The decline of the beta Canis Majoris pulsation in alpha Virginis

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Summary. The amplitude of the β CMa variation in α Virginis (Spica) has decreased since its discovery in 1968, to a level that has been almost undetectable since 1972. In this paper, the behaviour of the pulsation before its disappearance is examined using all the available photometric and radial velocity data. It is shown that in 1968–69 the amplitude of the pulsation was modulated by the 4-day orbital period, while the phase of the pulsation remained constant. In 1970–71, when the light amplitude was half of that in the previous two years, there were large random variations in both amplitude and phase, plus some phase variation which was correlated with the orbital period. There seems to have been a rapid decrease in period since 1968 and it is suggested that this, together with the amplitude decrease, implies that the (unknown) β CMa pulsation mechanism is a resonance phenomenon.

1 Introduction

Unpublished photometric observations by Shobbrook in 1971, 1972, 1973 and 1976 as well as UV observations from the Copernicus Orbiting Astronomical Observatory by Hutchings & Hill (1977) indicate that the short-period β CMa variation in α Vir has become almost, or completely, undetectable. Consequently, it was considered important to investigate the behaviour of the pulsation immediately before its disappearance, especially any changes in amplitude and phase from night to night, using all the available photometric and radial velocity data. Recent published observations on α Vir consist of photometry obtained in 1968 (Shobbrook et al. 1969, Paper 1), photometry obtained in 1969 and 1970 and radial velocities obtained in 1969 (Shobbrook, Lomb & Herbison-Evans 1972, Paper 2) and radial velocities obtained in 1970 and 1971 by Dukes (1974).

Dukes found three previously unreported periodicities in the radial velocity. In view of this and since we now have a better understanding of the statistics of frequency analysis than previously (Lomb 1976), some of the frequency analyses of previously published radial velocity observations discussed in Paper 2 have been re-examined together with the frequency analyses of the 1968 to 1970 photometry and the radial velocities of Dukes (1974).

2 Nightly amplitudes and phases: calculation

As a first step in obtaining the nightly amplitudes and phases of the β CMa light variation in 1968 to 1970, the ellipsoidal variation associated with the 4-day orbital period had to be
removed from the data. The formula used for the ellipsoidal light variation was that derived in Paper 1 and later corrected by Rucinski (1970). Although this formula leaves a small residual 4-day variation, it fully accounts for the observed drifts in the zero point during each night’s observations. As is pointed out in the conclusion to Paper 1, these drifts can easily be misinterpreted as changes in amplitude; this is presumably the explanation of Dukes’ (1974) remark that the 1968 photometry shows amplitude changes of up to 0.01 mag in about one-tenth of a day. The following relation was then fitted by least squares to the observations on each night on which they fully cover one cycle of the short period:

\[ \Delta m = a_i \sin(2\pi ft + \phi_i) + c_i \]

where \( a_i \), \( \phi_i \) and \( c_i \) are the constants for night \( i \), \( \Delta m \) is the magnitude at time \( t \) and 

\[ 1/f = 0.173787 \ \text{day}. \]

This value of the short period is slightly revised from that given in Paper 2, in order to give a better fit to the data in the interval from 1968 to 1969. The amplitudes and phases obtained are given in Table 1; note that amplitudes are given in m.mag where 1 m.mag = 0.001 mag. The errors quoted in the table are not standard deviations, since neither the \( a_i \) nor the \( \phi_i \) can be regarded as normal variables, but are slightly larger.

Shobbrook (unpublished) observed the star on nine nights in 1971, 1972 and 1973. These observations, along with the photometric observations discussed in Papers 1 and 2, have been lodged with the Royal Astronomical Society under the file number IAU(27) RAS-38. The amplitudes were obtained after removal of the ellipsoidal light variation, on the four nights on which the observing session lasted longer than 0.17 day. These were all much lower than in previous years; the highest amplitude being 2.4 ± 0.1 m.mag. Unfortunately, in 1971, 1972 and 1973, only one comparison star, \( \theta \) Vir, could be used in the reduction of the photometry, since the second comparison star, 73 Vir, appeared to vary by ~ 0.02 mag on some nights and the photometry was less accurate than previously. Consequently, the variation on a night was taken as real only if the observations followed the fitted sine curve without noticeable systematic deviation, and if at least two maxima and one minimum or one maximum and two minima were covered by the observations. These criteria are satisfied only on one night, JD 2441047, and the amplitude and phase on that night are included in Table 1.

