(?)		89554		+0.014(?)		RG	*BBS* **15**, 3, 1974
2440589.547	V	II	90424.5		+0.058		90426.5		−0.010		KL	*BBS* **15**, 3, 1974
2440674.399	V	I	90782		+0.057		97084		−0.009		KL	*BBS* **15**, 3, 1974
2440682.589	V	II	90816.5		+0.058		90818.5		−0.008		KL	*BBS* **15**, 3, 1974
2440688.410	V	I	90841		+0.065		90843		−0.001		KL	*BBS* **15**, 3, 1974

Table II (continued)

J.D.$_{\odot}$	Type of obs.	Min.	Based on $P = 0^d.237350$				Based on corrected $P = 0^d.2373455$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2440688.417	V	I	90841		$+0^d.072$		90843		$+0^d.001$		RD	*BBS* **15**, 3, 1974
2440692.303	V	II	90857.5		+0.041		90859.5		−0.025		RD	*BBS* **15**, 3, 1974
2440692.431	V	I(c)	90858		+0.051		90860		−0.015		RD	*BBS* **15**, 3, 1974
2440698.383	V	I	90883		+0.069		90885		+0.003		KL	*BBS* **15**, 3, 1974
2440711.429	V	I	90938		+0.061		90940		−0.005		RD	*BBS* **15**, 3, 1974
				90934.6		$+0^d.059$		90936.6		$-0^d.007$		
2440711.542	V	II	90938.5		+0.055		90940.5		−0.011		RD	*BBS* **15**, 3, 1974
2440720.580	V	II	90976.5		+0.073		90978.5		+0.008		RD	*BBS* **15**, 3, 1974
2440725.426	V	I	90997		+0.054		90999		−0.011		RD	*BBS* **15**, 3, 1974
2440731.469	V	II	91022.5		+0.044		91024.5		−0.021		RD	*BBS* **15**, 3, 1974
2440733.368	V	II	91030.5		+0.044		91032.5		−0.021		RD	*BBS* **15**, 3, 1974
2440735.402	V	I	91039		+0.071		91041		$+0^d.006$		V	*BBS* **15**, 3, 1974
2440741.456	V	II	91064.5		+0.063		91066.5		−0.002		V	*BBS* **15**, 3, 1974
2440742.403	V	II	91068.5		+0.060		91070.5		−0.005		UR	*BBS* **15**, 3, 1974
2440947.702	V	II	91933.5		+0.051		91935.5		−0.010		KL	*BBS* **15**, 3, 1974
				92169		+0.052		92171		$-0^d.009$		
2441059.494	V	II	92404.5		+0.052		92406.5		−0.007		KL	*BBS* **15**, 3, 1974
2441390.477	V	I	93799		+0.050		93801		−0.002		RD	*BBS* **15**, 3, 1974
2441391.420	V	I	93803		+0.044		93805		−0.009		RD	*BBS* **15**, 3, 1974
2441392.370	V	I	93807		+0.045		93809		−0.008		RD	*BBS* **15**, 3, 1974
2441436.404	V	II	93992.5		+0.050		93994.5		−0.002		HP	*BBS* **15**, 3, 1974
2441439.367	V	I	94005	93983.2	+0.046	+0.044	94007	93985.2	−0.005		KL	*BBS* **15**, 3, 1974
2441439.372	V	I	94005		+0.051		94007		0.000		HP	*BBS* **15**, 3, 1974
2441440.424	V	II(c)	94009.5		+0.035		94011.5		−0.017		KL	*BBS* **15**, 3, 1974
2441471.406	V	I	94140		+0.043		94142		−0.008		RD	*BBS* **15**, 3, 1974
2441506.404	V	II	94287.5		+0.032		94289.5		−0.019		KL	*BBS* **15**, 3, 1974
2441706.620	V	I	95131		+0.043		95133		−0.003		KL	*BBS* **15**, 3, 1974
2441707.929	V	II	95136.5		+0.036		95138.5		−0.010		TM	*BBS* **15**, 3, 1974

Table II (continued)

