PHOTOELECTRIC ACTIVITY OF THE SHELL STAR *o* And: NEW OBSERVATIONS AND DISCUSSION

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(Received 14 March, 1980)

Abstract. Photoelectric observations of the shell star *o* And, obtained in 1979, are presented. The star shows variations of some hundredth of magnitudes during a few hours. The trend to retake the values of the luminosity and colour indices prior to the reduction happened between JD 42,714–27, seems to continue. We also give a qualitative model which explains satisfactorily the main features observed after the 1975 shell episode.

1. The Observations

The light variability of the shell-type star *o* And, despite many observations collected from the beginning of the century, is not to this date satisfactorily understood. In fact, the hypothesis of a close pair, advanced by some authors (see Fracassini *et al.*, 1977), has not been confirmed; and, on the other hand, it is not clear enough which mechanisms inside the shell or the star are able to explain the observed behaviour.

For these reasons, we observed *o* And photometrically at the Merate observatory beginning in 1975 (1975, 1976, 1977 observations are published in Bossi *et al.*, 1977, and Guerrero and Mantegazza, 1979).

In this note we report the measurements made in 1979. Table I shows the *U*, *B* and *V* values of the normal points and Figure 1 the light curve related to JD 44,107, in which *o* And has been observed for about five hours.

First we can emphasize, at least for the observations of JD 44,107, a variation of about $0^{\text{m}}.05$ in the three colours; whilst Padalia (1978), according to his measurements obtained during the period October 1976–December 1977, did not find any kind of activity. This fact is also shown by the nightly variation of the normal points which we can derive by Table I. At last we can see in Figure 1 that the colour indices do not show any sensible variation during the whole night.

If we now consider the averages of the normal points for each night in the *B* colour (the bars indicate in magnitude the range covered during the period of the observations; no bar points refer to the nights in which the observations were of short duration), and the same for the colour indices (*U–B*) and (*B–V*), we obtain Figure 2, which represents the bringing up to date of Figure 2 given in Guerrero and Mantegazza, 1979. From this figure we can draw the conclusion that *o* And, after the light minimum which took place between JD 42,714–27 seems to become stable assuming the values preceding that minimum.

Astrophysics and Space Science **72** (1980) 433–437. 0004–640X/80/0722–0433$00.75

TABLE I

Hel. JD 2444 . . .	ΔV	σ	Hel. JD 2444 . . .	ΔB	σ	Hel. JD 2444 . . .	ΔU	σ
107.404	1.485	0.007	107.416	1.657	0.003	107.428	2.244	0.003
.409	1.490	0.004	.421	1.659	0.003	.433	2.241	0.003
.440	1.493	0.003	.453	1.663	0.007	.470	2.257	0.003
.445	1.479	0.007	.459	1.671	0.002	.509	2.279	0.002
.482	1.503	0.004	.503	1.694	0.002	.540	2.274	0.004
.488	1.502	0.006	.523	1.688	0.002	.556	2.243	0.012
.516	1.521	0.002	.545	1.694	0.005	.582	2.266	0.005
.536	1.517	0.005	.575	1.675	0.002	.605	2.260	0.003
.567	1.506	0.002	.598	1.674	0.002	113.477	2.237	0.005
.591	1.497	0.002	113.460	1.660	0.002	123.306	2.268	0.003
113.444	1.490	0.003	.466	1.656	0.002	.335	2.273	0.001
.452	1.484	0.002	114.379	1.657	0.002	.362	2.262	0.003
114.371	1.485	0.002	123.298	1.687	0.002			
123.290	1.516	0.003	.325	1.684	0.003			
.316	1.511	0.004	.352	1.679	0.003			
.343	1.508	0.002						

2. Discussion

What follows is an attempt to explain the light behaviour of o And beginning from the shell episode which happened on July 1975 (Koubsky, 1975) and is shown in Figure 2.

