A NEW VARIABLE IN THE FIELD OF AH HER

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Abstract

Monitoring three comparison stars in the field of AH Her which were suspected variables resulted in the confirmation of significant variability in one, named by its Designation as 1640+25C. The new variable appears to be of the W UMa type with a period of 0.323460 day and amplitude of 0.6 magnitude in V.

1. Introduction

At the 1996 Spring Meeting of the AAVSO in Atlanta, Pellock (1996) presented a paper on the suspected variables among the comparison stars and field stars on AAVSO charts. One of the fields was that of AH Her, which had four suspects. I have been monitoring AH Her with a CCD system and could image three of the suspects and AH Her within the 10.75 by 10.75 arc-minute field of view of the chip (Figure 1). Comparison star magnitudes are shown on AAVSO charts as two, three, or four digit numbers without a decimal point. In this paper, comparison stars are referred to without the decimal point.

2. Observations

The observations were made with a 24-inch (0.6-m) Ritchey-Chretien reflector and a Photometrics CH250 system. Each night a 600-second exposure was made through a V filter. The magnitudes of the stars on the chart were calibrated with the three secondary standards in BVR published by Misselt (1996). Table 1 lists the comparison and check stars.

3. Discussion

Figure 2 shows the V magnitude of suspected variables Vb and Ve versus JD of observation. The comparison star 150 was also plotted to demonstrate the noise level

Table 1: Comparison, check, and variable magnitudes and colors for suspected variables in the field of AH Her.

Chart label	V	B-V	V-R	
126	12.670	+0.490	+0.324	Primary comparison star
153	15.042	+0.854	+0.429	Check star
121	12.553	+0.733	+0.698	Vb
128	12.654	+0.496	+0.297	Possible variable
Var?	var	+0.55	+0.410	Vc
142	14.114	+0.661	+0.354	Ve

to be expected for a faint star.

Vb, which was originally assigned as comparison star 121 but later marked "var?", is labelled in Figure 2 as 121, but we see that its magnitude is between 12.50 and 12.60. Ve is labelled as 142. The mean magnitude of Ve appears to be 14.11, which agrees with the Misselt value of 14.114. Neither Vb nor Ve seems to exhibit any sign of noticeable variability during the 170 days of this study.

Figure 3 shows the stars 128 and Vc versus JD. Comparison star 128 was not on the list of suspected variables but it appeared nearly equal to comparison star 126. Therefore, it was monitored along with the other suspects. The mean magnitude of 128 is 12.65. The light appears to fade by 0.10 magnitude during the 170 days of the study. Comparison star 128 may have brightened since it was plotted on the original chart. This star needs continued monitoring and should be placed on the suspected variable list.

The star Vc [$16^h15^m29^s$ +25°17.8' (2000)] shows definite signs of variability in Figure 3. At first the period appeared to be about 18 days. As more observations were obtained, however, that period could not account for all the points. Night-by-night observations seemed to fall at random brightness levels. Then, when AH Her was in outburst, exposures were obtained at 30 minute intervals during the night. This series showed rapid changes in Vc. The next night the field was observed every 11 minutes for 5 continuous hours. Vc varied in a cycle of just under 4 hours!

Figure 4 shows the data of Vc plotted with an assumed period of 0.161730 day. What type of variable has this shape light curve? At first it appeared that it was a dwarf Cepheid, but the shape of the phase plot is not entirely right for a dwarf Cepheid. Such a variable should have a rapid rise and slow decline in brightness. Vc has equal rise and decline.

Perhaps Vc is an RR Lyrae-type variable. Stars of the RRc class have nearly symmetrical light curves resembling a sine curve with periods of a few hours.

One last possibility is that Vc is an eclipsing binary and the period is really twice as long, i.e., 0.323460 day. Figure 5 shows the data plotted with this period, and the light curve now looks like that of a W UMa eclipsing binary.