J.D.$_\odot$	Type of obs.	Min.	Based on $P = 0^d.237350$				Based on corrected $P = 0^d.2373455$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2441747.676	V	I	95304		$+0^d.038$		95306		$-0^d.008$		TM	*BBS* **15**, 3, 1974
2441747.806	V	II	95304.5		+0.049		95306.5		+0.003		TM	*BBS* **15**, 3, 1974
2441761.443	V	I	95362		+0.038		95364		−0.007		KL	*BBS* **15**, 3, 1974
2441764.775	V	I	95376		+0.047		95378		+0.002		TM	*BBS* **15**, 3, 1974
2441765.715	V	I	95380		+0.038		95382		−0.007		TM	*BBS* **15**, 3, 1974
2441774.504	V	I	95417		+0.045		95419		0.000		KL	*BBS* **15**, 3, 1974
2441792.776	V	I	95494		+0.041		95496		−0.003		TM	*BBS* **15**, 3, 1974
2441793.725	V	I	95498		+0.041		95500		−0.004		TM	*BBS* **15**, 3, 1974
				95500.4		$+0^d.042$		95502.4		$0^d.004$		
2441794.321	V	II	95500.5		+0.043		95502.5		−0.002		KL	*BBS* **15**, 3, 1974
2441823.390	V	I	95623		+0.043		95625		−0.007		KL	*BBS* **15**, 3, 1974
2441828.500	V	II	95644.5		+0.044		95646.5		−0.001		HP	*BBS* **15**, 3, 1974
2441830.382	V	II	95652.5		+0.027		95654.5		−0.017		RG	*BBS* **15**, 3, 1974
2441834.666	V	II	95670.5		+0.038		95672.5		−0.006		TM	*BBS* **15**, 3, 1974
2441837.399	V	I	95682		+0.042		95684		−0.002		RG	*BBS* **15**, 3, 1974
2441837.400	V	I	95682		+0.044		95684		−0.001		KL	*BBS* **15**, 3, 1974
2441841.676	V	I	95700		+0.047		95702		+0.003		TM	*BBS* **15**, 3, 1974
2441847.606	V	I	95725		+0.043		95727		−0.001		TM	*BBS* **15**, 3, 1974
2441847.607	V	I	95725		+0.044		95727		0.000		GG	*BBS* **15**, 3, 1974
2442026.679	V	II	96479.5		+0.035		96481.5		−0.005		KL	*BBS* **13**, 2, 1973
				96538.5		+0.040		96540.5		$-0^d.003$		
2442054.696	V	II	96597.5		+0.045		96599.5		0.000		KL	*BBS* **13**, 2, 1973
2442089.456	V	I	96744		+0.034		96746		−0.006		KL	*BBS* **14**, 1, 1974
2442119.362	V	I	96870		+0.033		96872		−0.005		KL	*BBS* **14**, 1, 1974
2442132.425	V	I	96925		+0.042		96927		+0.004		RD	*BBS* **14**, 1, 1974
2442139.662	V	II	96955.5		+0.040		96957.5		+0.001		KL	*BBS* **15**, 1, 1974
2442145.346	V	II	96979.5		+0.027		96981.5		−0.011		KL	*BBS* **15**, 1, 1974
2442146.419	V	I	96984		+0.033		96986		−0.006		RG	*BBS* **15**, 1, 1974

Table II (continued)