The radial velocity observations obtained in 1969 (Paper 2) consist of 30 observations on one night and the remaining 11 spread over 82 day. An orbital velocity curve with the

<table>
<thead>
<tr>
<th>JD 2400000+</th>
<th>Amplitude (m.mag)</th>
<th>( \beta ) CMa phase* (deg)</th>
<th>JD 2400000+</th>
<th>Amplitude (m.mag)</th>
<th>( \beta ) CMa phase* (deg)</th>
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<tbody>
<tr>
<td>39927.0812</td>
<td>13.3 ± 1.4</td>
<td>122 ± 6</td>
<td>40340.0403</td>
<td>13.9 ± 0.8</td>
<td>116 ± 3</td>
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<td>39931.2179</td>
<td>20.3 ± 2.7</td>
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<td>15.3 ± 0.9</td>
<td>118 ± 4</td>
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<td>18.0 ± 0.8</td>
<td>111 ± 3</td>
<td>40346.0398</td>
<td>11.6 ± 0.7</td>
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<td>39947.0799</td>
<td>13.6 ± 0.9</td>
<td>124 ± 4</td>
<td>40631.2050</td>
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<tr>
<td>39955.0505</td>
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<td>40648.1581</td>
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<tr>
<td>39956.1189</td>
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<td>118 ± 2</td>
<td>40649.1634</td>
<td>4.5 ± 1.1</td>
<td>157 ± 15</td>
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<tr>
<td>39957.0988</td>
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<td>121 ± 2</td>
<td>40654.1630</td>
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<td>40024.9783</td>
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<tr>
<td>40025.9563</td>
<td>18.4 ± 1.4</td>
<td>113 ± 4</td>
<td>41047.1040</td>
<td>1.9 ± 0.5</td>
<td>246 ± 15</td>
</tr>
</tbody>
</table>

* Zero point for the phases is at JD 2439957.525.
Table 2. 1969 to 1971 nightly amplitude and phase of the βCMa radial velocity variation in αVir.

<table>
<thead>
<tr>
<th>JD 2440000+</th>
<th>Blended or unblended</th>
<th>Amplitude P (km/s)</th>
<th>Phase* P (deg)</th>
<th>Amplitude P/2 (km/s)</th>
<th>Phase* P/2 (deg)</th>
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<tr>
<td>283.145</td>
<td>U</td>
<td>7.8 ± 1.2</td>
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<tr>
<td>697.823</td>
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<td>8.9 ± 2.4</td>
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<tr>
<td>698.833</td>
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<td>4.4 ± 1.9</td>
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<td>699.795</td>
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<td>12.3 ± 1.2</td>
<td>74 ± 6</td>
<td>2.4 ± 1.3</td>
<td>122 ± 31</td>
</tr>
<tr>
<td>700.799</td>
<td>U</td>
<td>4.3 ± 1.7</td>
<td>69 ± 24</td>
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<tr>
<td>703.791</td>
<td>B</td>
<td>5.5 ± 1.7</td>
<td>78 ± 19</td>
<td>2.9 ± 1.5</td>
<td>13 ± 36</td>
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<tr>
<td>706.801</td>
<td>U</td>
<td>5.3 ± 1.6</td>
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<td>5.0 ± 1.5</td>
<td>187 ± 20</td>
</tr>
<tr>
<td>707.795</td>
<td>B</td>
<td>12.4 ± 2.0</td>
<td>77 ± 9</td>
<td>3.1 ± 1.7</td>
<td>50 ± 30</td>
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<tr>
<td>716.768</td>
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<td>5.7 ± 2.4</td>
<td>172 ± 24</td>
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<td>0.9 ± 1.2</td>
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<tr>
<td>727.760</td>
<td>B</td>
<td>1.5 ± 2.1</td>
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<td></td>
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<tr>
<td>728.746</td>
<td>U</td>
<td>3.6 ± 1.8</td>
<td>7 ± 29</td>
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<td>B</td>
<td>3.3 ± 1.4</td>
<td>117 ± 28</td>
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<tr>
<td>735.727</td>
<td>B</td>
<td>1.5 ± 1.7</td>
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<tr>
<td>747.706</td>
<td>B</td>
<td>2.0 ± 2.0</td>
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<td>1073.767</td>
<td>U</td>
<td>3.4 ± 2.0</td>
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<tr>
<td>1074.782</td>
<td>B</td>
<td>5.8 ± 1.1</td>
<td>40 ± 13</td>
<td>3.6 ± 1.2</td>
<td>7 ± 22</td>
</tr>
</tbody>
</table>

