ST PERSEI: A POSSIBLE MULTI-BODY SYSTEM

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Abstract. Detailed period study of the eclipsing binary ST Per is presented. A new period ($P = 2\overset{d}{.}648339$) is given. Period changes in different portions of the O–C diagram with a new period have been estimated. The total changes in period (ΔP) ranges from 2.17×10^{-5} d to 2.64×10^{-4} d which is appreciably large. Sufficient number of minima in the time interval 1934 to 1985 for this system are available. Distinct increasing and decreasing trends are evident, the change in the tendency appears to have occurred around 1947. Sinusoidal variation is seen between cycles 7000–10000, which indicates that ST Per is a three-body system, the period of the third body being about 22 years. However, the sinusoidal variation is not perfectly symmetric in shape, therefore, it is suspected that ST Per is a four- (or multi-) body system.

1. Introduction

Miss Leavitt (cf. Pickering, 1907) first announced the variability of ST Persei (BD + 38°606). No detailed period study is available in the literature during the last 80 years, even the O–C diagram is not found. Wood (1946) compiled 52 minima from the literature and found that some period change appears to have occurred around 1931. Since then many observers (Table I) have given the light elements of ST Per but, unfortunately, none could cover the light curves or minima portions fully well and, thus could not comment on its period behaviour. The author has attempted its detailed period study for the first time, which is still restricted in the sense that secondary minima of ST Per are hardly available in the literature.

2. Epoch, Period, and New Period

Epochs and periods of ST Per, presented by several observers, are listed in Table I. Change in the period of the system is evident.

TABLE I

Periods and epochs of ST Per

Author	Period and epoch
Enebo (1910)	J.D. 2418678.272 + $2\overset{d}{.}648383$
Kordylewska (1934)	J.D. 2419030.5038 + $2\overset{d}{.}6483615$
Wood (1946)	J.D. 2429528.5853 + $2\overset{d}{.}6483348$
Tsesevich (1958)	J.D. 2429528.5897 + $2\overset{d}{.}6483488$
Wood and Forbes (1963)	J.D. 2433283.94286 + $2\overset{d}{.}64833739$
Lucy and Sweeney (1976)	J.D. 2419032.5320 + $2\overset{d}{.}6483615$
Srivastava (1970)	J.D. 2440148.4085 + $2\overset{d}{.}6483339$
Weis and Chen (1976)	J.D. 2442036.6876 + $2\overset{d}{.}64835$ (adopted)
Srivastava (1970) (present study)	J.D. 2440156.3557 + $2\overset{d}{.}6483344$
Srivastava (1987) (present work)	J.D. 2417857.33 + $2\overset{d}{.}648339$

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In all, 102 minima have been collected from the literature, out of which 3 are photographic, 7 photoelectric, and 4 unspecified, while the remaining 88 minima are visual. Only one minimum (Srivastava, 1983) is secondary.

Of the 102 minima only 95 have been considered for the present period discussion because the remaining 7 minima mostly visual have revealed unusual O–C values, not conforming to the instant period trends. From these, a new period of ST Per has been obtained employing the method of least squares. The corrected period using the initial epoch comes out to be $2\overset{d}{.}648339$ ($\pm 0\overset{d}{.}000002$).

