# PERIOD STUDY OF XY CETI

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**Abstract.** A first period study of the eclipsing binary XY Ceti is presented. A new period ($P = 2^{d}.7807135$), based on all available times of minima, is given. Period changes in different portions of the O–C diagram, with a new period, have been estimated. The total change in period ($\Delta P/P$) ranges from $1.1 \times 10^{-5}$ d to $1.2 \times 10^{-4}$ d, thus, $\Delta P$ ranges from $3.1 \times 10^{-5}$ d to $3.3 \times 10^{-4}$ d. The O–C diagram suggests that the trend of the period has changed around the year 1959. Two portions of increasing and decreasing trends also reveal that the period changes ($\Delta P/P$) of the order of $10^{-5}$ d are present, which are appreciably large.

## 1. Introduction

Strohmeier and Knigge (1961) discovered the eclipsing binary nature of XY Ceti ( = HD 18597 = BD + 2°460). This system has not been extensively observed so far and, hence, no period study is available in the literature. Morrison and Morrison (1968), Srivastava and Padalia (1975), and Al-Naimiy *et al.* (1978) observed the system photoelectrically, and only author's (Srivastava and Padalia, 1975) light curves are complete. Author's data have been used by several authors (cf. Srivastava, 1987), and the orbital elements and absolute dimensions have been derived, using various methods of element determinations, which are at variance. The author has attempted its detailed period study for the first time and is presented in this communication. Minima given by Brelstaff (cf. Isles, 1986) are not available to us.

## 2. Epoch, Period, and New Period

Epochs and periods of XY Ceti, presented by several observers, are given in Table I.

All 25 minima are available in the literature, out of which 14 minima are photographic, 9 photoelectric (including 7 of the author), and 2 are visual.

Out of the 25 minima, 12 are primary and 13 are secondary. From these minima, a

TABLE I

Epochs and periods of XY Ceti

| Author | Epoch and period |
|---|---|
| Strohmeier and Knigge (1961) | J.D. 2426734.285 + $1^{d}.390356$ |
| Morrison and Morrison (1968) | J.D. 2438372.949 + $2^{d}.780712$ |
| Srivastava and Padalia (1975) | J.D. 2438372.949 + $2^{d}.7807118$ |
| Srivastava (present work) | J.D. 2426734.271 + $2^{d}.7807135$ |

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TABLE II

Minima of XY Ceti

| J.D.$_{\odot}$ | Type of obs. | Min. | O–C based on $P = 2^{d}.780712$ | | | | O–C based on $P = 2^{d}.7807135$ | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cycle | Mean of cycles | O–C | Mean of O–C values | Cycle | Mean of cycles | O–C | Mean of O–C values | |
| 2426734.271 | pg | II | 0.5 | | $0^{d}.000$ | | 0.5 | | $0^{d}.000$ | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| | | | | 0.5 | | $+0^{d}.007$ | | 0.5 | | $+0^{d}.007$ | |
| 2426734.285 | pg | II | 0.5 | | +0.014 | | 0.5 | | +0.014 | | Strohmeier: 1963, *Sky Telesc.* **26**, 1963 |
| 2426945.596 | pg | II | 76.5 | | −0.009 | | 76.5 | | −0.009 | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2427365.467 | pg | II | 227.5 | | −0.026 | | 227.5 | | −0.026 | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2427386.362 | pg | I | 235.0 | 233.8 | +0.014 | −0.020 | 235.0 | 233.8 | +0.013 | −0.021 | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2427397.423 | pg | I | 239.0 | | −0.048 | | 239.0 | | −0.049 | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2428127.413 | pg | II | 501.5 | | +0.005 | | 501.5 | | +0.005 | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2436843.514 | pg | I | 3636.0 | | −0.036 | | 3636.0 | | −0.041 | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2436943.559 | pg | I | 3636.0 | | +0.011 | | 3636.0 | | +0.004 | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |

*Table II (continued)*

| J.D.$_\odot$ | Type of Obs. | Min. | O–C based on $P = 2^d.780712$ | | | | O–C based on $P = 2^d.7807135$ | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cycle | Mean of cycles | O–C | Mean of O–C values | Cycle | Mean of cycles | O–C | Mean of O–C values | |
| 2436943.604 | pg | I | 3636.0 | | $+0^d.056$ | | 3636.0 | | $+0^d.049$ | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2436850.510 | pg | II | 3638.5 | 3634.1 | +0.009 | +0.026 | 3638.5 | 3664.1 | +0.003 | +0.017 | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2436850.556 | pg | II | 3638.5 | | +0.055 | | 3638.5 | | +0.047 | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2436903.379 | pg | II | 3657.5 | | +0.044 | | 3657.5 | | +0.039 | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2437316.292 | pg | I | 3806.0 | | +0.042 | | 3806.0 | | +0.015 | | Strohmeier and Knigge: 1961, *AN* **286**, 133 |
| 2438372.949 | pe | II | 4186.0 | | +0.008 | | 4186.0 | | +0.085 | | Morrison and Morrison: 1968, *AJ* **73** 777 |
| 2440529.387 | pe | II | 4961.5 | | +0.004 | | 4961.5 | | −0.004 | | Srivastava and Padalia: 1975, *ASS* **38**, 79 |
| 2440532.161 | pe | II | 4962.5 | | −0.003 | | 4962.5 | | −0.010 | | Srivastava and Padalia: 1975, *ASS* **38**, 79 |
| 2440543.298 | pe | II | 4966.5 | | +0.011 | | 4966.5 | | −0.004 | | Srivastava and Padalia: 1975, *ASS* **38**, 79 |

*Table II (continued)*

| J.D.$_{\odot}$ | Type of Obs. | Min. | O–C based on $P = 2^{d}.780712$ | | | | O–C based on $P = 2^{d}.7807135$ | | | | Reference |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Cycle | Mean of cycles | O–C | Mean of O–C values | Cycle | Mean of cycles | O–C | Mean of O–C values | |
| 2440557.194 | pe | II | 4971.5 | 5023.7 | $+0^{d}.004$ | $+0^{d}.008$ | 4971.5 | 5023.7 | $-0^{d}.004$ | $-0^{d}.003$ | Srivastava and Padalia: 1975, *ASS* **38**, 79 |
| 2440906.177 | pe | I | 5097.0 | | +0.007 | | 5097.0 | | −0.001 | | Srivastava and Padalia: 1975, *ASS* **38**, 79 |
| 2440917.301 | pe | I | 5101.0 | | +0.008 | | 5101.0 | | 0.000 | | Srivastava and Padalia: 1975, *ASS* **38**, 79 |
| 2440931.204 | pe | I | 5106.0 | | +0.008 | | 5106.0 | | 0.000 | | Srivastava and Padalia: 1975, *ASS* **38**, 79 |
| 2442071.284 | v | I | 5516.0 | 5555.3 | −0.004 | −0.007 | 5516.0 | 5555.3 | −0.013 | −0.015 | Diethelm: 1974a, *BBS* **13**, 2 |
| 2442289.565 | v | II | 5594.5 | | −0.009 | | 5594.5 | | −0.017 | | Diethelm: 1974b, *BBS* **17**, 13 |
| 2443453.3049 | pe | I | 6013.0 | | +0.003 | | 6013.0 | | −0.0063 | | Al-Naimiy *et al.*: 1978, *IBVS*, No. 1415 |

new period of XY Ceti has been derived employing the method of least squares. The new period, using the initial epoch, comes out to be $2^d.7807135 \pm 0^d.0000002$.