How to distinguish between the RRc and W UMa possibilities? More data points would not help. If Vc were a W UMa system, then both of the stars should have the same surface brightness and color. The equal depths of the eclipses require this. The system should be a double-lined spectroscopic binary, but no means of obtaining the required spectrum were available.

Researching the properties of RR Lyr stars at the library gave the clues needed to resolve the problem. RRc stars should have a mean B-V of +0.2, and the spectrum should range from A0 to A3 or rarely into spectral class F (Allen 1976).

W UMa variables have components in the F, G, and K spectral class ranges (Allen 1976). The spectral class of the system could be determined from B-V measures. The

Table 2. Period range and minimum period versus spectral type for W UMa contact binaries. Vc falls near the middle of the table at G and has a period consistent with the entries there (after Allen 1976).

Spectral Type	A	F	G	K	M
Period range (day)	0.6–1.3	0.4–0.7	0.3–0.6	0.26–0.5	
P min (day)	0.4	0.27	0.20	0.13	0.10

RRc color index would be expected to vary during the cycle while the W UMa color index would indicate cooler stars and remain nearly constant.

It was difficult to get good B measures of Vc because the B response of our chip is rather poor. An exposure in B long enough to get a good signal-to-noise measure meant that the variable would undergo a significant phase change during the exposure. Some B-V measures were made at maximum while a long series of V-R were obtained. The results for Vc were: (B-V) = +0.55 and (V-R) = +0.41. Figure 6 shows the R points plotted over the V points with a vertical shift of 0.41 magnitude. The points overlay remarkably well throughout the entire cycle. No significant color change is noticed.

The system is too red for an RRc-type variable since the colors imply late F to G type stars. The system must be a W UMa variable. W UMa systems are contact binaries. W UMa itself is composed of two F8 and F7 stars orbiting each other with a period of 0.33 day at a center-to-center distance of 2.5 solar radii.

Kepler's third law and the known diameters and masses of stars of given spectral type allow one to calculate minimum separations and periods for the various spectral types. Allen (1976) tabulates this relationship, which is shown in Table 2. Vc falls near the center of the table at G spectral class and has an observed period consistent with the table entries of 0.3 to 0.6 day.

4. Conclusion

The observed properties of 1640+25C are compatible with a W UMa eclipsing binary system of period 0.323460 day and a date of minimum at 2450200.128 JDb (JDb = Julian Date with barycentric correction). Additional data will be collected to refine the period and initial epoch of the system.

Long term variations in the other suspected variables are not yet ruled out. The comparison star 128 will continue to be monitored as a suspected variable.

Note added in proofreading: Additional data obtained in the 1996–97 observing season shows that no change is needed for the period or time of minimum reported above.

References

Allen, C. W. 1976, *Astrophysical Quantities*, Athlong Press, Univ. of London, England, and John de Graff Inc., New York, 216, 232.

Misselt, K. A. 1996, *Pub. Astron. Soc. Pacific*, **108**, 146.

Pellock, R. T. 1996, *J. Amer. Assoc. Var. Star Obs.*, **25**, 43.

