RADIAL-VELOCITY AND PHOTOMETRIC VARIATIONS OF o And: CRITICAL EVALUATION OF POSSIBLE PERIODS

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The bright Be star o And has been observed for over 90 years. Throughout this time numerous observers detected highly variable spectrum, photometric changes and substantial range of radial velocity of this star. Much effort has been devoted for period searching in these data. In the present study we collected all available (to our knowledge) radial velocities and photometric measurements in the visible region and tried to evaluate the reported periodicities.

We have found 418 radial velocities of o And in the literature and have measured RV for additional 80 plates (see Table 1).

Table 1: Sources of radial velocities for o And

File	Number of RV	Dates of obs.	Reference
B	70	1906 - 1912	Beardsley (1969)
W	50	1906 - 1907	Harper (1915)
P	105	1936 - 1938	Tremblot (1938)
IA	27	1961 - 1967	Galeotti, Pasinetti (1968)
K	28	1965	this paper, Crimea
IB	69	1967 - 1975	Fracassini et al. (1977)
O	52 H shell	1975 - 1976	this paper, Ondřejov
G	64 lines	1975 - 1977	Gulliver, Bolton (1978)
Misc.	33	1900 - 1980	

The histograms of some files are presented in Fig. 1. The scatter is quite important. In the phases without shell the scatter must be caused mainly by measuring errors (especially when oscilloscopic device is not used). On the other hand, good measurements of sharp cores are much more reliable but they reveal real variation $\pm$10 km/s. The velocities from files IA, IB are affected by even larger scatter caused probably by the instabilities of the spectrograph. Thus, only files B, W, P, K, O and G have been used for the study of long-term variations. In order to reduce the scatter, the velocities were con-

M. Jaschek and H.-G. Groth (eds.), Be Stars, 315–318.

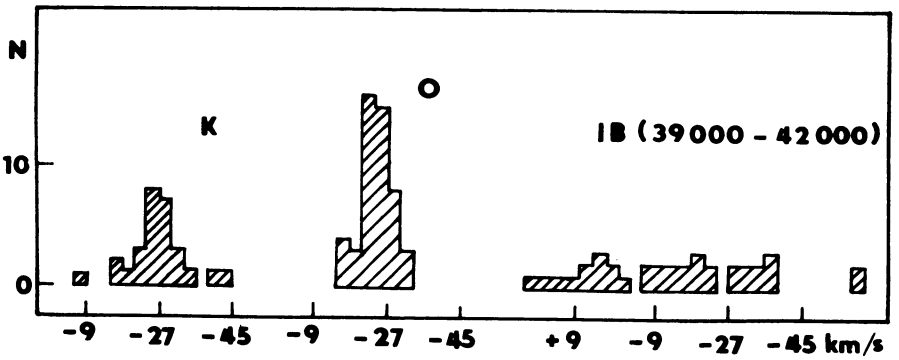

Figure 1. Frequency distribution of the RV of o And (see Table 1).

densed into 29 points, each representing the mean over intervals 50 - 100 days. A search for periods in the range 5 to 140 years was then made. The least squares solution gave the following elements: P=25.9 years, e=0.41, ω=60°, K=9.4 km/s, γ=-21.6 km/s. Fig. 2 gives the phase diagram. The result is close to the period reported by Fracassini et al.(1977), even though they used different material (files B, W, IA, IB).

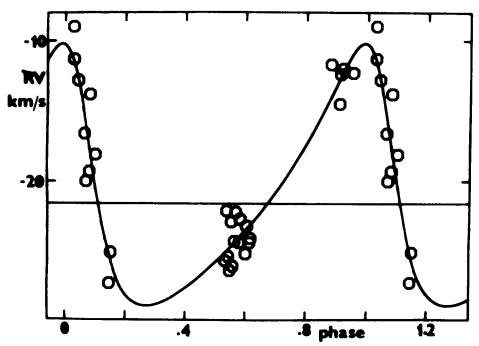

Figure 2. RV curve of o And.

A search for periods in the range 0.5 to 1000 days was made for velocities of files O and G. With the exception of two quasi-periodicities 3.5 and 1.2 d the search was unsuccessful.

We have analysed 879 UBV measurements of o And and 201 points in the instrumental system. Details are given in Table 2. It is clear that long-term variations are present in the data (see Fig. 3). There are also short-term changes but their amplitude is not constant. This complicated behaviour of the photometric data causes that any

Table 2: Sources of photometry for o And.

