

**PZ AQUILAE: PERIOD CHANGES  
IN A POPULATION II CEPHEID**

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Abstract

The photometric behavior of the galactic variable PZ Aquilae is examined during the fifty years 1934 - 1983. Using photographic observations from the Maria Mitchell Observatory, two intervals of constant period were found. The current period is 8.7546 days.

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1. Introduction

PZ Aquilae is a galactic cepheid variable located in the Scutum star cloud. As part of the program of variable star research at the Maria Mitchell Observatory (MMO), the photometric behavior of this object during the interval from 1934 into 1983 was examined, using archival plates and new observations made during the summer 1983 season.

2. Observations

Plates of the Scutum field have been taken at MMO for many years, and are still secured as part of the observatory's ongoing photographic patrol. Approximately 1500 plates in the MMO collection have centers in the Scutum region, and a large number of these contain images of PZ Aql. The current study examined some 1100 plates taken between June, 1934, and July, 1983.

A sequence based on the finder chart and comparison star magnitudes of Kurochkin (1958) was used for estimating the variable's brightness. Visual scrutiny of the plates with a hand-held eyepiece yielded 912 usable points for subsequent light curve analysis. Plates of markedly inferior image quality or on which sequence stars were off the edge were rejected.

Gaps or intervals containing few plates occur between 1941 and 1946 (approximately 20 plates) and between 1957 and 1965 (no plates). The 1957 - 1965 gap proved to be a significant problem for the completeness of the present analysis.

3. Analysis

Arbitrary sequence magnitudes and times of observation were analyzed with the aid of MMO's TRS-80 microcomputer. Programs to compute and plot heliocentric phases based on published elements were used to obtain composite light curves for intervals ranging from one observing season to several decades.

Different plots were then compared to see if phase shifts occurred between the intervals in question. The procedure involved manually fitting a typical PZ Aql light curve to successive composite light curves, in essence, finding the best fit for the entire curve rather than just using rising branches or extrema. Individual composite light curves contained from 23 to 99 points. The phase shifts for 20 different sub-intervals over the past half-century were then plotted on an O-C (delta phase and days) versus JD diagram to see if there had been any substantial changes in the period of PZ Aql between 1934 and 1983.

Three major features were evident on the O-C diagram: (i) a constant period of about 8.752 days between 1934 and 1957; (ii) the extended gap from 1957 into the 1970's; and (iii) a second constant period of about 8.755 days from the late 1970's onward. Linear regressions were performed on the intervals of constant periods with the following results:

$$\text{JD}_{(\text{max})} = 2431890.218 + 8.7521 n, \quad (1)$$

$$\pm 0.039 \quad \pm 0.00014$$

for JD 2427620 to 2435993 and  $n = 16$ ; and

$$\text{JD}_{(\text{max})} = 2444293.386 + 8.7546 n, \quad (2)$$

$$\pm 0.015 \quad \pm 0.00023$$

for JD 2442904 to 2445530 and  $n = 4$ .

#### 4. Discussion

Previous investigations of the period of PZ Aql have been performed by Williams (1941), Bakos (1950), Kurochkin (1958), Vasiljanovskaja and Erleksova (1970), and Schaltenbrand and Tammann (1971). For the interval from the mid-1930's through the late 1950's, the elements used by Kurochkin and Vasiljanovskaja and Erleksova ( $P = 8.7518$  days,  $M = \text{JD } 2433150.4$ ) are in good agreement with the present results. However, the Second Supplement (Kukarkin *et al.* 1974) to the General Catalogue of Variable Stars (Kukarkin *et al.* 1969) (GCVS) gives

$$\text{JD}_{(\text{max})} = 2433150.4 + 8.7504 E \quad (3)$$

between JD 2427900 and 2434750. Williams' and Bakos' periods disagree with both my 8.7521 day period and the work of the three Russian observers; phase shifts are noticeable in the 1940's using either Williams' or Bakos' elements and the MMO data. Thus, a period of 8.752 days well represents the behavior of PZ Aql during 1934 - 1957.

Period changes during the 1957 - 1970's gap are unclear. The First Supplement (Kukarkin *et al.* 1971) to the GCVS gives

$$\text{JD}_{(\text{max})} = 2435364.60 + 8.7573 E \quad (4)$$

from JD 2435300 onwards while the Second Supplement gives

$$\text{JD}_{(\text{max})} = 2437370.547 + 8.7573 E \quad (5)$$

for then-current (1974) elements. Schaltenbrand and Tammann's (1971) period is 8.7518 days, but their epoch of JD 2437370.547 results in a phase shift of 0.2 cycle for 1934 - 1957. Unfortunately, the reference containing observations of Mitchell *et al.* (1964) and a complete translation of Vasiljanovskaja and Erleksova (1971) were unavailable to the author in his attempt to resolve this confusion of PZ Aql's period and changes from 1957 into the mid-1970's.