* Zero point for the phases is at JD 2439957.525.

elements fitted to the 1969 velocities in Paper 2 was subtracted from the velocities on the night with 30 observations. This is in accordance with the philosophy adopted in Paper 2 of using for each set of velocities, the orbit fitted to those velocities. The reason for this is not that it is considered that the true orbit of the star is changing, but that with the broad lines of the star (v sin i = 165 km/s) the measured velocities will contain systematic effects due to different techniques of measurement and reduction of the spectrograms. The same relation as was used for the photometry was fitted to the residuals and the resulting amplitude and phase is given in Table 2.

With the radial velocities of Dukes (1974), as with the other data, only those nights were used where the observations extended over at least one cycle of the short period. A spectroscopic binary curve was subtracted for the velocities on these nights, with elements given by Dukes. The residuals from this orbit present a somewhat more difficult problem than the other data, since on approximately half the observing nights the velocities were obtained when the lines of the primary were seriously blended with the lines of the secondary. One of the effects of blending is that the observed velocities show systematic deviations from the calculated orbital velocity curve. To take account of this the relation fitted to the residuals on ‘blended’ nights was

\[ V = a_i \sin(2\pi ft + \phi_i) + k_i t + c_i \]

where the \( k_i t \) term allows for the effect of the blending on the observed orbital velocity curve. This is a similar procedure to that adopted by Dukes. On ‘unblended’ nights the \( k_i t \) term was not included in the fit. A significance test based on the \( \chi^2 \) distribution with two degrees of freedom (Lomb 1976) was applied to each night. If in Table 2 only the amplitude and not the phase of the variation is listed for a particular night, it indicates that the fitted relation was not significant at the 5 per cent level and that the quoted amplitude is an upper limit to the amplitude of the pulsation. On some nights there is a clear harmonic component in the residuals. Consequently, for each night which showed a significant variation with the funda-
mental, a new fit was made with the first harmonic included in the fitted relation. That is, the relation fitted was

\[ V = a_i \sin(2\pi ft + \phi_i) + a'_i \sin(4\pi ft + \phi'_i) + k_i t + c_i \]

or

\[ V = a_i \sin(2\pi ft + \phi_i) + a'_i \sin(4\pi ft + \phi'_i) + c_i \]

depending on whether it was a 'blended' or an 'unblended' night. Where the inclusion of the first harmonic led to a statistically significant improvement in the goodness of the fit, the amplitudes and phases of both the fundamental and the harmonic are listed in Table 2. For the 'unblended' nights the amplitudes and phases listed in Table 2 are in good agreement with those given by Dukes, but on the 'blended' nights there are significant differences in the given phases on some nights. This could be due to the subtraction of different slopes on these nights. It is interesting to note that on the whole the fit on the 'blended' nights is far better than on the 'unblended' nights. On the 'blended' nights the rms residual ranges from 3.4 to 6.7 km/s, while on the 'unblended' nights it ranges from 4.2 to 9.4 km/s. This is presumably a measurement effect; the blended lines show single smooth peaks and as a result it is easier to set on them with the measuring machine.

3 Nightly amplitudes and phases: results

It can be seen from Table 1 that there was a very large drop in light amplitude between 1969 and 1970. Consequently, the 1968–69 observations were examined separately from those of 1970–71.

Fig. 1(a) shows the nightly amplitudes in 1968 and 1969 plotted against the phase of the orbit from periastron (calculated with the elements of the 'adopted' orbit in Paper 2). There is an unmistakable amplitude modulation with the orbital period. It should be noted that the two nights of very low amplitude at phases 0.26 and 0.29 are separated by one year, and so give credence to the reduced amplitude at that phase of the orbit. The one night, at phase 0.94, which lies off the curve defined by the other nights, is one of the two nights in 1968 on which the observations had to be obtained from the deflections on a chart recorder instead of reading them off a digital counter (see Paper 1); also, it has by far the highest

![Figure 1](https://example.com/figure1.png)

Figure 1. The nightly amplitudes (a) and phases (b) of the \( \beta \)CMa light variation in 1968 (dots) and in 1969 (diagonal crosses) are plotted against orbital phase from periastron. Note that the error bars in orbital phase are not errors but indicate the lengths of the observing sessions.
r.m.s. residual (7.2 m.mag) of all the nights in Table 1. The two dips in the curve come at the
times of conjunction. Using the elements of the 'adopted' orbit in Paper 2 these times are
calculated to be:

primary in front of the secondary — phase 0.32 ± 0.03 from periastron,
primary behind the secondary — phase 0.89 ± 0.02 from periastron.