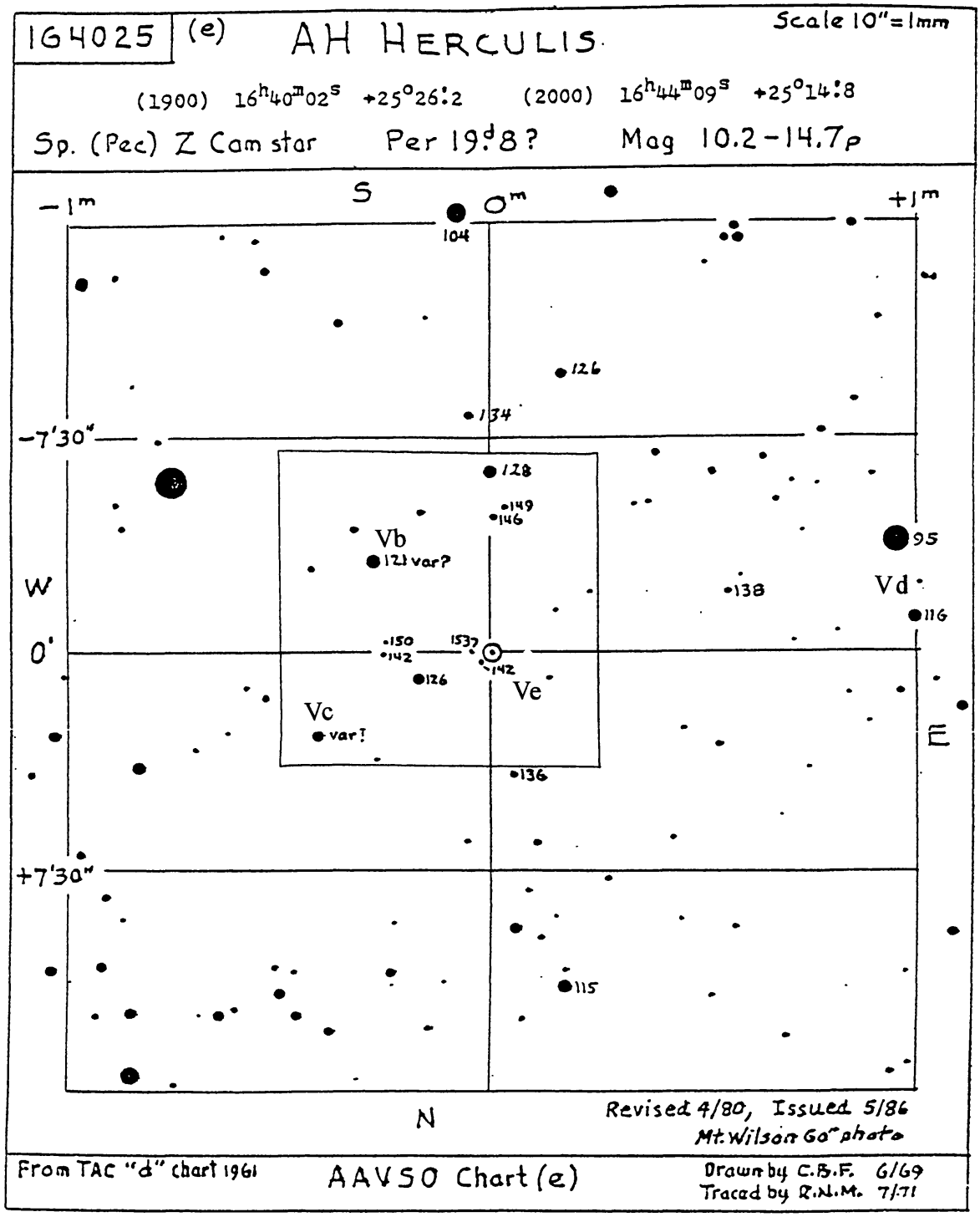

Figure 1. AAVSO "e" scale standard chart for AH Her showing the suspected variables listed in Table 1. The suspected variables within the field of the CCD image are shown in the inner box.