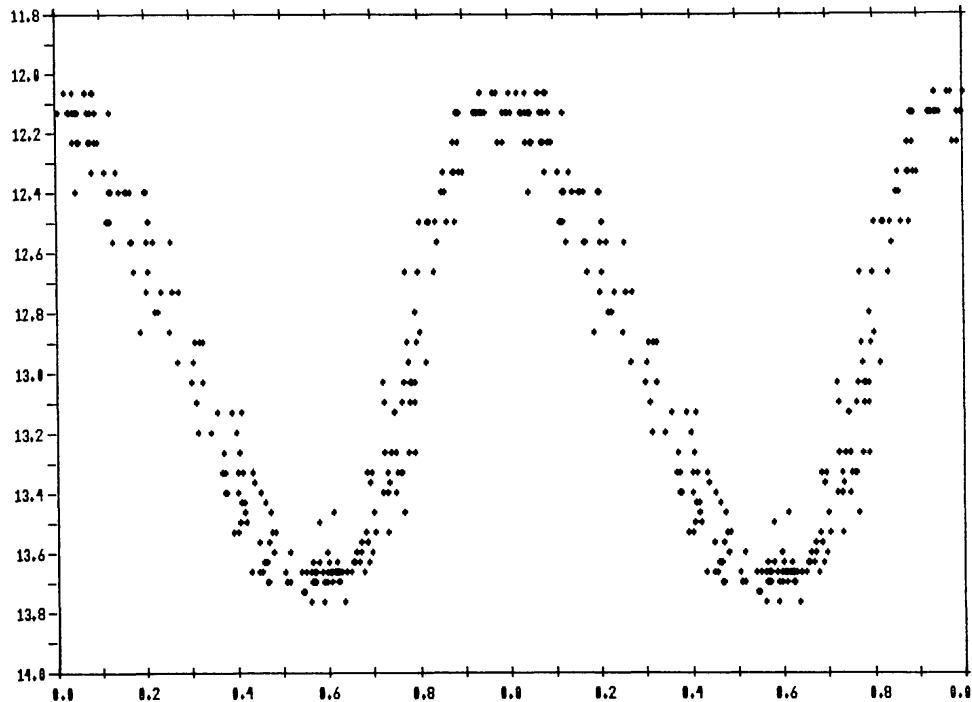
Since 1976, MMO observations show the period of PZ Aql to be again constant, but longer than it had been previously. The present period of this cepheid is 8.7546 days.

#### 5. Acknowledgements

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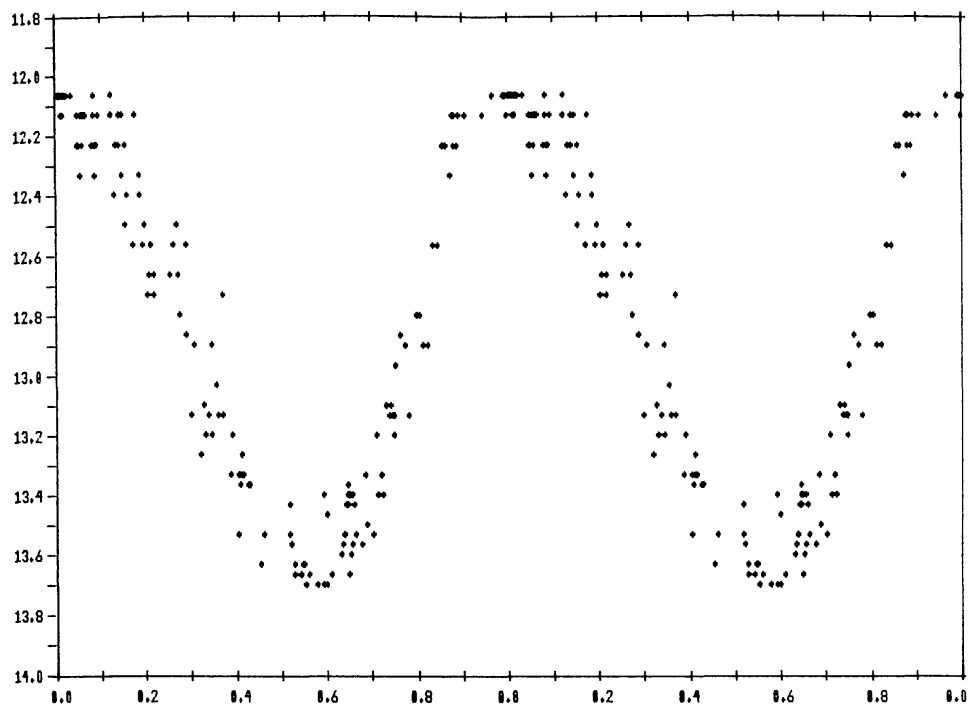
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Star Name: PZ AQL	246 OK Points
Period: 8.75210000	0 UC
Epoch: 31890.218	0 FT
Interval: 28966.889 to 32504.475	0 Other
(Helio) 3 / 1938 to 11 / 1947	246 Points Total

Figure 1. Light curve of PZ Aquilae for the interval 1938-1947. The observations were computer-plotted from the elements  $JD(\max) = 2431890.218 + 8.7521$ , with the phase reduced to a fractional value between 0 and 1. Magnitudes are photographic.



Star Name:	<b>PZ AQL</b>	159	OK Points
Period:	8.75460000	0	UC
Epoch:	44293.386	0	FT
Interval:	42904.784 to 45530.771	0	Other
(Helio)	5 / 1976 to 7 / 1983	159	Points Total

Figure 2. Light curve of PZ Aquilae for the interval 1976-1983. The observations were plotted from the elements  $JD_{(max.)} = 2444293.386 + 8.7546E$ . Magnitudes are photographic.