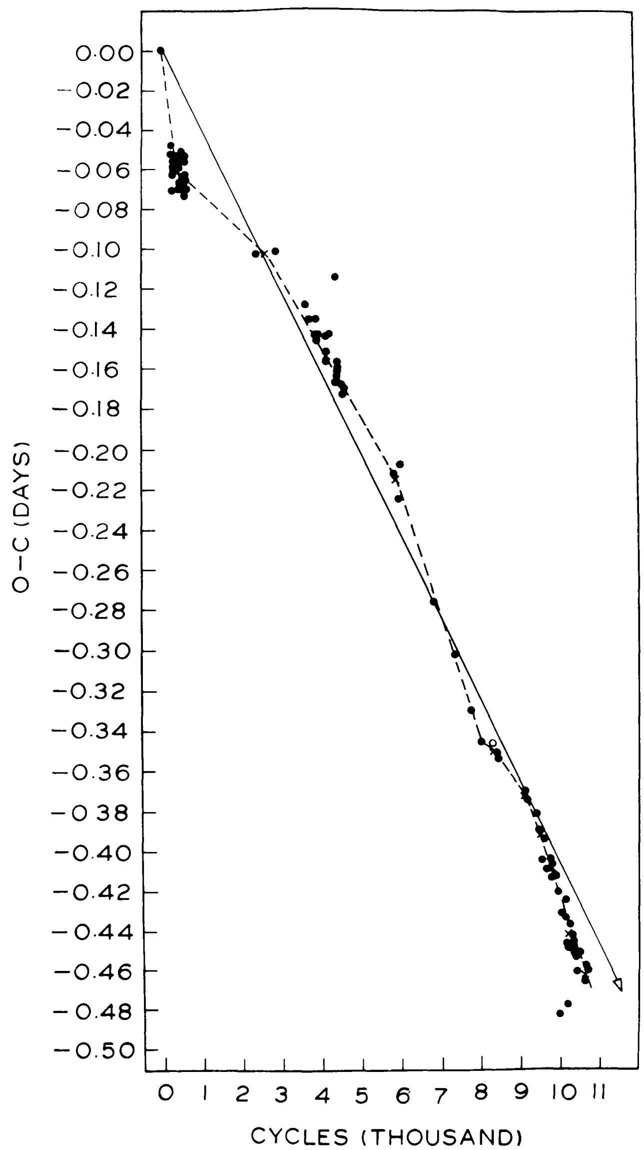

Fig. 1. O–C diagram based on $P = 2\overset{d}{.}648382$. Filled and open circles indicate primary and secondary minima values, respectively, while the crosses represent the mean values. The solid line, having an arrow, shows the declining trend of the period, while the dashed lines show period fluctuations around the solid line.

3. O–C Diagrams and Period Changes

All the available times of minima, obtained in the time interval 1908 to 1985, have been listed in Table II. Two O–C diagrams (Figures 1 and 2) are based on the following ephemeris:

$$\text{Primary Minimum} = \text{J.D. } 2417\,857.33 + 2^{\text{d}}.648382E\,, \quad \text{(Enebo, 1907, 1910)}\,,$$

and

$$\text{Primary Minimum} = \text{J.D. } 2417\,857.33 + 2^{\text{d}}.648339E \quad \text{(present work)}\,,$$

respectively, have been drawn.

Figure 1 shows an average period decrease of nearly 51 s yr^{-1}, which is appreciably large. Increasing and decreasing tendencies of period are also shown in Figure 1 by dashed lines. These do no reveal any systematic variation either in length of time or in amplitude of period fluctuations around smoothen solid line marked by an arrow at one end. The period behaviour has been assumed to be constant between epochs of different period change and also that O–C (s) > $0^{\text{d}}.01$ are appreciable. Figure 2 reveals interesting behaviour of orbital period of ST Per. This O–C diagram gets split up into 7 portions (*AB*, *BC*, *CE*, *EG*, *GI*, *IM*, and *MN*) between points *A* to *N*. This figure has