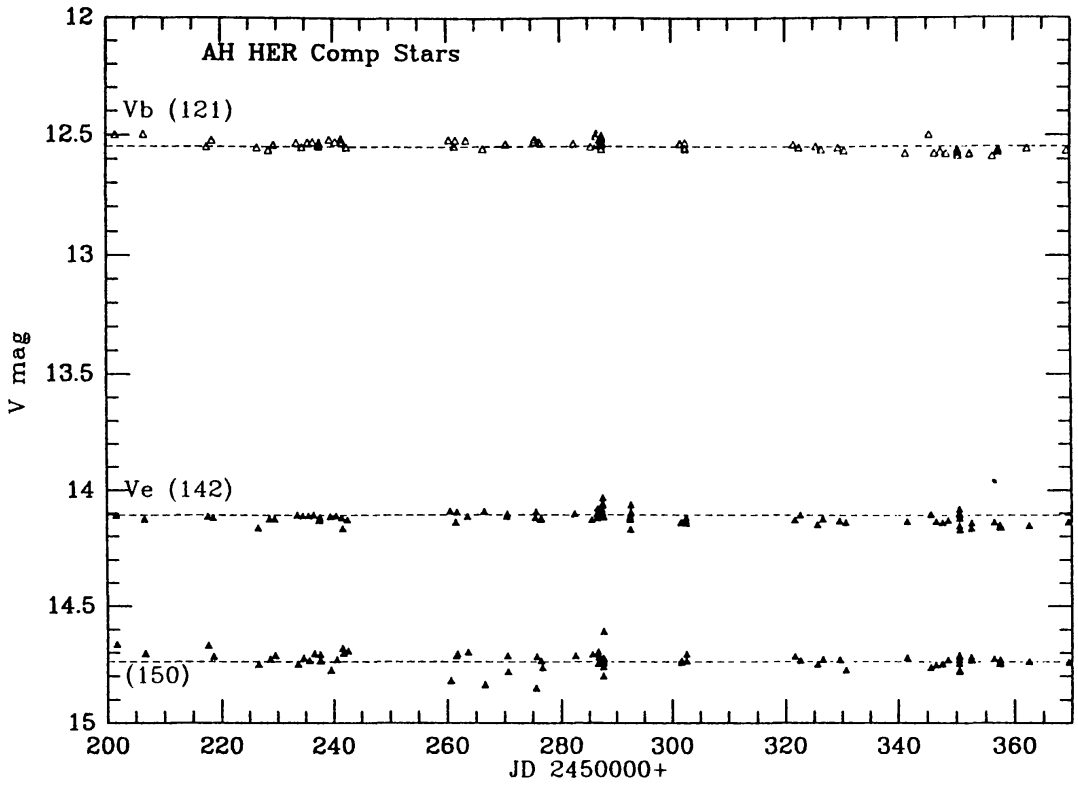

Figure 2. Plot of suspected variables Vb and Ve versus JD. The comparison star 150 was included to show expected noise for a faint comparison star that was assumed constant.