Fig. 1(b) shows the nightly phase of the β CMa light variation in 1968 and 1969 plotted
against orbital phase. The phases are remarkably constant although there could be peaks of
about 5° in phase at both conjunctions. Note that 'phase' is defined such that an increase in
phase indicates the arrival of maxima and minima in the light variation earlier than predicted.
The phase variation due to light travel time across the orbit is undetectable since it has a
total range of only ~ 1° in the phase of the 4-hr period. From the figure the mean phase
can be taken to be 119 ± 2°.

Fig. 2(a) shows the nightly light amplitudes in 1970 and 1971 plotted against orbital
phase from periastron. The amplitudes are, on average, smaller than the 1968–69 ampli-
tudes by a factor of slightly more than 2 and they show a large scatter, but without any
resemblance to the modulation curve of 1968–69. The radial velocity amplitudes in 1970
and 1971 are plotted in Fig. 2(b). These also show a large scatter, again without resemblance
to the modulation curve of 1968–69 or even to the 1970–71 light amplitudes. It seems,
therefore, that the amplitude variations in 1970–71 are random. The amplitude of the first
harmonic in the radial velocities is not plotted, but there does not seem to be any clear
relationship between the amplitude of the fundamental and the amplitude of the harmonic;
that is, the shape of the velocity curve also varies randomly.

In Fig. 2(c) the phases of the 1970–71 light and radial velocity variations have been
plotted. The phases of the velocities have been corrected to the phases of the light variation,
using the result obtained in Paper 2 that maximum light occurs later than the phase of mean
velocity on the decreasing branch of the radial velocity by 0.055 of the phase or 20°. In
contrast to the situation in 1968 and 1969 there is a large variation in phase. Some of this
variation is obviously random, or at least not correlated with the orbital period; this is best
shown by two nights which almost overlap in orbital phase near orbital phase 0.6 and yet
have a β CMa phase difference of more than 160°. On the other hand, if four nights are
ignored (the two at orbital phase 0.6 and the two 1971 nights) there seems to be a smooth
curve present. The increase in phase at 0.9 of the orbit, the time of conjunction with the
primary behind the secondary, is particularly well defined. It is demonstrated by two nights
of light variation and two nights of radial velocity variation in 1970.

Another obvious feature of Fig. 2(c) is that the phase on almost every night is above the
119° mean phase in 1968–69. This suggests that the period is decreasing. If we assume a
linear change in period, the phases should fit the parabolic equation

$$\phi = A + Bt + Ct^2.$$  

Here A and B are constants, t is the Julian date and

$$C = -\frac{\pi \dot{p}}{p^2}$$

where p is the period and \(\dot{p}\) is the rate of change of period. This relation was fitted by least
squares to the phases on those nights which have their phases listed in Tables 1 and 2. A
different constant A was fitted to the light and velocity phases. A period decrease of
0.000005 ± 0.000002 day/yr (or 43 ± 17 s/century) was found. This large rate of change
of period has to be treated with caution, however, since the phases in 1970–71 were con-
siderably affected by both the random and periodic changes discussed above. The difference
between the fitted constant $A$ for the light and velocity phases was such that maximum light lags behind mean velocity decreasing by $15 \pm 10^\circ$ or $0.042 \pm 0.028$ of the phase. This is in good agreement with the $0.055 \pm 0.032$ given in Paper 2 for 1969 only and used in drawing Fig. 2.

4 Frequency analysis

The frequency analysis program used has been described in Paper 2 as well as in Shobbrook & Lomb (1972). Basically, it fits by least squares a series of sine curves of different frequencies to the data and plots the reduction in the sum of squares of the residuals at each frequency. Each time a period is found in the data it is subtracted from the observations (prewhitening) before starting the search for further periodicities. When two or more periodicities have been found, a simultaneous least-squares fit is made of the periods to the observations in order to allow for the mutual influence of the periods on each others' amplitudes and phases. To correct for the mutual influence on the actual values of the
periods, a subsequent non-linear least-squares fit can be carried out by the program, if required.