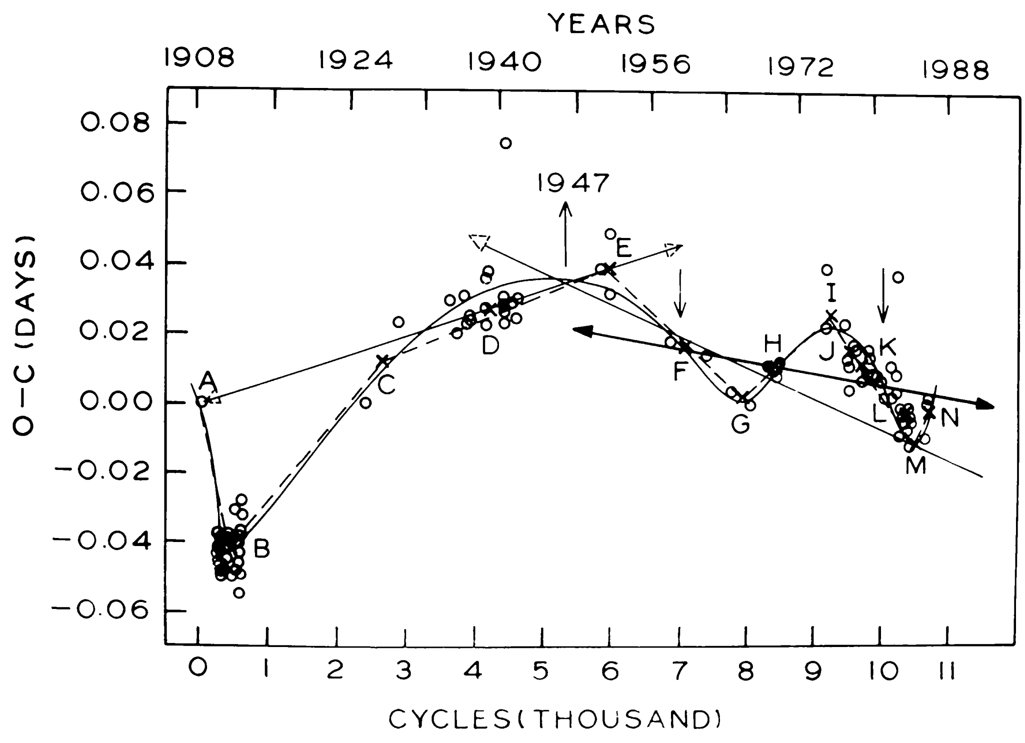

Fig. 2. O–C diagram based on $P = 2^{\text{d}}.648339$. Filled and open circles indicate secondary and primary minima values, respectively, while the crosses indicate the mean values. The solid curve is the free-hand (smoothened) curve. Two thin solid lines showing dashed arrows at one end, represent the increasing and decreasing trends of the period wherein the year of change in period tendency is shown by an upward arrow, while a thick solid line, having solid arrows at both ends, show the sinusoidal variation wherein the period of the third body is indicated by two downward arrows.

TABLE II

Minima of ST Persei

J.D.⊙	Type of obs.	Min.	O–C based on $P = 2^d.648382$				O–C based on corrected $P = 2^d.648339$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2417857.33	v	I	0		$0^d.000$		0		$0^d.000$		Enebo, S.	*AN* **176**, 373 (4233), 1907
2418524.674	v	I	252		−0.048		252		−0.037		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418532.615	v	I	255		−0.052		255		−0.041		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418548.506	v	I	261		−0.052		261		−0.040		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418601.467	v	I	281		−0.058		281		−0.046		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418625.299	v	I	290		−0.062		290		−0.049		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418633.254	v	I	293		−0.052		293		−0.039		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418646.487	v	I	298		−0.061		298		−0.048		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418649.135	v	I	299		−0.061		299		−0.048		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418654.430	v	I	301		−0.063		301		−0.050		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418662.367	v	I	304		−0.071		304		−0.058		Enebo, S.	*AN* **184**, 225 (4407), 1910
2418678.272	v	I	310		−0.056		310		−0.043		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418715.346	v	I	324		−0.060		324		−0.046		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418760.372	v	I	341		−0.056		341		−0.042		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418895.440	v	I	392		−0.055		392		−0.039		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418940.456	v	I	409		−0.062		409		−0.045		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2418985.484	v	I	426		−0.055		426		−0.038		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419030.5038	pg	I	443		−0.0594		443		−0.0404		Kordylewski, A.	*SAC* **12**, 45, 1934
				422		$-0^d.060$		422		$-0.^d042$		
2419030.504	v	I	443		−0.059		443		−0.040		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419032.5320	v	I	444		−0.6800 (?)		444		−0.6605 (?)		Lucy, L. B. and Sweeny, M. A.	*AJ* **76**, 544, 1971
2419033.155	v	I	444		−0.067		444		−0.038		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419067.571	v	I	457		−0.070		457		−0.050		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419115.260	v	I	475		−0.051		475		−0.031		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419255.615	v	I	528		−0.061		528		−0.038		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419279.450	v	I	537		−0.061		537		−0.038		Nijland, A. A.	*AN* **234**, 97 (5598), 1928