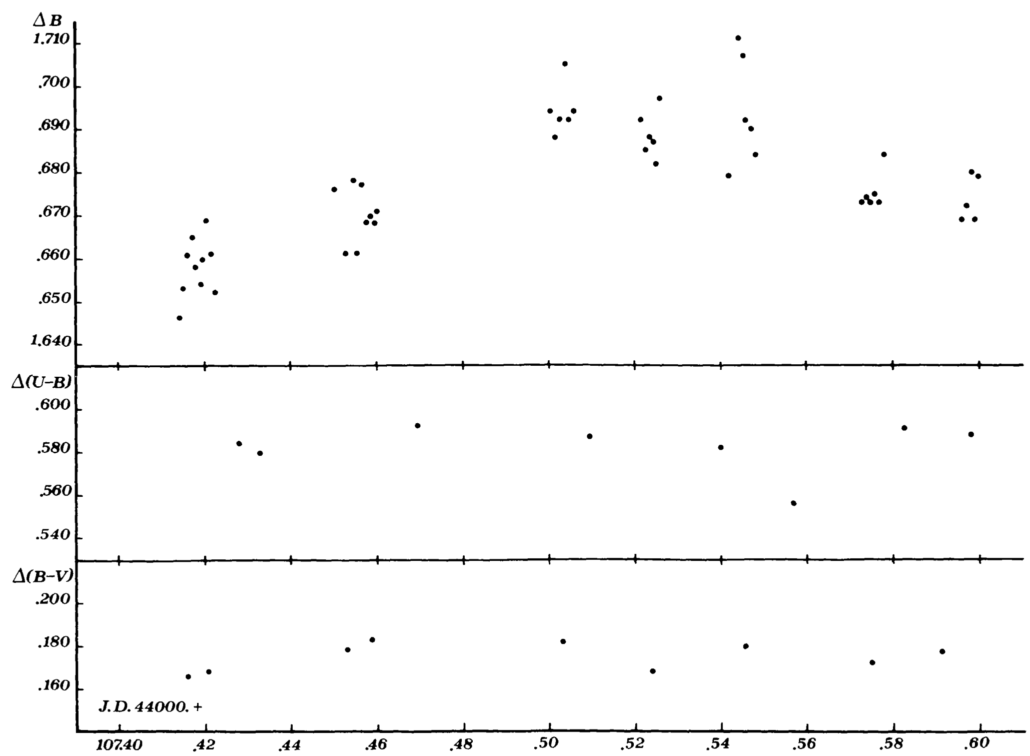

Fig. 1

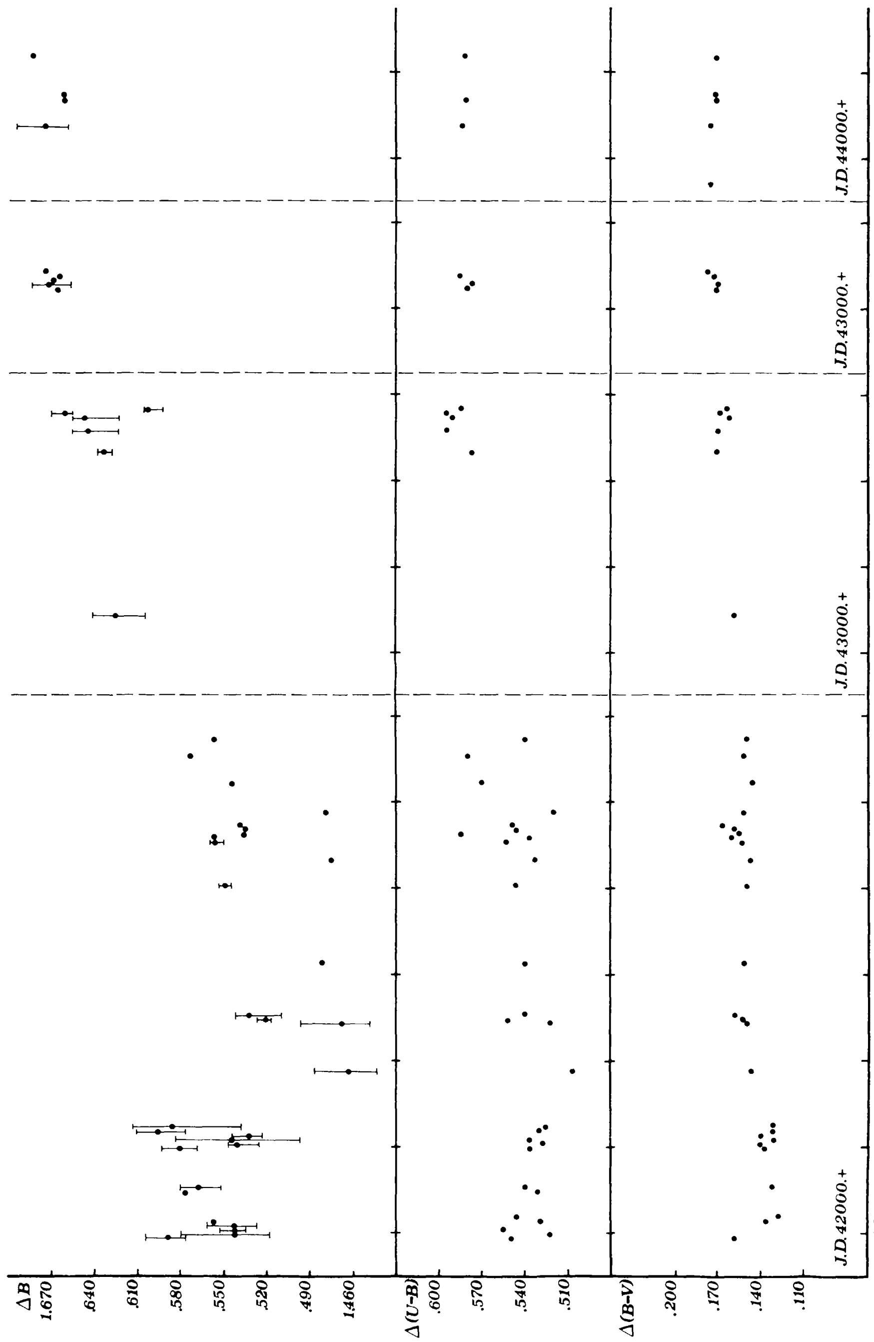
ΔB
1.670
.640
.610
.580
.550
.520
.490
1.460
Δ(U-B)
.600
.570
.540
.510
Δ(B-V)
.200
.170
.140
.110
J.D.42000.+
J.D.43000.+
J.D.43000.+
J.D.44000.+
690
710
730
750
770
790
810
80
100
110
130
490
510
100
120