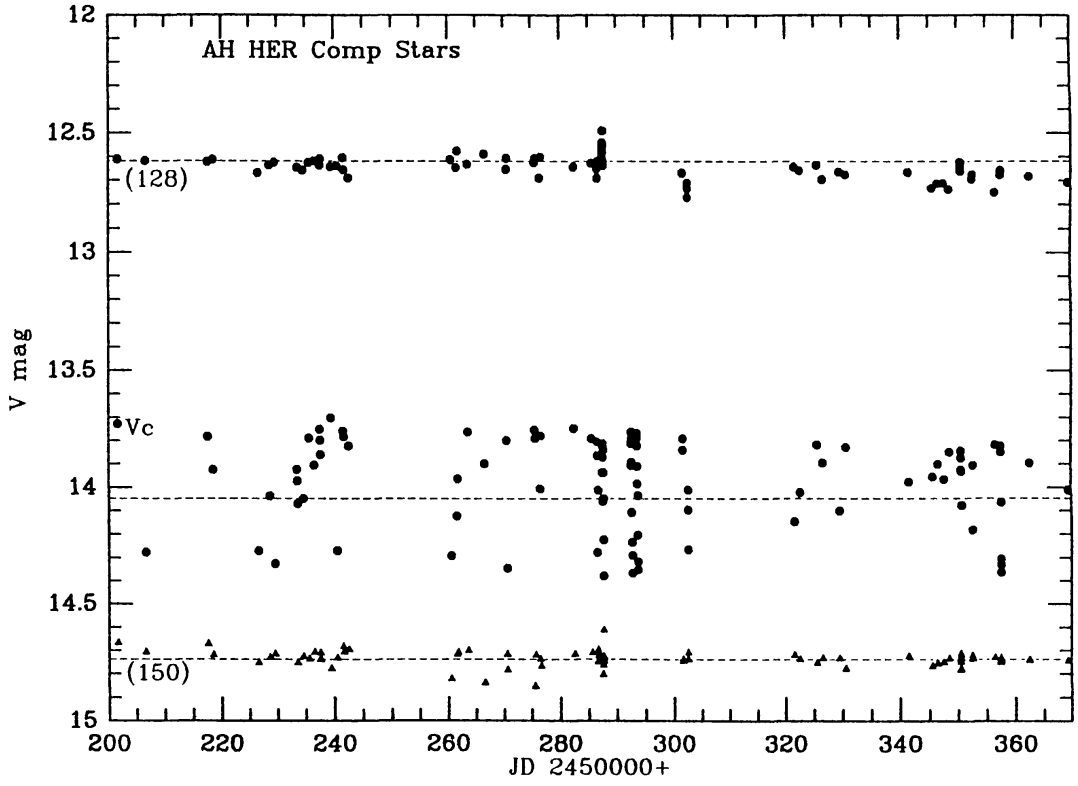

Figure 3. Plot of comparison star 128 and suspected variable Vc versus JD. Vc shows significant variations in less than a day. Comparison 128 is closer to magnitude 12.6 than to 12.8. During the 170 days of monitoring 128, it seems to have faded by 0.10 magnitude.