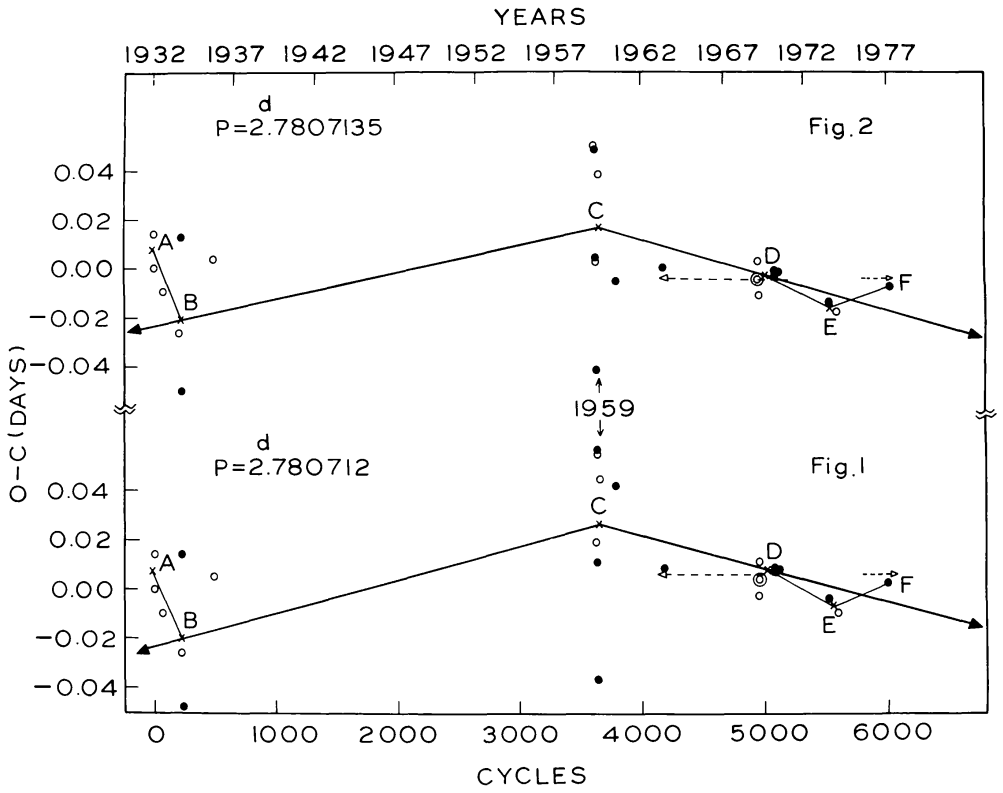
## 3. O–C Diagrams and Period Changes

All the available times of minima, observed in the time interval 1932 to 1977, are listed in Table II. Two O–C diagrams (Figures 1 and 2), based on the ephemeris:

Primary minimum = J.D. 2426734.271 + $2^d.780712E$,
(Strohmeier and Knigge, 1961; Morrison and Morrison, 1968)

Primary minimum = J.D. 2426734.271 + $2^d.7807135E$,
(Strohmeier and Knigge, 1961) (present)

respectively, have been drawn. Both figures appear similar apparently. In understanding the period behaviour, the period has been assumed to be constant between epochs of different period change and, also, that $O-C(s) > 0^d.01$ are important. Although, equal weights have been assigned to all minima, yet weighing them differently, makes no change in the shape of the O–C diagram.




Figs. 1 and 2. O–C diagrams of XY Ceti. Filled and open circles indicate primary and secondary minima values, while the crosses indicate the mean values. The heavy solid lines, having solid arrows at their ends, show period tendencies, while the thin solid lines represent the period fluctuations. Dashed lines having open arrows at both ends signify the mean O–C level of photoelectric minima.

Figure 2 is scantily covered, yet period fluctuations around the years 1936, 1959, 1969, 1974 are apparent. The O–C diagram (Figure 2) gets split up into 5 portions (*AB*, *BC*, *CD*, *DE*, *EF*) position *AB* is well covered. On the other hand, the portion *BC* is scantily covered, and its importance is questionable. Portion between points *C* to *E* is also sufficiently covered, and show a tendency of decrease around the year 1959. Portion *EF* is still incomplete and, thus, much emphasis cannot be given to this portion. Period fluctuations (or changes) in different portion of the O–C diagram (Figure 2) have been estimated, and are given in Table III.

TABLE III

Changes of period in XY Ceti

| Portion | Interval of cycles | $\Delta P/P$ | Total change in period (days), $\Delta P$ |
|---|---|---|---|
| *AB* | 0– 234 | $1.20 \times 10^{-4}$ (?) | $3.34 \times 10^{-4}$ (?) |
| *BC* | 234–3664 | $1.11 \times 10^{-5}$ | $3.09 \times 10^{-5}$ |
| *CD* | 3664–5024 | $1.47 \times 10^{-5}$ | $4.09 \times 10^{-5}$ |
| *DE* | 5024–5555 | $2.26 \times 10^{-5}$ | $6.28 \times 10^{-5}$ |
| *EF* | 5555–6013 | $1.90 \times 10^{-5}$ | $5.28 \times 10^{-5}$ |
| | Mean | $3.75 \times 10^{-5}$ | $1.04 \times 10^{-4}$ |

? = leaving this unusually high value, the means come out to be $1.69 \times 10^{-5}$ and $4.69 \times 10^{-5}$ d, respectively.

The *AB* portion gives a value of $\Delta P = 3.34 \times 10^{-4}$ d, which is unusually high for a detached system XY Ceti and, thus, left out from the means. Appreciable scatter in the photographic minima, around the years 1936 and 1959, is understandable, while the photoelectric minima lie more or less on the same line in the O–C diagram, with minor change, thus it may be possible that photographic minima are possessed with some errors. On the other hand, if we presume that photographic minima are practically reliable, then we can believe that the period fluctuations of the order of $10^{-5}$ d are present in the system XY Ceti. In the light of above discussions it is definite that the period has changed around the year 1959, and two trends (increasing and decreasing), which are shown by two solid lines, with filled arrows at their ends.

## 4. Summary

A period study of the eclipsing binary system XY Ceti has been presented for the first time, which reveals that period fluctuations ($\Delta P$) of the order of $10^{-5}$ d are present. Photographic minima show large scatter, and two distinct period tendencies of the period are evident, and the change in tendency of the orbital period seems to have occurred around the year 1959. More photoelectric minima are required to comment definitely on the tendency of the period. Available photoelectric minima show a negligible period change.

## References

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