Fig. 2

The presence of the light minimum is not surprising: the shell's optical thickness can grow while new matter is going out; then, following the subsequent expansion, it begins to decrease. The trend of the colour indices to assume more negative values is due to the fact that the star looks reddened in the presence of the envelope: as this envelope vanishes, the colour indices tend to take the previous values.

A very rough model in which the mass of the shell, supposed to be spherical, grows according to the equation

$$m = M(1 - e^{-r^2/2R^2}),$$

where r is the difference, depending on the time, between the radius of the envelope and the one of the star, can give a good qualitative picture of these phenomena. Even considering the shell like a black-body which absorbs radiation from the star and gives it out at different temperatures, we obtain the light and $(B\text{–}V)$ colour index curves, depending on the shell radius, in good agreement with the observational data. This fact is shown in Figure 3, assuming $R = 17.5R_*$, where R_* is the stellar radius.

In this schematic model only the initial reddening is overestimated. We consider the envelope in equilibrium, neglecting the thermal capacity, and we also assume the radiation absorption due to opacity as the only heating mechanism. In this way the shell looks colder, and therefore redder, than what it really is.

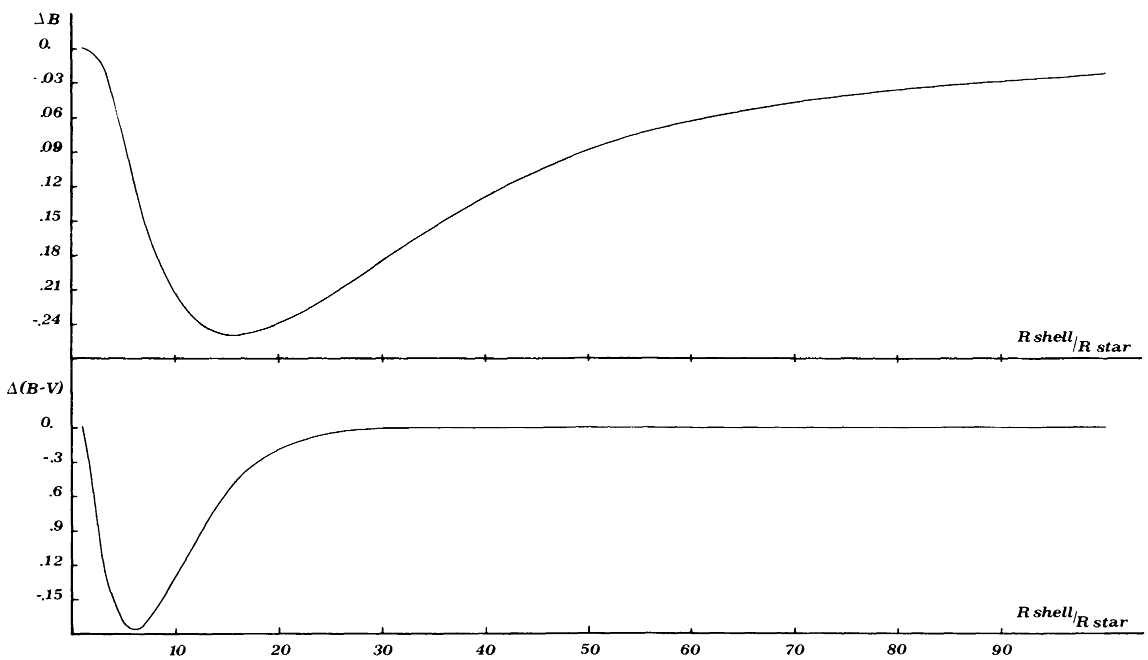

Fig. 3

References

Bossi, M., Guerrero, G. and Mantegazza, L.: 1977, *Astron. Astrophys. Suppl.* **29**, 327.
Fracassini, M., Pasinetti, L. and Pastori, L.: 1977, *Astrophys. Space Sci.* **49**, 145.
Guerrero, G. and Mantegazza, L.: 1979, *Astron. Astrophys. Suppl.* **36**, 471.
Koubsky, P.: 1975, *IAU Circ.* No. 2802.
Padalia, T. D.: 1978, *Infor. Bull. Var. Stars* No. 1477.