Table II (continued)

J.D.$_{\odot}$	Type of obs.	Min.	O–C based on $P = 2^{d}.648382$				O–C based on corrected $P = 2^{d}.648339$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2419308.577	v	I	548		$-0^{d}.066$		548		$-0^{d}.043$		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419311.232	v	I	549		−0.070		549		−0.046		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419348.299	v	I	563		−0.070		563		−0.055		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419353.599	v	I	565		−0.067		565		−0.043		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419361.538	v	I	568		−0.073		568		−0.049		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419385.390	v	I	577		−0.056		577		−0.032		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419398.626	v	I	582		−0.062		582		−0.037		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419409.229	v	I	586		−0.053		586		−0.028		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2419430.403	v	I	594		−0.066		594		−0.040		Nijland, A. A.	*AN* **234**, 97 (5598), 1928
2424155.080	pg	I	2378		−0.102		2378		0.000		Kordylewski (Banachiewicz, T.)	*SAC* **45**, 1926
				2632		$-0^{d}.102$		2632		$+0^{d}.012$		
2425500.459	v	I	2886		−0.101		2886		+0.023		Nijland, A. A.	*AAc* **1**, 29, 1928
2427473.478	v	I	3631		−0.127		3631		+0.029		Lause, F.	*AN* **260**, 292 (6233), 1936
2427738.303	v	I	3731		−0.135		3731		+0.020		Lause, F.	*AN* **260**, 292 (6233), 1936
2428103.785	–	I	3869		−0.135		3869		$+0^{d}.031$		Dugan, R. S.	*CP* **21**, 47, 1946
2428106.425	v	I	3870		−0.143		3870		+0.023		Lause, F.	*AN* **260**, 292 (6233), 1936
2428212.360	–	I	3910		−0.144		3910		+0.025		Woodward, E.	*HB* **917**, 7, 1943
2428212.361	v	I	3910		−0.143		3910		+0.026		Lause, F.	*AN* **260**, 292 (6233), 1936
2428842.676	v	I	4148		−0.143		4148		+0.036		Wood, F. B.	*CP* **21**, 47, 1946
2428847.964	v	I	4150		−0.151		4150		+0.027		Wood, F. B.	*CP* **21**, 47, 1946
2428879.740	v	I	4162		−0.156		4162		+0.023		Wood, F. B.	*CP* **21**, 47, 1946
2428927.425	v	I	4180	4186	−0.142	−0.152	4180	4186	+0.038	+0.027	Wood, F. B.	*CP* **21**, 47, 1946
2429525.940	v	I	4406		−0.161		4406		+0.028		Wood, F. B.	*CP* **21**, 47, 1946
2429528.586	v	I	4407		−0.163		4407		+0.026		Wood, F. B.	*CP* **21**, 47, 1946
2429528.5897	v	I	4407		−0.1593		4407		+0.0298		Tsesevich, V. P.	*VS* **11**, 1939
2429528.6345	v	I	4407		−0.1145 (?)		4407		+0.0746 (?)		–	*PPEN* **XII**, 36, 1980
2429549.770	v	I	4415		−0.167		4415		+0.023		Wood, F. B.	*CP* **21**, 47, 1946

Table II (continued)