J.D.$_\odot$	Type of obs.	Min.	Based on $P = 0^d.237350$				Based on corrected $P = 0^d.2373455$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2442147.378	V	I	96988		$+0^d.042$		96990		$+0^d.004$		RG	*BBS* **15**, 1, 1974
2442148.327	V	I	96992	97025.3	+0.042	$+0^d.037$	96994	97027.2	+0.004	$-0^d.001$	RG	*BBS* **15**, 1, 1974
2442156.370	V	I	97026		+0.015(?)		97028		−0.023(?)		RG	*BBS* **15**, 1, 1974
2442157.342	V	I	97030		+0.037		97032		−0.001		RG	*BBS* **15**, 1, 1974
2442158.529	V	I	97035		+0.038		97037		0.000		RG	*BBS* **15**, 1, 1974
2442177.399	V	II(c)	97114.5		+0.038		97116.5		0.000		HP	*BBS* **15**, 1, 1974
2442177.400	V	II(c)	97114.5		+0.039		97116.5		+0.001		RG	*BBS* **15**, 1, 1974
2442187.368	V	II	97156.5		+0.038		97158.5		+0.001		RG	*BBS* **15**, 1, 1974
2442193.414	V	I	97182		+0.032		97184		−0.005		RG	*BBS* **15**, 1, 1974
2442223.444	V	II	97308.5		+0.037		97310		0.000		RD	*BBS* **16**, 2, 1974
2442427.556	V	II	98168.5		+0.028		98170.5		−0.005		KL	*BBS* **20**, 2, 1975
2442439.544	V	I	98219		+0.030		98221		−0.002		KL	*BBS* **20**, 2, 1975
2442501.379	V	II	98479.5		+0.035		98481.5		+0.004		KL	*BBS* **21**, 2, 1975
2442503.398	V	I	98488		+0.037		98490		+0.006		KL	*BBS* **21**, 2, 1975
2442504.460	V	II	98492.5		+0.031		98494.5		−0.001		KL	*BBS* **22**, 2, 1975
2442509.570	V	I	98514		+0.038		98516		+0.007		KL	*BBS* **22**, 2, 1975
2442510.626	V	I	98518		+0.026		98520		−0.006		KL	*BBS* **22**, 2, 1975
2442517.389	V	I	98547		+0.025		98549		−0.007		RG	*BBS* **22**, 2, 1975
2442521.429	V	I	98564		+0.030		98566		−0.002		RG	*BBS* **22**, 2, 1975
2442524.522	V	I	98577		+0.037		98579		+0.006		KL	*BBS* **22**, 2, 1975
2442528.565	V	I	98594		+0.045		98596		+0.014		KL	*BBS* **22**, 2, 1975
				98584.9		+0.031		98587.0		0.000		
2442532.342	V	I	98610		+0.024		98612		−0.006		RG	*BBS* **22**, 2, 1975
2442534.370	V	I	98618		+0.035		98620		+0.004		RG	*BBS* **22**, 2, 1975
2442540.426	V	I	98644		+0.039		98646		+0.008		HP	*BBS* **22**, 2, 1975
2442541.375	V	I	98648		+0.038		98650		+0.007		HP	*BBS* **22**, 2, 1975
2442549.431	V	I	98682		+0.024		98684		−0.006		RG	*BBS* **22**, 2, 1975
2442550.392	V	I	98686		+0.036		98688		+0.005		HP	*BBS* **22**, 2, 1975

Table II (continued)

J.D.$_\odot$	Type of obs.	Min.	Based on $P = 0^d.237350$				Based on corrected $P = 0^d.2373455$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2442561.411	V	II	98732.5		$+0^d.018$		98734.5		$-0^d.013$		RG	*BBS* **22**, 2, 1975
2442568.418	V	I	98762		+0.023		98764		−0.007		RD	*BBS* **23**, 3, 1975
2442570.443	V	II	98770.5		+0.030		98772.5		0.000		KL	*BBS* **23**, 3, 1975
2442571.386	V	II	98774.5		+0.024		98776.5		−0.006		RG	*BBS* **23**, 3, 1975
2442572.456	V	I	98779		+0.026		98781		−0.004		HP	*BBS* **23**, 3, 1975
2442745.722	V	I	99509		+0.027		99511		0.000		KL	*BBS* **24**, 3, 1975
2442753.678	V	II	99542.5		+0.031		99544.5		+0.005		KL	*BBS* **25**, 2, 1975
2442775.630	V	I	99635		+0.029		99637		+0.002		RD	*BBS* **25**, 2, 1975
2442830.337	V	II	99865.5		+0.026		99867.5		+0.001		RG	*BBS* **26**, 2, 1976
2442860.716	V	II	99993.5		+0.024		99995.5		0.000		BK	*IBVS* **1249**, 3, 1977
2442861.676	V	II	99997.5		+0.035		99999.5		+0.010		BK	*IBVS* **1249**, 3, 1977
2442864.395	V	I	100009		+0.025		100011		0.000		RG	*BBS* **27**, 2, 1976
2442866.292	V	I	100017		+0.023		100019		−0.002		RG	*BBS* **27**, 2, 1976
2442866.424	V	II	100017.5		+0.036		100019.5		+0.011		RG	*BBS* **27**, 2, 1976
2442867.364	V	II	100021.5		+0.027		100023.5		+0.002		RG	*BBS* **27**, 2, 1976
2442869.383	V	I	100030		+0.028		100032		+0.004		RG	*BBS* **27**, 2, 1976
2442870.330	V	II	100034.5		+0.026		100036.5		+0.002		RG	*BBS* **27**, 2, 1976
2442871.634	V	II	100039.5		+0.024		100041.5		0.000		KL	*BBS* **27**, 2, 1976
2442872.360	V	II	100042.5		+0.038		100044.5		+0.014		KL	*BBS* **27**, 2, 1976
2442874.369	V	I	100051		+0.030		100053		+0.006		HP	*BBS* **27**, 2, 1976
2442885.408	V	II	100097.5		+0.032		100099.5		+0.008		RG	*BBS* **27**, 2, 1976
2442886.346	V	II	100101.5		+0.021		100103.5		−0.004		RG	*BBS* **27**, 2, 1976
				100102.7		$+0^d.027$		100104.7		$+0^d.003$		
2442899.404	V	II	100156.5		+0.024		100158.5		0.000		RG	*BBS* **27**, 2, 1976
2442900.353	V	II	100160.5		+0.024		100162.5		0.000		RD	*BBS* **28**, 2, 1976
2442900.368	V	II	100160.5		+0.039		100162.5		+0.015		RG	*BBS* **28**, 2, 1976
2442904.373	V	II	100177.5		+0.009		100179.5		+0.015		RG	*BBS* **28**, 2, 1976
2442904.394	V	II	100177.5		+0.031		100179.5		+0.007		HP	*BBS* **28**, 2, 1976

