THE CHANGING PERIOD OF AF SCUTI

ERIC SCHULMAN
Maria Mitchell Observatory
Nantucket, MA 02554

Received 15 December 1988

Abstract

The RR Lyrae variable AF Scuti was examined for period changes in the interval 1917 through 1988 on the plates of the Maria Mitchell Observatory collection. The deviation from a constant period was found to be statistically significant, and the data indicate that the period is increasing at a rate of 0.072 day per million years.

* * * * *

1. Introduction

AF Scuti, an RR Lyrae variable, was discovered in 1924 at the Harvard College Observatory by Annie Cannon (1924). Marjorie Williams (1941) estimated that it could get as bright as 12.8 magnitude and as faint as 14.0 photographic and Uitterdijk (1949) determined the following elements for the star:

$$JD_{(max)} = \underset{\pm 0.003}{2427355.204} + \underset{\pm 0.0000013}{0.5289735}\ E. \qquad (1)$$

2. Observations

Although over 1700 plates in the Scutum region have been taken at the Maria Mitchell Observatory since 1917, acceptable images of AF Scuti were found on only 580 of them. The star is located from 8 to 12 south of the usual plate centers in Scutum and, as a result, has unacceptable images on about a third of the plates and is absent from an additional third.

The apparent brightness was determined by comparing AF Scuti to four comparison stars whose magnitudes were determined by using a Cuffey iris photometer to transfer from the photoelectric **B** magnitudes in NGC 6712 determined by Sandage et al. (1966). Figure 1 is a finding chart showing the variable and comparison stars. Table I gives the derived magnitudes of the comparison stars.

3. Analysis

Data reduction was done on an IBM PC using the methods of Belserene (1986). The phase for each of the observations was determined and the data were partitioned into 23 sub-intervals of usually one or two observing seasons. A composite light curve plotting apparent magnitude vs. heliocentric phase was constructed using all 580 observations. A mean light curve was then calculated by averaging the composite curve in 50 overlapping phase bins using a 3-bin triangular smoothing filter. Each sub-interval was compared to the mean light curve using a non-linear least squares fit to determine phase of maximum based on the best fit for the entire curve. An O-C diagram was plotted and the following revised elements were determined by least squares:

$$JD_{(max)} = \underset{\pm 0.001}{2432250.864} + \underset{\pm 0.00000013}{0.52897492}\ E. \qquad (2)$$

$$JD_{(max)} = \underset{\pm 0.002}{2432250.857} + \underset{\pm 0.00000014}{0.52897428}\ E + \underset{\pm 0.09 \times 10^{-10}}{0.52 \times 10^{-10}}\ E^2. \qquad (3)$$

The functional form of a second degree polynomial is equivalent to assuming a constant rate of change of the star's period. A statistical F-test (Pringle 1975) indicates that the probability that the curvature is due to chance deviations from a constant period is less then 0.005. Using the elements from equation (3), a new composite light curve (Figure 2) and mean light curve (Figure 3) were plotted. The range of AF Scuti was determined from Figure 3 to be 12.9 to 14.5 photographic. A new O-C diagram (Figure 4) using the elements from equation (2) implies the following revised elements:

$$JD_{(max)} = \underset{\pm 0.001}{2432891.440} + \underset{\pm 0.00000012}{0.52897437}\ E + \underset{\pm 0.09 \times 10^{-10}}{0.52 \times 10^{-10}}\ E^2. \qquad (4)$$

Note that the errors in equation (4) are slightly smaller then those in equation (3). The curvature implies a rate of change of the period of $+0.20 \times 10^{-9}$ $\pm 0.03 \times 10^{-9}$ in dimensionless units or $+0.072$ ± 0.012 day per million years.

4. Acknowledgements

I would like to thank Dr. Emilia P. Belserene, Director of the Maria Mitchell Observatory, for her time, guidance, and suggestions, without which this research would not have been possible. This work was funded by the National Science Foundation under grant AST 86-19885.

REFERENCES

Belserene, E. P. 1986, **Journ. Amer. Assoc. Var. Star Obs. 15**, 243.
Cannon, A. J. 1924, **Circ. Harvard Coll. Obs.**, No. 265.
Pringle, J. E. 1975, **Month. Not. Roy. Astron. Soc. 170**, 633.
Sandage, A., Smith, L., and Norton, R. 1966, **Astrophys. Journ. 144**, 886.
Uitterdijk, J. 1949, **Ann. Leiden Obs. 20**, 41.
Williams, M. 1941, Ph. D. Thesis. University of Michigan.