No. of obs.	Type	Dates of obs.	Reference
201	Inst.	1956 - 1958	Schmidt (1959)
3	UBV	1964	Johnson et al. (1966)
253	UBV	1966	Olsen (1972)
270	UBV	1975 - 1979	this paper, Hvar
161	UBV	1975 - 1979	Bossi et al. (1980)
192	UBV	1976 - 1977	Padalia (1979)

https://doi.org/10.1017/S0074180900037992 Published online by Cambridge University Press

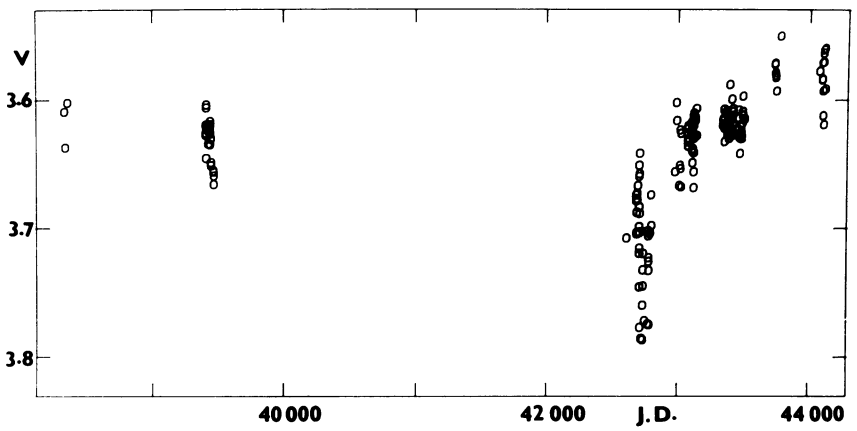

Figure 3. V magnitude versus time for o And.

attempt to find simple period must fail. When the data were segmented it was possible to disclose periods in several segments but we were unable to find any period common to all segments.

The only positive result of the analysis of radial velocities is the 25.9 year period. But the coverage is not good and one should look for reliable RV in the time of expected minima. All shorter periods found in the data are not convincing and it is necessary to analyse data from at least two shell events. It was not possible to detect the period of about 1.5 days in good RV measurements from the last shell episode.

No short-term period was found in the UBV data even after removal of long-term variation. However, it seems that there is a correlation between amplitude of short-term changes and the shell activity.

REFERENCES

Bossi,M.,Guerrero,G.,Mantegazza,L.,and Scardia,M.: 1980,Astrophys. Space Sci.
Fracassini,M.,Pasinetti,L.E.,and Pastori,L.: 1977,Astrophys. Space Sci. 49, 145
Galeotti,P.,and Pasinetti,L.E.: 1968, Rend. Acc. Naz. Lincei 45, 39
Gulliver,A.F., and Bolton,C.T.: 1978, Publ. Astron. Soc. Pacific 90, 732
Harper,W.E.: 1915, Report to the Chief Astronomer for 1911, Ottawa, p. 154
Johnson,H.L.,Mitchell,R.I.,Iriarte,B.,and Wiśniewski,W.Z.: 1966, Comm. LPL 4, 99
Olsen,E.H.: 1972, Astron. Astrophys. 20, 167
Padalia,T.D.: 1979, private communication
Schmidt,H.: 1959, Z. Astrophys. 48, 249
Tremblot, F.: 1938, Bull. astron. 11, 401

DISCUSSION

Harmanec: It should be made clear that the only possible real period in RV we believe is the 25.9 year period. As three independent groups of observers confirmed this star to be a speckle-interferometric binary, it is quite reasonable to believe in such a long period.

Fracassini: I wish to point out that the orbital elements you have found are quite near to those found by us, with our method and measurements, with a period of 30 years. The mass function value found by you is near to the particular case with $i \approx 90^{\circ}$ and $M_1 = M_2$. Therefore, it should be possible (and very interesting to observe some eclipsing phenomena.

Mantegazza: Looking at the large gap in the R.V. data phased with the 26 years period, I think that there may be a large number of periods that can equally well phase the data. (The PDM method tends to overestimate the long periods when the data distribution contains large gaps.)
I have also tried to analyze the several sets of photometric data existing in the literature in the search for short-term periodicities. My conclusions are the following: It doesn't exist any clear periodicity, or, if it exists, it is hidden by some types of stellar and/or shell noise. The only thing that can be told is that the variations have a time scale around one day. I believe that the existing sets of data are inadequate for an accurate study of such variations. In fact, if you generate a synthetic pseudo-periodic random time series and if you sample it with the times of the real observations, from this analysis you obtain the same inconclusive results as with the real observational data.

Koubsky: The 26 year period is a result of a period search in the range 5-140 years, using programs developed by Morbey.
Both, the mean variance and significance were far the best for this period. On the other hand, the fit for the period derived by Fracassini et al. (24 years) was much worse.

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