o And PHOTOMETRY, POLARIMETRY AND A TENTATIVE MODEL OF THE LIGHT VARIABILITY

P.Harmanec[1], K.Oláh[6], H.Božić[2], P.Hadrava[1], J.Horn[1], P.Koubský[1], S.Kříž[1], N.H.Minikunov[3], M.Muminović[4], J.R.Percy[5], A.G.Skcherbakov[3], M.Stupar[4], A.E.Tarasov[3]

1) Astronomical Institute, Czechoslovak Academy of Sciences, 251 65 Ondřejov, Czechoslovakia

2) Hvar Observatory, Faculty of Geodesy, University of Zagreb, 58450 Hvar, Yugoslavia

3) Crimean Astrophysical Observatory, Nauchnyj, Crimea, 334413 U.S.S.R.

4) Universitetsko Astronomsko Društvo, M.Tita 44, 71000 Sarajevo, Yugoslavia

5) Department of Astronomy, University of Toronto, Toronto, Ontario, M5S 1A1 Canada

6) Konkoly Observatory, Hungarian Academy of Sciences, Box 67, 1525 Budapest XII, Hungary

Basic information about the star

o And (HR 8762, HD 217675-6) is a bright ($V=3.55^m$, $B-V=-0.11^m$ $U-B=-0.50^m$) B6 III-Ve star. Its emission-line and shell spectrum is known to come and go on a time scale of years. In fact, the presence of a strong shell spectrum misled the authors of the HD catalogue to assign the star two HD numbers.

o And is a prototype of Be rapid light variables in the sense that it has the longest record of photoelectric monitoring which goes back to 1915! The long history of attempts to understand the variations of this star has recently been summarized by Harmanec (1983). Collecting and analyzing all historical photoelectric observations, Harmanec (1984) concluded that the light variations of o And can be understood as a superposition of a long-term cyclic (8.5^y) variation with an amplitude over 0.1^m (the star being faintest at the recorded shell maxima) and a rapid periodic variation with a period of 1.571272 days.

Our observational data

Systematic UBV observation of the star has continued intensively in recent years as a part of the on-going Be star observing campaign (see the Be Star Newsletters). Here, we shall deal with the V band observations from the 1983 to 1985 observing seasons. The 1983 data have been obtained during the minicampaign reported here by Stagg. The 1984 data are from the Hvar and KPNO observatories, the 1985 data come from the Automatic Photoelectric Telescope at Phoenix, from Hvar and Sarajevo. Remarkable variations of the amplitude and shape of the light curve were observed, even during one season (see Fig.1). Additionally, UBVRI polarimetric data have also been obtained at the Crimea Observatory

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Fig. 1 V band light curves of o And in 1983-85

