

PERIOD CHANGES IN ECLIPSING BINARY STARS OBSERVED BY AMATEURS

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Abstract

Recent period changes in UU And, SW Cyg, WW Cyg, TY Del, TW Dra, TU Her, Z Per, and Y Psc have been revealed by visual times of minima obtained over the past two decades. New ephemerides are reported for these stars.

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1. Introduction

Orbital period changes in Algol-like eclipsing binary stars are interesting phenomena. Some of the cyclic changes in O-C diagrams have been traced to apsidal motion and light-time effects. However, erratic changes that are presumed to be due to changes in the period of revolution have never been successfully explained. This failure of theory points out the depth of this problem, since the phenomenon of period change has been well known for over a century.

Visual observers have contributed a great wealth of data on these stars during the past two decades by timing the eclipses. A smaller number of amateur photoelectric observers have also contributed data. The two most active groups are the AAVSO and the European BBSAG (Swiss Astronomical Society's Eclipsing Variable Observers). Some day their data may contribute to understanding the phenomenon of period change.

This paper examines the periods of eight Algol-like systems that show large period changes since the advent of intensive visual observations around 1967. There is no attempt in this paper to explain why the changes happen. My purposes are 1) to illustrate the phenomenon by looking at some recent period changes revealed by amateur observations, and 2) to provide accurate and up-to-date ephemerides for the stars.

2. Data and Analysis

About half of the data used in this study were already collected by the author for a previously published study (Mallama 1980). That study included AAVSO and BBSAG data collected between 1967 and 1978, with a small amount of data from other sources. The new data for this study are all taken from the BBSAG Bulletins from 1968 to 1987. AAVSO data are not yet available for this period.

For each star analyzed an observed-minus-calculated (O-C) diagram was generated. This diagram shows the difference between the observed time of minimum (in this study, it is usually an average of several times, actually) and the time calculated by a formula that assumes a constant period. In this paper periods are newly derived and are based on a least-squares solution for data obtained after the last period change. On the O-C diagrams, a positive slope indicates a longer period, and vice-versa.

3. Results

The eight stars listed in Table I show dramatic changes in their recent O-C diagrams, which are plotted in Figures 1 and 2. Table I

also lists the number of minima, the years of observation considered, the year of the most recent period change, and the newly derived ephemerides for primary minima. A few notes on two of the stars in this study follow.

UU Andromedae This star shows two period changes, the first about 1976 and the second about 1983. Both changes are large, distinct, and approximately the same size and sign; they produce a step-like O-C diagram.

SW Cygni There is an interesting shape to the O-C diagram. Notice that it does not show an abrupt period change like those of UU And. Rather, it appears that either a period change happened about 1978 or that a gradual change is taking place. The data in Table I correspond to the first assumption. However, curvature in the O-C curve (the second assumption) is consistent with a comment in the **General Catalogue of Variable Stars** (Kukarkin *et al.* 1969) that "deviations O-C in the interval J. D. 2414600 - 2434000 show a sinusoidal wave with half amplitude 0^d080 with $\pi = 4400$ P".

4. Discussion

The data in Section 3 demonstrate how amateur observations can reveal interesting period change phenomena in eclipsing binary stars. The stars reported on here are just a few of the thousands that are accessible to visual and photoelectric observers with small telescopes.

REFERENCES

Kukarkin, B. V. *et al.* 1969, **General Catalogue of Variable Stars**, 3rd Edition, Moscow.

Mallama, A. 1980, **Astrophys. Journ. Suppl.** 44, 241.