On about half of Dukess' (1974) nights of observation the measured velocities were affected by blending. The necessary corrections to the measured orbital velocities were discussed in Section 2. It would not have been surprising if the observed short-period variation had also been affected by the blending. However, this is not the case for there is no significant difference between the amplitudes and phases listed in Table 2 on 'blended' and 'unblended' nights; for 1970 the mean amplitude difference is 0.4 ± 0.9 km/s and the mean phase difference is 7 ± 10°. Thus there is no reason why the observations on the 'blended' and the 'unblended' nights cannot be combined into one set of data for the frequency analysis. The only major difference, as noted in Section 2, is the quality of the observations. The two nights with the highest rms residuals, of 9.4 and 8.1 km/s respectively, are JD 2440719 and 2440721; plots of the measured velocities on these nights do not show any systematic variation but only a large scatter. These two nights were deleted from the frequency analysis. Only the 1970 observations were used and only those made on nights listed in Table 2. On all nights, after removal of the orbital variation, the mean magnitude was subtracted and on 'blended' nights the fitted slope was also subtracted. Apart from the main period of 0.1738 day, two periodicities were found in the data in the region from 0.3 to 0.14 day, but the period of the second of these periodicities could not be ascertained unambiguously and two alternative values, separated by one cycle/day (c/d) in frequency, are possible. Removal of the three variations brings the rms residual down to 5.0 km/s and leaves an almost flat frequency spectrum with the highest peak giving a reduction in the sum of squares of only 5 per cent. The three periods are compared with the four periods found by Dukess in Table 3. Dukess' value for $P_3$ is a one c/d alias (see Paper 2) of the two alternative values for $P_3$ found here. His value of $P_2$ is somewhat different from that found here and there is no evidence for his $P_4$.

The 1968–70 light variations were examined to look for either the three new periods found by Dukess (1974) or the two found above. As there was a large change in amplitude during the three years the frequency analysis was carried out separately on each year's observations. It was stated in Section 2 that the removal of the ellipsoidal light variation still left a small residual orbital variation, but it was found possible in each of the three years to find a spurious periodicity of a few days period, which removed the major part of the scatter in the nightly mean magnitudes. There were peaks of up to 20 per cent in height in the three separate spectra. However, no peak was significantly higher than some of the other peaks in its spectrum and there was no frequency at which there were peaks in all three years. Further, there were no peaks at any of the frequencies that have been found in the radial velocities of Dukess (1974).

In Paper 2 frequency searches for short periods were carried out on a number of sets of radial velocity data published prior to the discovery of the β CMa nature of the star as well as on a set of velocities from 1969. Two of these sets, the 1969 velocities and the velocities

<table>
<thead>
<tr>
<th>Table 3. Comparison of periodicities derived from the radial velocity variations of α Vir.</th>
<th>Dukess (1974)</th>
<th>Present paper</th>
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<tr>
<td>Period</td>
<td>Amplitude</td>
<td>Period</td>
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<td>(km/s)</td>
<td>(day)</td>
</tr>
<tr>
<td>$P_1$</td>
<td>0.17379</td>
<td>3.8</td>
</tr>
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<td>$P_2$</td>
<td>0.17285</td>
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</tr>
<tr>
<td>$P_3$</td>
<td>0.24297</td>
<td>1.8</td>
</tr>
<tr>
<td>$P_4$</td>
<td>0.27646</td>
<td>2.1</td>
</tr>
</tbody>
</table>

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of Struve et al. (1958), were found to contain the 0.1738-day periodicity only, a third from Struve & Ebbighausen (1934) had the 0.1738-day period as well as a second periodicity with variable amplitude and a fourth from Baker (1909) had a main period of 0.252 day. These last two sets of data have again been examined. In the 1934 velocities, when it was pre-whitened with the 0.1738-day period (as well as with the orbital variation with the appropriate elements from Paper 2), divided into groups and the broadened spectrum calculated (see Paper 2), a second periodicity appeared in two of the four groups. To test the statistical significance of this result the prewhitened data were replaced by Gaussian noise with the same rms deviation and the broadened spectrum calculated. The amplitudes obtained in the four groups for the highest peak of this noise spectrum were comparable to the amplitudes obtained for the second periodicity in the 1934 data. Thus we have to conclude that this second periodicity is not statistically significant. For the 1908 velocities a broadened spectrum was calculated after dividing the 54 data points (with the spectroscopic binary curve subtracted) into three groups, one in 1907 and two in 1908. A check was maintained on the amplitudes for each frequency in the three groups. It was found that the 0.252-day periodicity gave clearly the lowest rms residual, but that there was a high amplitude at a period of 0.1738 day in the last two groups, consisting of the velocities measured in 1908. Analysing only the 1908 velocities, the peak at 0.1738 day was the third highest in the spectrum, after the peaks at 0.252 day and its one c/d alias at 0.201 day, and was only slightly smaller than those two peaks. It seems, therefore, that the true short period in the Baker (1909) velocities is once again 0.1738 day, but with a highly variable amplitude, possibly as in the 1970 velocities.