Table II (continued)

J.D.$_\odot$	Type of obs.	Min.	Based on $P = 0^d.237350$				Based on corrected $P = 0^d.2373455$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2442913.409	V	II	100215.5		$+0^d.026$		100217.5		$+0^d.002$		RG	*BBS* **28**, 2, 1976
2442916.375	V	I	100228		+0.025		100230		+0.002		RG	*BBS* **28**, 2, 1976
2442916.394	V	I	100228		+0.044		100230		+0.021		HP	*BBS* **28**, 2, 1976
2442920.643	V	I	100246		+0.021		100248		−0.003		BK	*IBVS* **1249**, 3, 1977
2442922.665	V	II	100254.5		+0.025		100256.5		+0.002		BK	*IBVS* **1249**, 3, 1977
2442923.371	V	I	100257.5		+0.019		100259.5		−0.004		RG	*BBS* **28**, 2, 1976
2442925.638	V	I	100267		+0.032		100269		−0.008		BK	*IBVS* **1249**, 3, 1977
2442937.378	V	II	100316.5		+0.022		100318.5		−0.001		RD	*BBS* **28**, 2, 1976
2442951.379	V	II	100375.5		+0.020		100377.5		−0.003		RG	*BBS* **28**, 2, 1976
2442953.412	V	I	100384		+0.036		100386		+0.013		RG	*BBS* **28**, 2, 1976
2442958.384	V	I	100405		+0.023		100407		0.000		RG	*BBS* **28**, 2, 1976
2442975.353	V	II(c)	100476.5		+0.022		100478.5		−0.001		KL	*BBS* **29**, 2, 1976
												BBS **33**, 2, 1976
2443210.330	V	II(c)	101466.5		+0.022		101468.5		−0.004		RG	*BBS* **33**, 2, 1976
2443212.339	V	I	101475		+0.014		101477		−0.004		RG	*BBS* **32**, 2, 1977
2443250.324	V	I	101635		+0.023		101637		+0.005		RG	*BBS* **32**, 2, 1977
2443254.358	V	I	101652	101677.8	+0.022	$+0^d.017$	101654	101679.9	+0.005	$-0^d.002$	RG	*BBS* **32**, 2, 1977
2443281.407	V	I	101766		+0.013		101768		−0.004		RG	*BBS* **32**, 2, 1977
2443288.412	V	II	101795.5		+0.016		101797.5		−0.001		RG	*BBS* **34**, 3, 1977
2443326.380	V	II	101954.5		+0.008		101957.5		−0.008		RG	*BBS* **35**, 3, 1977
									+0.001			*BBS* **36**, 3, 1977–78
2443447.673	V	II	102466.5		+0.015		102468.5				KL	*BBS* **37**, 1978
									+0.006			*BBS* **37**, 1978
2443568.368	V	I	102975		+0.018		102977				RG	*BBS* **37**, 1978
2443616.425	V	II	103177.5		+0.011		103179.5		+0.001		KL	*BBS* **37**, 1978
2443622.364	V	II	103202.5	103279.1	+0.018	+0.013	103204.5	103281.1	+0.008	+0.003	KL	*BBS* **38**, 1978
2443659.306	V	I(c)	103358		+0.051?		103360		+0.041(?)		RG	*BBS* **40**, 2, 1978
2443663.410	V	II	103375.5		+0.001				−0.009		RG	*BBS* **42**, 1979
							103377.5					
2443713.388	V	II	103586		+0.017				+0.008		KL	
							103588					
2443831.700	V	II	104126.5		+0.041(?)		104128.5		+0.035(?)		EP	
2443932.388	V	II	104508.5		+0.011		104510.5		+0.007		RG	