J.D.$_\odot$	Type of obs.	Min.	O–C based on $P = 2^d.648382$				O–C based on corrected $P = 2^d.648339$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2429557.715	v	I	4418		$-0^d.157$		4418		$+0^d.023$		Wood, F. B.	*CP* **21**, 47, 1946
2429925.840	v	I	4557		−0.167		4457		+0.029		Wood, F. B.	*CP* **21**, 47, 1946
2429973.505	v	I	4575		−0.173		4575		+0.024		Wood, F. B.	*CP* **21**, 47, 1946
2430055.609	v	I	4606		−0.168		4606		+0.030		Wood, F. B.	*CP* **21**, 47, 1946
2433283.94286	–	I	5825		−0.21224		5825		+0.03826		Wood, D. B. and Forbes, J. E.	*AJ* **68**, 257, 1963
2433625.5717	pg	I	5954	5911	−0.2247	$-0^d.215$	5954	5911	+0.0313	$+0^d.039$	Szczepanowska, A.	*SAC* **21**, 82, 1950
2433625.5895	pe	I	5954		−0.2069		5954		+0.0489		Lenouvel, F.	*Publ. Obs. Haute-Provence* **2,** 4627, 7, 1950
2435932.262	pg	I	6825		−0.275		6825		+0.018		Szczepanowska, A.	*AA* **9**, 47, 1959
				7088		−0.289		7088		+0.016		
2437325.284	pe	I	7351		−0.302		7351		+0.014		Dueball, J. and Lehmann, P. B.	*AN* **288**, 167, 1965
2438371.3675	pe	I	7746		−0.3294		7746		+0.0037		Pohl, E. and Kizilirmak, A.	*AN* **288**, 69, 1964
				7882		−0.337		7882		+0.002		
2439091.712	v	I	8018		−0.345		8018		0.000		Robinson, L. J.	*IBVS*, No. 29, 3, 1966
2439837.230	pe	II	8299.5		−0.346		8299.5		+0.011		Srivastava, R. K.	Ph.D. Thesis, Kumaon University, Naini Tal, p. 74, 1983
2440148.4085	pe	I	8417	8379	−0.3527	−0.350	8417	8379	+0.0092	+0.011	Srivastava, R. K.	*BAC* **21**, 219, 1970
2440156.355	pe	I	8420		−0.3507		8420		+0.0114		Srivastava, R. K.	*BAC* **21**, 219, 1970
2442036.6876	pe	I	9130		−0.3700		9130		+0.0226		Weis, E. W. and Chen, K. Y.	*AA* **26**, 15, 1976
2442076.409	v	I	9145	9188	−0.374	−0.377	9145	9188	+0.039	+0.025	Locher, K.	*BBS* **19**, 1974
2442460.412	v	I	9290		−0.387		9290		+0.013		Locher, K.	*BBS* **21**, 4, 1975
2442754.388	v	I	9401		−0.381		9401		+0.023		Peter, H.	*BBS* **25**, 1, 1976

Table II (continued)