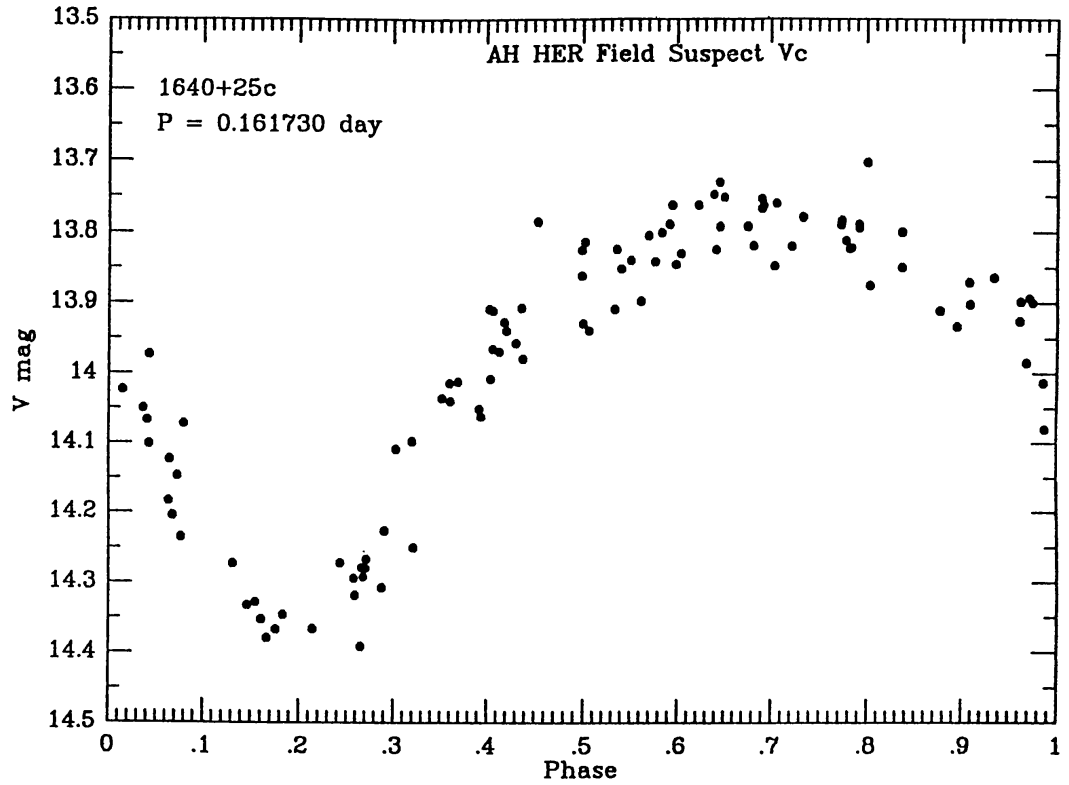

Figure 4. Light curve of Vc plotted with an assumed period of 0.161730 day. The shape suggests an RR Lyr variable of type c.

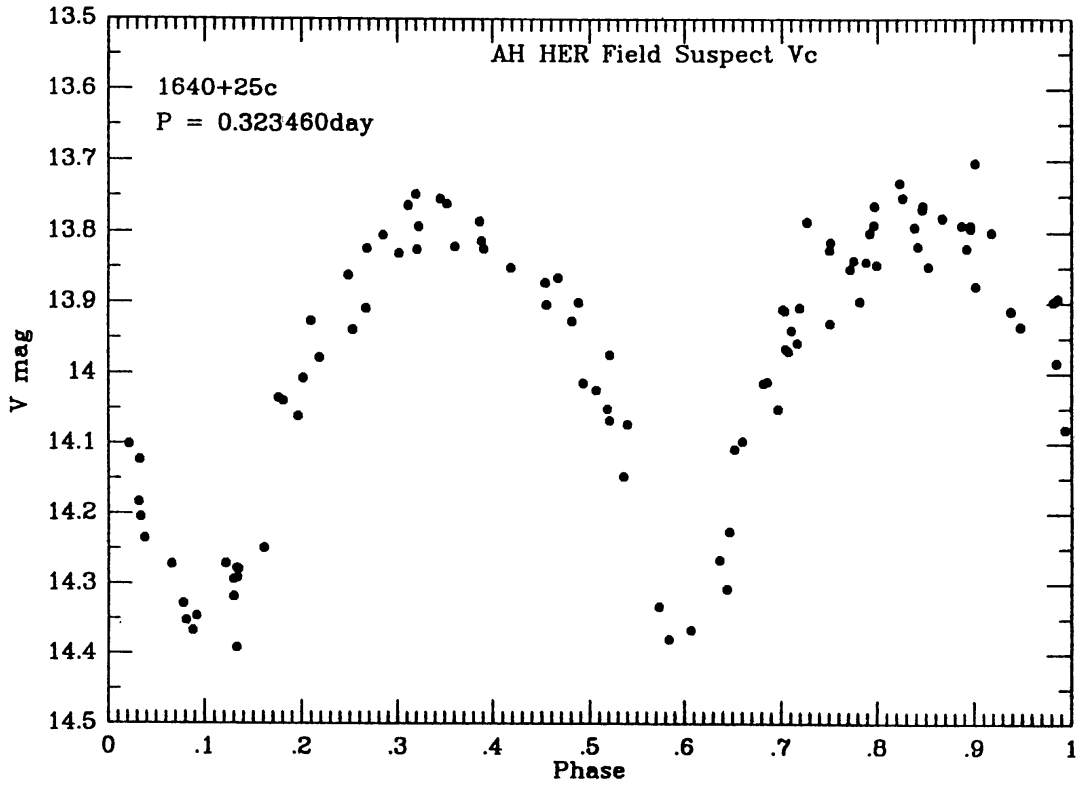

Figure 5. Light curve of Vc plotted with an assumed period of 0.323460 day. The shape implies a W UMa type contact eclipsing variable.