Table II (continued)

J.D.$_\odot$	Type of obs.	Min.	Based on $P = 0^d.237350$				Based on corrected $P = 0^d.2373455$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2443957.379	V	I	104614		$+0^d.012$		104616		$+0^d.008$		RG	*BBS* **42**, 1979
2443983.365	V	II	104723.5		+0.008		104725.5		+0.005		RG	*BBS* **43**, 1979
2444008.405	V	I	104829		+0.008		104831		+0.005		RG	*BBS* **43**, 2, 1979
				104791.0		$+0^d.009$		104793.0		$+0^d.006$		
2444010.424	V	II	104837.5		+0.009		104839.5		+0.006		HP	*BBS* **43**, 2, 1979
2444017.421	V	I	104867		+0.005		104869		+0.002		RG	*BBS* **43**, 2, 1979
2444039.380	V	II	104959.5		+0.008		104961.5		+0.006		RG	*BBS* **43**, 2, 1979
2444046.381	V	I	104989		+0.008		104991		+0.006		RG	*BBS* **44**, 2, 1979
2444290.375	V	I	106017		+0.006		106019		+0.008		RG	*BBS* **44**, 2, 1979
2444316.361	V	II	106126.5		+0.002		106128.5		+0.005		RG	*BBS* **46**, 2, 1979
2444337.375	V	I	106215		+0.011		106217		+0.014		RG	*BBS* **47**, 2, 1980
2444342.343	V	I	106236		−0.006		106238		−0.002		RG	*BBS* **47**, 2, 1980
				106260.9		−0.001		106262.9		+0.002		*BBS* **47**, 2, 1980
2444343.409	V	II	106240.5		−0.008		106242.5		−0.005		RD	
2444358.362	V	II	106303.5		−0.008		106305.5		−0.004		KL	*BBS* **47**, 2, 1980
2444371.446	V	II	106358.5		+0.022(?)		106360.5		+0.026(?)		RD	*BBS* **47**, 2, 1980
2444395.398	V	II	106459.5		+0.001		106461.5		+0.006		RG	*BBS* **48**, 2, 1980
2444402.391	V	I	106489		−0.007		106491		−0.003		RG	*BBS* **48**, 2, 1980
												BBS **48**, 2, 1980
2444691.367	V	II	107706.5		−0.005		107708.5		+0.005		RG	
2444701.440	V	I	107749		−0.019		107751		−0.009		RG	*BBS* **53**, 2, 1980
				107856.3		$-0^d.011$		107858.3		0.000		*BBS* **54**, 2, 1981
2444744.420	V	I	107930		0.000		107932		+0.011		RG	
2444770.390	V	II	108039.5		−0.020		108041.5		−0.008		RG	*BBS* **54**, 2, 1981
												BBS **55**, 1981
2445044.299	V	II	109193.5		−0.013		109195.5		+0.004		RG	
2445054.375	V	I	109236		−0.014		109238		−0.007		RG	*BBS* **59**, 2, 1982
2445055.333	V	I	109240		−0.015		109242		+0.002		RG	*BBS* **59**, 2, 1982
2445101.380	V	I	109434		−0.014		109436		+0.004		RG	*BBS* **59**, 2, 1982
2445115.384	V	I	109493	109452.2	−0.014	−0.016	109495	109454.2	+0.004	+0.001	RG	*BBS* **60**, 2, 1982
												BBS **60**, 2, 1982

Table II (continued)