J.D.$_{\odot}$	Type of obs.	Min.	O–C based on $P = 2^d.648382$ Cycle	Mean of cycles	O–C	Mean of O–C values	O–C based on corrected $P = 2^d.648339$ Cycle	Mean of cycles	O–C	Mean of O–C values	Observer	Reference
2442971.548	v	I	9483		$-0^d.389$		9483		$+0^d.014$		Locher, K.	*BBS* **29**, 4, 1976a
				9486		$-0^d.392$		9486		$+0^d.015$		
2443040.390	v	I	9509		−0.404		9509		+0.004		Locher, K.	*BBS* **30**, 1976b
2443154.281	v	I	9552		−0.394		9552		+0.017		Locher, K.	*BBS* **33**, 4, 1977
2443485.314	v	I	9677		−0.409		9677		+0.007		Peter, H.	*BBS* **36**, 1, 1978
2443739.560	v	I	9775		−0.407		9775		+0.013		Locher, K.	*BBS* **38**, 4, 1978a
2443747.508	v	I	9776	9772	−0.404	−0.409	9776		+0.016	+0.011	Locher, K.	*BBS* **38**, 4, 1978a
2443832.248	v	I	9808		−0.413		9808		+0.009		Locher, K.	*BBS* **40**, 3, 1978b
2443869.325	v	I	9822		−0.413		9822		+0.009		Locher, K.	*BBS* **41**, 3, 1979a
2444208.311	v	I	9950		−0.420		9950		+0.008		Locher, K.	*BBS* **45**, 5, 1979b
2444290.349	v	I	9981		−0.482(?)		9981		−0.053(?)		Diethelm, R.	*BBS* **46**, 3, 1980
2444515.512	v	I	10066		−0.431		10066		+0.002		Mavridis, G.	*BBS* **51**, 4, 1980
2444637.336	v	I	10112		−0.433		10112		+0.002		Locher, K.	*BBS* **53**, 3, 1981a
2444637.336	v	I	10112		−0.433		10112		+0.002		Peter, H.	*BBS* **53**, 3, 1981a
2444637.412	v	I	10112		−0.357(?)		10112		+0.078(?)		Peter, H.	*BBS* **53**, 3, 1981a
2444642.504	v	I	10114		−0.562(?)		10114		−0.127(?)		Peter, H.	*BBS* **53**, 4, 1981a
2444645.290	v	I	10115		−0.424		10115		+0.011		Stoikidis, N.	*BBS* **53**, 3, 1981a
2444649.300	v	I	10116		+0.938(?)		10116		−1.276(?)		Locher, K.	*BBS* **53**, 3, 1981a
2440660.345	v	I	10120		−1.259(?)		10120		−0.824(?)		Petter, H.	*BBS* **53**, 3, 1981a
2444846.554	v	I	10191		−0.447		10191		−0.009		Locher, K.	*BBS* **56**, 5, 1981b
2444907.427	v	I	10214		−0.477(?)		10214		−0.038(?)		Mourikis, D.	*BBS* **58**, 4, 1982
2444907.468	v	I	10214	10226	−0.436	−0.441	10214	10226	+0.003	−0.001	Andrakakou, M.	*BBS* **57**, 4, 1981b
2444915.401	v	I	10217		−0.448		10217		−0.009		Peter, H.	*BBS* **57**, 4, 1981b
2445013.397	v	I	10254		−0.442		10254		−0.001		Kohl, M.	*BBS* **59**, 3, 1982a
2445193.482	v	I	10322		−0.447		10322		−0.003		Locher, K.	*BBS* **62**, 5, 1982b
2445193.484	v	I	10322		−0.445		10322		−0.001		Kohl, H.	*BBS* **62**, 5, 1982b
2445323.247	v	I	10371		−0.453		10371		−0.007		Germann, R.	*BBS* **64**, 5, 1983
2445323.249	v	I	10371		−0.451		10371		−0.005		Locher, K.	*BBS* **64**, 5, 1983

Table II (continued)

J.D.$_{\odot}$	Type of obs.	Min.	O–C based on $P = 2^d.648382$				O–C based on corrected $P = 2^d.648339$				Observer	Reference
			Cycle	Mean of cycles	O–C	Mean of O–C values	Cycle	Mean of cycles	O–C	Mean of O–C values		
2445352.382	v	I	10382		$-0^d.450$		10382		$-0^d.003$		Peter, H.	*BBS* **64**, 5, 1983
2445368.271	v	I	10388		−0.451		10388		−0.005		Peter, H.	*BBS* **65**, 4, 1983
2445405.340	v	I	10402		−0.460		10402		−0.12		Stoikidis, N.	*BBS* **65**, 4, 1983
				10516		$-0^d.463$		10516		$-0^d.011$		
2446006.516	v	I	10629		−0.466		10629		−0.009		Peter, H.	*BBS* **74**, 5, 1984
2446083.327	v	I	10658		−0.458		10658		0.000		Locher, K.	*BBS* **75**, 2, 1985
				10665		−0.460		10665		+0.001		
2446120.402	v	I	10672		−0.461		10672		+0.002		Peter, H.	*BBS* **76**, 4, 1985