TABLE I

Eclipsing Binary Stars Analyzed for Period Change

Star	Minima Observed	Years Observed	Period Change	New Ephemerides	
				Epoch	Period
UU And	67	1973-86	1983	2445211.5037	1.4863117
SW Cyg	32	1967-85	1978	3692.5042	4.5730685
WW Cyg	43	1972-85	1975	2594.1441	3.3177858
TY Del	78	1967-85	1979	3837.3064	1.1911369
TW Dra	65	1969-85	1976	2960.2097	2.8068743
TU Her	55	1972-85	1980	4342.5679	2.2670035
Z Per	31	1968-85	1975	2413.4547	3.0562868
Y Psc	53	1970-86	1981	4490.4501	3.7657537

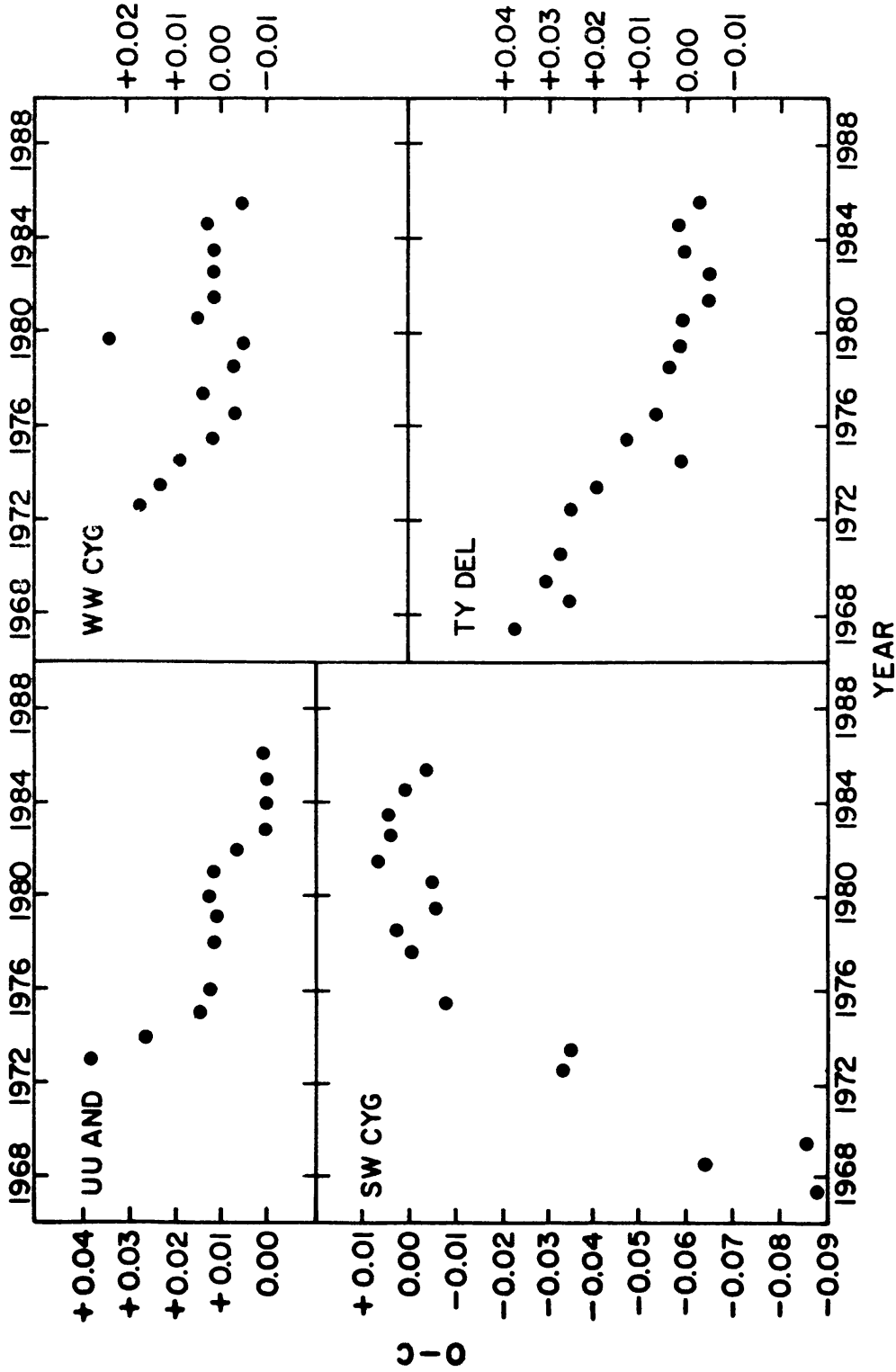


Figure 1. The O-C diagrams for UU And, SW Cyg, WW Cyg, and TY Del.