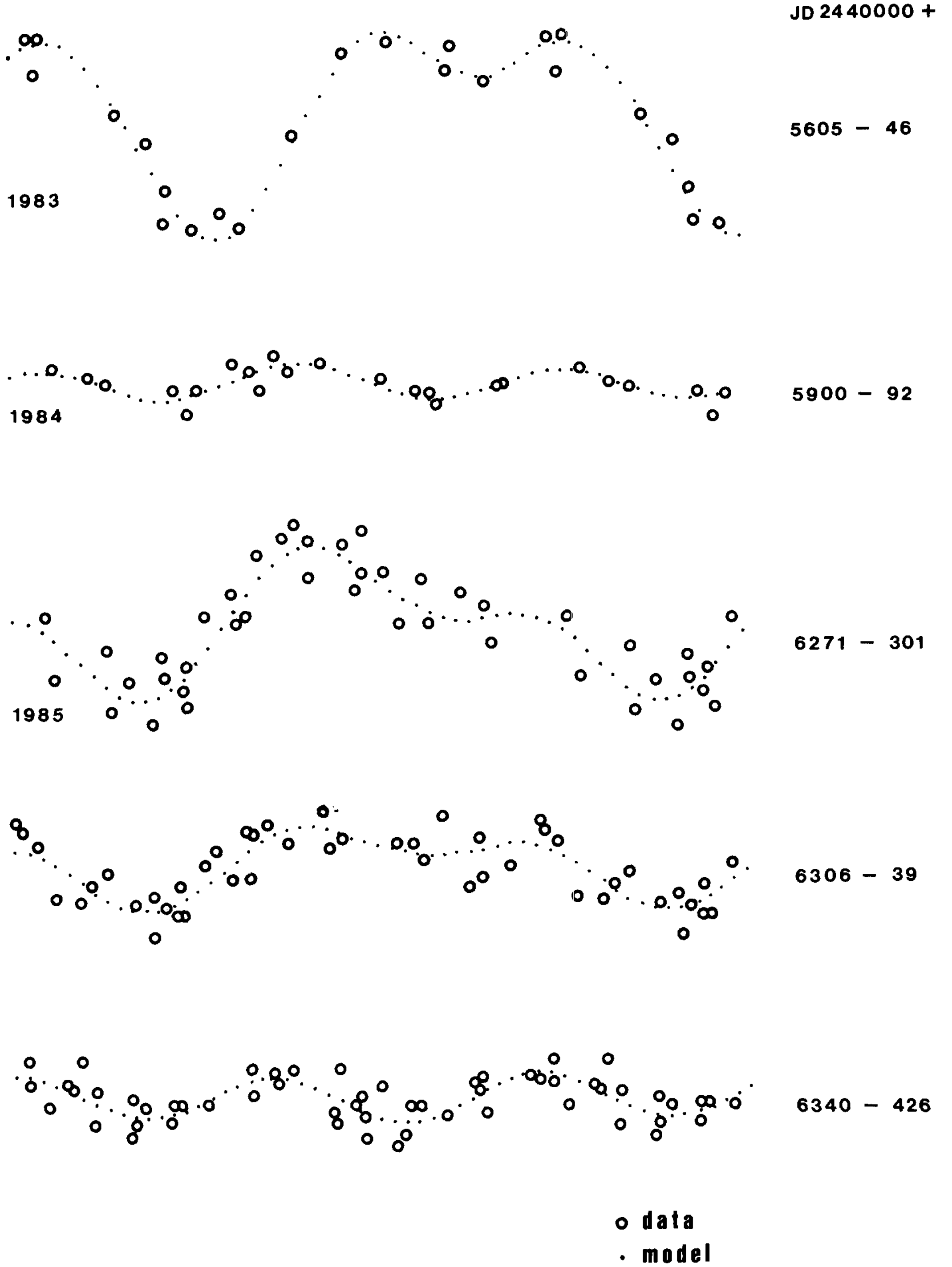

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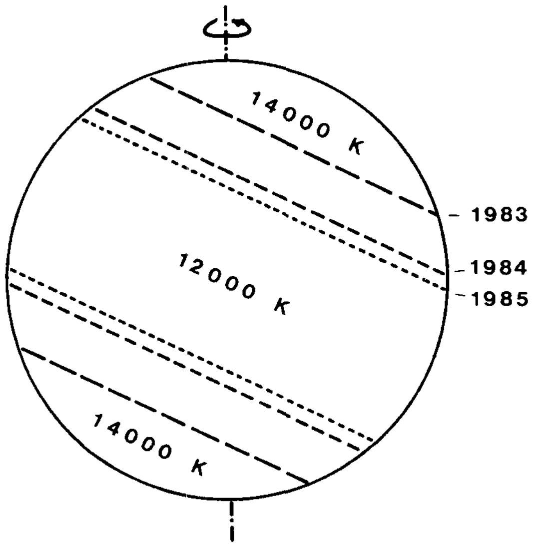
Fig. 2 A schematic model of the light variations observed



in 1985. They indicate a drop of polarization in U and B bands at the same time as the decrease of the amplitude of the light variations.

The first attempt at modelling

We attempted to model the light curves by the star-spot model using the computer programs developed by one of us (K.O.). The best consistent fit was obtained for a model of two nearly identical "hot spots" symetrically placed on the opposite sides of the star and for inclination of the rotation axis of 8o^{o} (see Fig.2).

Our preliminary results certainly do not represent the only possible representation of the photometric data displayed and some other models should also be confronted with them before far reaching conclusions are derived. Colour, radial-velocity, and line-profile variations will also provide us with additional constraints of possible classes of the models.

With these reservations in mind, one can proceed to the following tentative physical interpretation of the above modelling. There seems to be a belt of a cooler material around the star, which is tilted with respect to the stellar rotation equator and which corotates with the star. The belt was much wider in 1983 when the shell and the H I emission lines in the optical spectrum were observed than in 1984-85 when an essentially normal B absorption spectrum was seen. An attempt at detecting the presence and variations of a possible magnetic field along the 1.57-day period is strongly encouraged by us.

Reference list

Harmanec, P. (1983). Hvar Obs. Bull. 7, 55.
Harmanec, P. (1984). Inf. Bull. Var. Stars #2506.

DISCUSSION FOLLOWING HARMANEC

Smith, M.A.:

For as short a period as 1.57 days for o And it is reasonable to assume that it is synchronously rotating and that its rotational and orbital axes are coaligned. If one computes the inferred stellar radius the usual way, via P(rot) = 50 Rsini/(vsini), one derives R > 8 solar radii. That is what is demanded for a rotational modulation model. I think 8 solar radii is a bit large for a B6 III star.

Cassinelli:

Is this star like σ Ori E in any way, e.g. is it a chemically peculiar star?

Harmanec:

The geometry seems to be similar.

Bolton:

The evidence is strong that the chemical composition is not peculiar.

Harmanec:

I agree.

Baade:

Again all that we know about Be stars is that they rotate rapidly and one should expect these systems to be roughly symmetric with respect to the equator. Don't you feel concern about the symmetry-breaking properties of the model you presented?

Harmanec:

Yes it is puzzling, but Tom Bolton and his collaborators also found it for σ Ori E. The present modeling does not take into account the continuous radiation of the belt (if it should coincide with the Be envelope). We intend to correct for it in the final version, so I cannot say at present what the effect will be. Anyway, you cannot produce light variations with this geometry unless the belt is filled with respect to the rotation equator.

Smith, M.A.:

I will point out that Penrod has examined line profile variations of this star in his thesis - he finds the same period that you do. He ascribes it to an l=2 nonradial pulsation mode. I have modeled the line width variations in his data and find that the profile variations are primarily caused by temperature variations, just as you do from photometry. My amplitude is 1100 K, close to your value. I believe Don would agree with this conclusion, but all inquiries should be directed to him to get the story straight.

Important correction to my earlier comment. Penrod's period from line profile variations is one-half of the value given by Harmanec.

Harmanec:

Thank you for the comment. In fact, also the modeling of the UV line profiles indicate temperatures close to 12000 K. I believe there is a good chance to arrive at a consistent model of o And.