Pe = photoelectric; Pg = photographic; v = visual; ? = doubtful values, not considered in the mean.
AN = Astronomische Nachrichten; *AA* = Acta Astronomica; *AJ* = Astronomical Journal; *BAC* = Bulletin of Astronomical Institutes of Czechoslovakia; *BBS* = Bedeckungs-veränderlichen Beobachter der Schweizerischen Astronomischen Gesellschaft Bulletin; *IBVS* = Information Bulletin on Variable Stars; *PC* = Princeton Contribution; *PPEN* = Publication of the University of Pennsylvania Astronomical Series; *SAC* = Rocznik Astronomiczny Observatorium Krakowskiego; *VS* = Variable Stars.

been used for the period discussion. The portions *AB* and *BC* are not properly covered as they lack sufficient minima around *A* and *C*, as such period variations in these portions are far from certain. The portion *MN* is likewise still incomplete, although not very rarely covered; its further tendency of increase or decrease is still awaited and, thus, period change in this portion is also questionable. The order of period change in the portions *AB* and *MN* are the largest compared to others (Table III). Since there is a

TABLE III

Changes of period in ST Persei

Portion	Interval of cycles	$\Delta P/P$	Total change in period (days), ΔP
AB	0 to 422	9.95×10^{-5}	2.64×10^{-4} (?)
BC	422 to 2632	2.44×10^{-5}	6.46×10^{-5}
CE	2632 to 5911	8.23×10^{-6}	2.17×10^{-5}
EG	5911 to 7882	1.88×10^{-5}	4.98×10^{-5}
GI	7882 to 9188	1.76×10^{-5}	4.66×10^{-5}
IM	9188 to 10516	2.71×10^{-5}	7.18×10^{-5}
MN	10516 to 10653	8.05×10^{-5}	2.13×10^{-4} (?)
	Mean (I)	3.94×10^{-5}	1.05×10^{-4}
	Mean (II)	1.92×10^{-5}	5.09×10^{-5} (↑)

Results are from Figure 2.
(?) = Incomplete trends.
↑ = mean (II) leaving the first (*AB*) and the last (*MN*) portion values.

solitary point at zero phase, thus the portion *AB* does not allow a certainty of period change compared to portion *MN*, however, the point *B* is extensively covered but, unfortunately, point *B* deviated largely from points *ACD*, etc. The same situation lies with the portion *BC*, however, there are number of points at point *B* but not at *A* and *C*.

The O–C diagram (Figure 2) suggests that two distinct portions *AE* and *EM* show increasing and decreasing tendencies of the period, the observations, mostly of Nijland (1928) around point *B*, do not appear to conform to the initial epoch. Sudden period change appears to have occurred around the year 1947 shown by an upward arrow in Figure 2, the junction point of two trends.

The period changes in different portions of the O–C diagram (Figure 2) ranges from 2.17×10^{-5} d to 2.64×10^{-4} d, the average being 1.07×10^{-4} d. The period change of the order of 10^{-4} d is very high. On the other hand, if we leave the portions *AB* and *MN* on the ground that these portions are separately covered, and considering that the portion *MN* is incomplete, respectively, the average period change stands at 5.09×10^{-5} d. ST Persei is a semi-detached system (cf. Srivastava, 1970) in which the secondary K-type component has been found to nearly fill its Roche lobe, such period change (5.1×10^{-5} d) is not unusual.