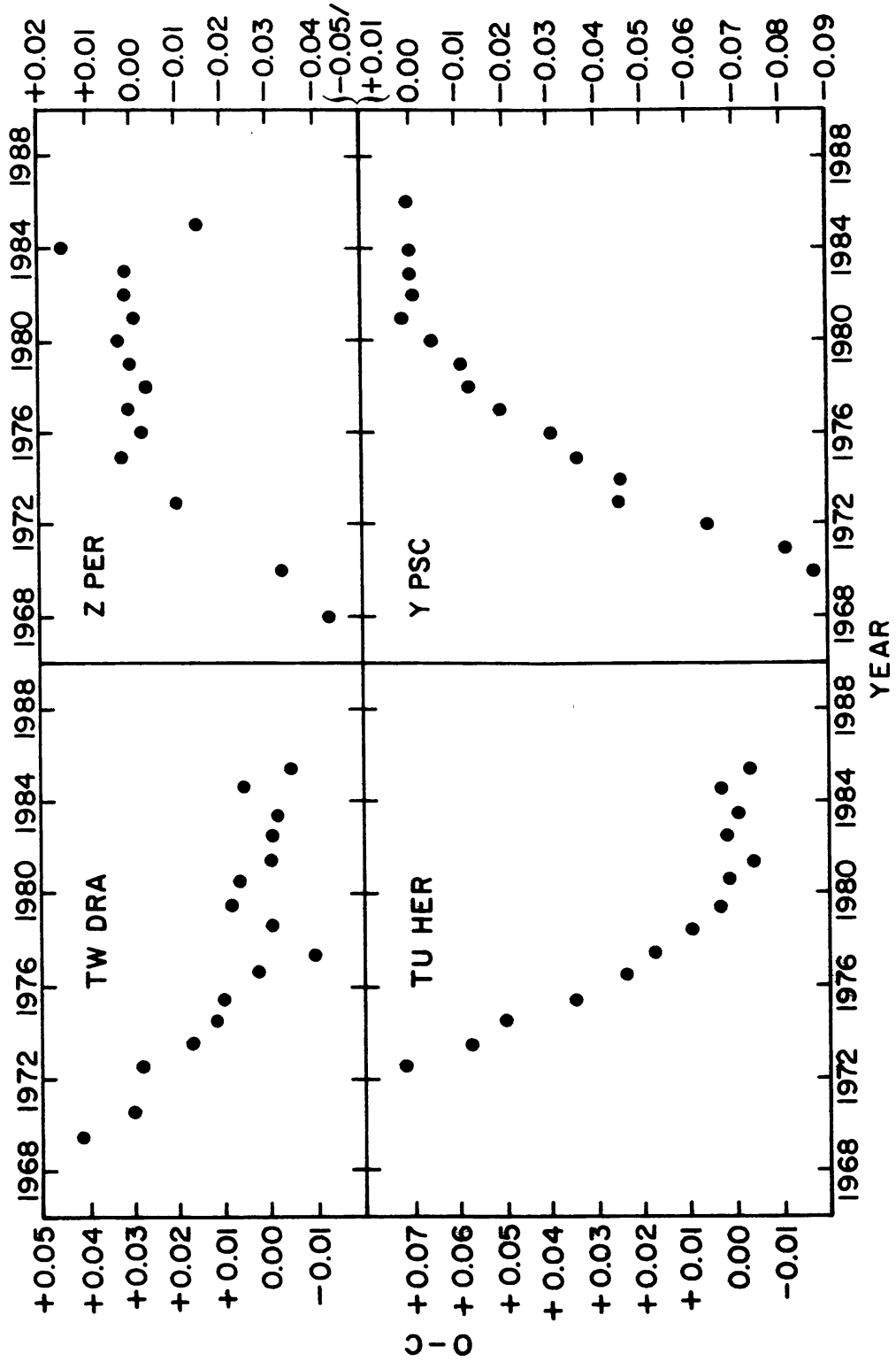


Figure 2. The O-C diagrams for TW Dra, TU Her, Z Per, and Y Psc.