With the exception of the 1970 velocities of Dukes (1974), in none of the other sets of velocity and photometric observations available on α Vir is a period other than 0.1738 day known to be present. Even with the 1970 velocities there is doubt regarding the values of these other periodicities. It seems reasonable to assume that they are not real periodicities, but attempts by the computer program to allow for the large amplitude and phase variations, random and periodic, that these velocities exhibit. In fact, fitting a curve based on the three periods listed in Table 3 to the 1970 velocities shows that the three periodicities account for the amplitude variations satisfactorily but not for the variations in phase.

5 Discussion
It has been shown that in 1968–69 the amplitude of the 0.1738-day period was modulated by the 4-day orbital period. The modulation was such that there was a decrease in amplitude whenever one of the tidal bulges on the primary was in the line of sight. This is in accordance with Fitch’s (1967) ideas of a connection between the ‘tide raising potential’ and amplitude. It is surprising, however, that the minimum when the primary was in front of the secondary was the deepest for then the separation between the two stars was ~ 19 per cent greater than when the primary was behind the secondary and so the tidal bulge was probably much less pronounced. The phases do not show any definite variation although there could have been slight increases of 5° at both conjunctions. The radial velocity amplitude in 1969 was 8 ± 1 km/s; within the errors this is the same as the amplitudes of 8.5 ± 1.5 and 9 ± 1.5 km/s found in Paper 2 from the velocities of Struve et al. (1958) and Struve & Ebbighausen (1934) respectively. This suggests that the behaviour of the star observed in 1968–69 has been stable for at least the previous 30 or 40 yr.

In 1970–71 the observed behaviour of the star underwent a drastic change. The light amplitudes were half that in the previous two years and the radial velocity amplitudes were, on the average, smaller than in 1969. Associated with this decrease in amplitude was a loss in the stability of the pulsation. There were large random variations in both the light and
radial velocity amplitude; on some nights the observed radial velocity range was larger than in 1969. Moreover, occasionally the radial velocity curve became significantly non-sinusoidal. Neither the light nor the radial velocity phases were constant, but show large variations. These variations are partly random and partly correlated with the orbit. The main feature of the correlation with the orbit is the increase of ~ 40° in phase at the time of conjunction with the primary behind the secondary, that is the conjunction when the two stars are closer together.

Although the disentangling and removal of the effects of random and periodic variation in the phases is difficult there are strong indications of a rapid period decrease of 43 ± 17 s/century from 1968 to 1971. This is in marked contrast to the behaviour from 1934 to 1968 during which time there was most probably a small steady decrease of ~1 s/century (Paper 2). It is tempting to think that the rapid decrease in period as well as in amplitude occurred because the β CMa pulsation is due to a resonance mechanism such as the one suggested by Osaki (1974) and that due to changes within the star, presumably only in the outer layers, the conditions of resonance are no longer satisfied. The most likely cause of these changes would be the influence of the secondary, for α Vir is the closest β CMa binary known and has a secondary of significant mass.

Recent observations show that the star is still pulsating, if at all, at a very low amplitude. The star was observed in 1975 with the Copernicus Orbiting Astronomical Observatory by Hutchings & Hill (1977). They could find no radial velocity variation, but they found a possible variation in continuum intensity at 1100 Å wavelength, at which wavelength, of course, the amplitude should be much larger than in the visual wavelengths. Unpublished observations by Shobbrook on one night in 1976 show no variation greater than 2 m.mag over 5 hr.

It seems improbable that a permanent change in the behaviour of α Vir occurred within such a short timespan and it is likely that the star will again start to pulsate with a significant amplitude in the next few years. Monitoring of the star until that time is important so that when the pulsation starts again, the behaviour of the star during the period of increasing amplitude can be observed in detail. These observations would give much useful empirical information about the unknown pulsation mechanism of β CMa stars.

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