4. Presence of Three or More Bodies in ST Per

The portion of the O–C diagram (Figure 2) between points *E* and *N* is fairly covered with minima. Between points *F* to *M*, a sinusoidal variation of period is distinctly visible, which is indicative of the presence fo a third body in ST Per. Although the secondary minima of this system are hardly available in the literature, the only secondary minimum given by Srivastava (1983) suggests that O–C residual of both types of minima, as given by Srivastava (1970, 1983), move in the same direction. The downward arrows in Figure 2 indicate that period of the third body is nearly 22 years.

Now, if we look at the sinusoidal variation, it is evident that the sinusoidal curve around the average solid line, containing solid arrows on both ends, is not symmetrical. In addition, the amplitudes of dips between points *I* and *G* and between the points *I* to *M* are not equal, and descending branches (*EG* and *DM*) of the sinusoidal curves are not of equal durations, as such these are asymmetric. Also, if we assume that portion between a point around 1947 near an upward arrow and *B* is also a branch of a sinusoidal curve then too, the sinusoidal variation is asymmetric. This type of asymmetry suggests that there may be four or more bodies in the system. If we reject the points *B*, even then the branch of curve, between a point around 1947 and *C*, is not strictly symmetric. In conclusion, the amplitudes of dips and durations of branches are not symmetric.

5. Contradictions and Sypports

The depths of primary minima have been given by various authors:

Author	Type	Depth of primary minimum
Nijland (1928)		$\sim 2^{\mathrm{m}}.3$
Wood (1946)	Visual measures	$3^{\mathrm{m}}.51$ (greater by more than a magnitude than that determined by Nijland)
Szczepanowska (1959)		$1^{\mathrm{m}}.88$
Weis and Chen (1976)	*R*	$2^{\mathrm{m}}.0$
	I	$1^{\mathrm{m}}.5$
Srivastava (1970)	*B*	$2^{\mathrm{m}}.4$
	V	$1^{\mathrm{m}}.9$
Weis and Chen (1976)	*B*	$3^{\mathrm{m}}.6$
[Revised from Srivastava's (1970) observations]	*V*	$2^{\mathrm{m}}.8$ (?)
Hall and Weedman (1971)	*V*	$2^{\mathrm{m}}.2$
Locher (1983)		$1^{\mathrm{m}}.88$

Considering the above values it is apparent that the depth of the primary was nearly 2 mag at the time of Nijland (1928), Szczpanowska (1959), Srivastava (1970), Hall and Weedman (1971), and Locher (1983). However, the wavelengths of Weis and Chen's

(1976) observations are different. Only Wood's (1946) visual measure indicate that the depth of the primary minimum is nearly 1 mag higher than others. Unfortunately, insufficient photometric observations are available for this system, and even Weis and Chen's (1976) photometry was not sufficient; as they stated that on none of the nights, when the primary eclipse was observed, were the observations sufficient to determine the time of the minima. On the basis of doubt created by Weis and Chen (1976), and adopted by Chaubey (1984) they pointed out that the depths reported by Srivastava (1970) were wrong without really verifying them. In the light of above discussion it appears that, even today, the only light curve that is fairly covered is that of Srivastava (1970); and the depth of primary minimum obtained by him is beyond any doubt. If there is an additional component (a fourth body) in the system, then the changes in primary depth will be complicated. Also, Srivastava's (1970) observations do not show variations outside eclipses, while Wood's (1946) observations give larger interaction effects. Since third-body type variations are not apparent in Srivastava's (1970) observations, but period shows evidence of change, hence, it may be possible that the effecting body is faint and very small or some alternative explanation has to be searched out.

One more thing which is evident from Figure 2, is that the period has changed around 1947, just after the publication of Wood (1946), as such this effect should be looked in terms of physical changes in ST Per.

6. Summary

Detailed period study of ST Per reveals that appreciable period changes of the order of 10^{-5} d are present. From discussions it appears that ST Per contains a third body having a period of nearly 22 years and, also, that it is a possible multi-body system. Weis and Chen's (1976) and Chaubey's (1984) contentions that Srivastava's (1970) observations are contaminated, and as such the indicated depths are not reliable, are not correct.

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