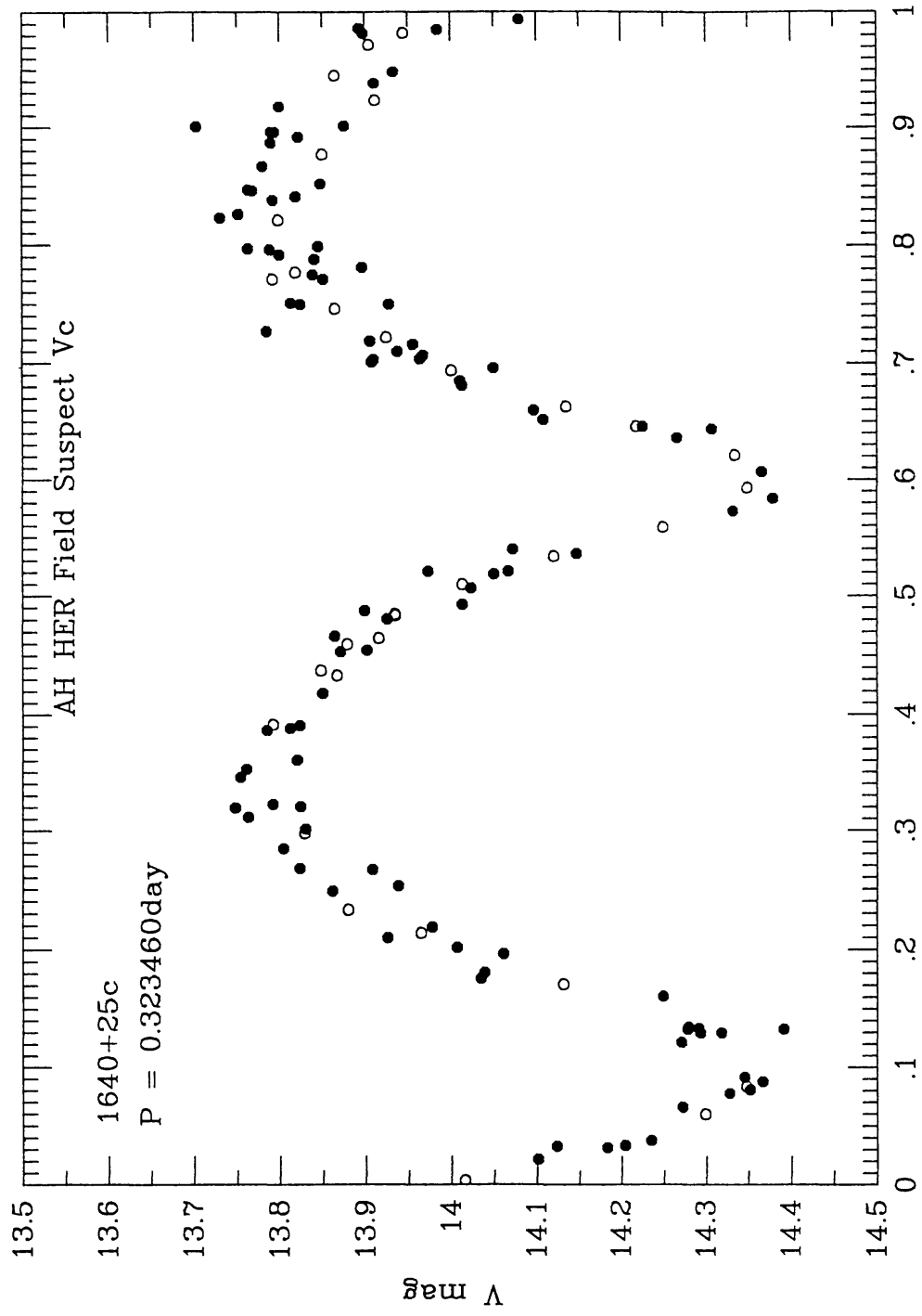

Figure 6. Light curve of Vc plotted with an assumed period of 0.323460 day. V magnitudes are plotted as solid circles and R magnitudes are plotted as open circles shifted 0.41 magnitude to overlay the V points. Note the consistent fit of the two colors throughout the cycle.