J.D.$_{\odot}$	Type of obs.	Min.	Based on $P = 0^d.237350$				Based on corrected $P = 0^d.2373455$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2445120.365	V	I	109514		$-0^d.017$		109516		$+0^d.001$		RG	*BBS* **60**, 2, 1982
2445138.405	V	I	109590		−0.016		109592		+0.003		RG	*BBS* **61**, 2, 1982
2445159.411	V	II(c)	109678.5		−0.015		109680.5		+0.004		RG	*BBS* **61**, 2, 1982
2445162.369	V	I	109691		−0.024		109693		−0.005		RG	*BBS* **61**, 2, 1982
2445397.340	V	I	110681		−0.029		110683		−0.006		RG	*BBS* **65**, 2, 1983
2445407.314	V	I	110723		−0.024		110725		0.000		RG	*BBS* **65**, 2, 1983
2445428.456	V	I	110812	110865.3	−0.006(?)– $0^d.027$		110814	110867.3	+0.018(?)– $0^d.003$		PW	*BBS* **66**, 2, 1983
2445441.377	V	I	110866		−0.021		110868		+0.003		RG	*BBS* **66**, 2, 1983
2445518.383	V	I	111191		−0.035		111193		−0.009		KL	*BBS* **68**, 3, 1983
2445811.400	pg	II(c)	112425.5		−0.027		112427.5		+0.004		FR	*BAVM* **39**, 1984–85
2445812.336	V	II	112429.5		−0.040		112431.5		−0.009		RG	*BBS* **71**, 1984
2445816.371	V	II	112446.5		−0.040		112448.5		−0.009		RG	*BBS* **71**, 1984
2445816.623	V	II	112447.5	112458.9	−0.025	−0.033	112449.5	112460.9	+0.006	−0.002	BK	*BBS* **72**, 1984
2445820.411	pg	II(c)	112463.5		−0.035		112465.5		−0.004		FR	*BAVM* **39**, 1984–85
2445820.526	pg	I	112464		−0.038		112466		−0.004		FR	*BAVM* **39**, 1984–85
2445837.625	V	I	112536		−0.029		112538		+0.003		BK	*BBS* **72**, 1984
2446173.340	V	II	113950.5		−0.046		113952.5		−0.007		RG	*BBS* **76**, 1985
2446175.357	–	I	113959		−0.046		113961		−0.007		Le	*SAC* **58**, 1987
2446175.358	V	I	113959	114049.1	−0.045	−0.047	113961	114051.1	−0.008	−0.008	RG	*BBS* **76**, 1985
2446210.369	V	I	114106		−0.043		114108		−0.004		RG	*BBS* **77**, 1985
2446249.403	V	I	114271		−0.053		114273		−0.013		RG	*BBS* **77**, 1985
2446535.414	V	I	115476		−0.049		115478		−0.004		AP	*BBS* **80**, 1985

pg = photographic, V = visual; I = primary minimum; II = secondary minimum; *AN = Astron. Nachr.*; *BBS = Bedeckungsveränderlichen Beobachter der Schweizerischen Astronomischen Gesellschaft, Bulletin* (*BBSAG Bull.*); *BAVM = Beobachtungsergebnisse Arbeitsgemeinschaft für Veränderliche Sterne, Mitteilungen* (*BAV Mitteilungen*); *SAC = Rocznik Astronomiczny Observatorium Krakowskiego.*

AP – A. Paschke; AR – A. Royer; Be – S. Beliawski; BK – B. Krobusek; EP – E. Poretti; HP – H. Peter; GG – Unknown; KL – K. Locher; Le – I. Lelaŕko; MW – M. Wittwer; FR – P. Frank; Pg – J. Pagaczewski; Pr – Prager; PW – P. Wils; RG – R. Germann; RD – R. Diethelm, TM – T. Morger; UR – unknown; W. – F. B. Wood: J. P. Oliver. D. R. Florkowski. and R. H. Koch.

This diagram also shows erratic period changes before 1967, and superposed sinusoidal variation on the regular period trend after 1967. Figures 1 and 2 are represented by Figures 1(a), 1(b), 2(a), and 2(b). In these figures, primary and secondary minima have been shown by filled and open circles, respectively, while the mean O–C values have been indicated by crosses. The parts of the O–C diagrams, between the time interval 1967 to 1986, have been shown in a magnified form in Figures 1(b) and 2(b).