TABLE I

Photographic Magnitudes of AF Scuti Sequence Stars

Star	Photographic Magnitude
A	12.7
B	13.3
C	13.6
D	14.4

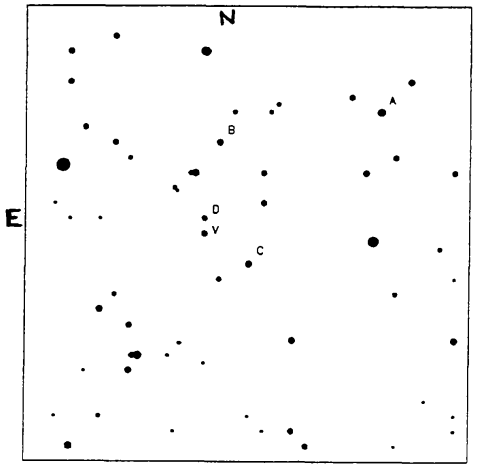

Figure 1. Finding chart for AF Scuti ($18^h\ 45^m\ 37^s$, $-14^\circ.02$ (1950)). The field is about 30' square.

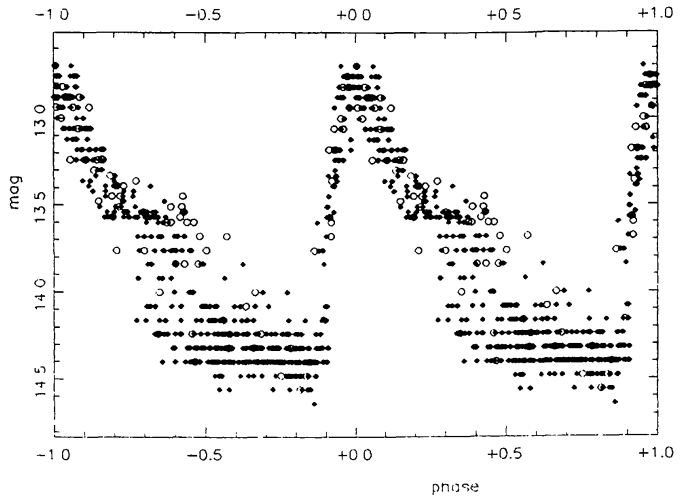

Figure 2. Composite light curve for AF Scuti from 1917 through 1988.

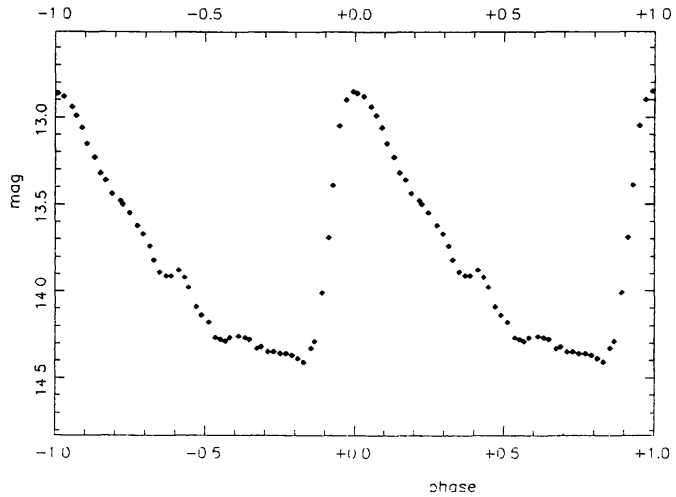

Figure 3. Phase-averaged light curve from the photographic observations of AF Scuti in Figure 2.

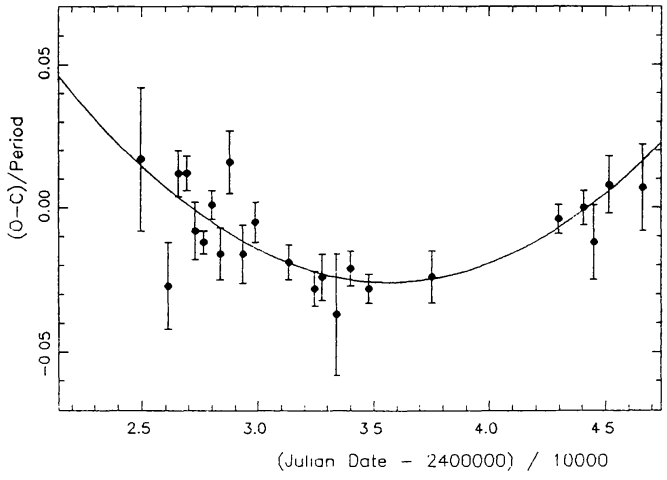

Figure 4. O-C diagram for AF Scuti.