The O–C diagram (Figures 2(a) and 2(b)) has been used for the period discussions. Our period discussion is based on the assumption that the period between epochs of period change remains almost constant. The O–C diagram gets split up into 26 portions between points *A* and *Z'*. Portions *AB*, *BC*, *CD*, and *GH* onwards, except *ZZ'* are properly covered. However, there are not sufficient minima at point *K*, but this point conforms to the period trend of RW Com and, hence, it is considerable. The portions *DE*, *EF*, and *FG* show an average period change of 1.5×10^{-6} d, yet these portions are open to question as only solitary minima are found at points *E* and *F*. Likewise, a solitary minimum lies at point *Z'*, hence, the portion *ZZ'* is also open to question. Portion *AB* lies in a small duration of time, and points *C* and *D* lie nearly in the O–C diagram; hence,

TABLE III
Changes in period of RW Com

Portion	Interval of cycles	Total change in period ($\Delta P/P$)
A B	0 to 311	6.43×10^{-6}
B C	311 to 3419	5.15×10^{-6}
C D	3419 to 4610	3.36×10^{-6}
D E	4610 to 27947	1.41×10^{-6}
E F	27947 to 58620	2.35×10^{-6}
F G	58620 to 86468	6.10×10^{-7}
G H	86468 to 87798	4.48×10^{-7}
H I	87798 to 89365	6.38×10^{-7}
I J	89365 to 90937	3.82×10^{-7}
J K	90937 to 92171	1.62×10^{-6}
K L	92171 to 93985	5.51×10^{-7}
L M	93985 to 95502	2.64×10^{-6}
M N	95502 to 96541	9.62×10^{-7}
N O	96541 to 97027	4.12×10^{-6}
O P	97027 to 98587	6.41×10^{-7}
P Q	98587 to 100105	1.98×10^{-6}
Q R	100105 to 101680	3.17×10^{-6}
R S	101680 to 103281	3.12×10^{-6}
S T	103281 to 104793	1.98×10^{-6}
T U	104793 to 106263	2.72×10^{-6}
U V	106263 to 107858	1.25×10^{-6}
V W	107858 to 109454	6.27×10^{-7}
W X	109454 to 110867	2.83×10^{-6}
X Y	110867 to 112461	6.27×10^{-7}
Y Z	112461 to 114051	3.77×10^{-6}
Z Z'	114051 to 115478	2.80×10^{-6}
} BD (from Table II)	311 to 4610	4.65×10^{-6}

it appears that the period is showing an upward tendency in the portion *BD*. The mean values of O–C clearly show a sinusoidal variation of the period in the time interval 1967 to 1986, and suggest the presence of a third body with an approximate period of 16 years. These variations appear to be real as O–C values are at times $> 0^{d}.01$. The period changes in different portion of the O–C diagram ranges from 5.5×10^{-7} d to 6.4×10^{-6} d, which are near to the lower limit for RS CVn binaries (Hall, 1976) but far from the value given by Milone *et al.* (1980). Thus, it is apparent that stronger period changes are not present in RW Com.

4. Conclusions

Even after the availability of large number of minima of RW Com, the system remained neglected for period study. Neither the O–C diagrams are available nor all the minima are collected. Minima given by Milone *et al.* (1980) do not conform to the period trend shown by a large sample of minima, as such they are not matchable for the present period study. Types of ten minima have been corrected as per period trend. Eight minima were suspected to be wrong as they gave unusual values of O–C in comparison to other minima in the vicinity, and thus they were not considered in calculating the means.

$\Delta P/P$ ranges from 5.5×10^{-7} to 6.4×10^{-6} in different portions of the O–C diagram (Figure 2), thus ΔP in the range 1.3×10^{-7} to 1.5×10^{-6} are present in the system. These period changes are considerably higher than the value given by Milone *et al.* (1980). These values suggest that strong period changes are not present in RW Com, but these lie near to the lower limit of period changes found in RS CVn binaries, and, thus, help in establishing the RS CVn nature of RW Com, which has been at stake so far. Struve (1950), and Milone and Naftilan found RS CVn binary signatures in RW Com, but the latest (December, 1985) Hall catalogue of RS CVn systems avoided its mention. Thus, the present study is important in confirming its RS CVn binary nature. Between 1967 to 1986 numerous minima are available and this part of the O–C diagram shows a sinusoidal variation of the period, and is indicative of the presence of a third body having a period of nearly 16 years, which is required to be confirmed. Figure 1, based on uncorrected period showed a declining trend in the interval 1967 to 1986 at a rate of 1 min per year, which was appeared to be mostly washed out on correcting the period (Figure 2). Considerable scatter is seen in the O–C diagram in this time interval, and it may be the outcome of changing light curve features. Photoelectric minima are virtually lacking in the literature, and are required to confirm above conclusions.

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