THE ULTRAVIOLET SPECTRAL ENERGY DISTRIBUTION OF THE MAGNETIC Ap STAR HD 170000 INSIDE AND OUTSIDE OF THE SPOTS

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ABSTRACT: Sixty five TD-1 scans of the magnetic silicon star HD 170000 have been investigated using the method for lightcurves analysis proposed by Hempelmann and Schöneich. The fluxes originating in two spots and in the rest surface of the star have been separated. The conclusion is that the whole stellar surface is strongly peculiar. Spot 1 is a region with the same peculiarity as the rest surface, but strengthened, whereas spot 2 shows additional peculiarities with respect to spot 1 and the rest surface.

Introduction. The magnetic CP stars are rotational variables. The properties of the variability of the peculiar spectral lines and of the brightness indicate that the peculiarity is correlated with peculiar regions on the star. But it is not clear until now, what are the properties of the stellar surface outside of such spots, which is not seen directly. The method for rotational lightcurve analysis proposed by Hempelmann and Schöneich (this conference) permits to separate the flux originating in the spots from that of the rest stellar surface. We will present here the results of the application of this method to the spectral flux variations of the magnetic Ap star HD 170000 in the ultraviolet.

Observational data. The used ephemeris of HD 170000:

$$JD(U_{max}) = 2442229.40 + 1.71646 \text{ days} \cdot E$$

was taken from MUSIELOK et al. (1980).

For the spectrophotometric investigation we used 65 scans obtained by the ultraviolet Sky-Survey -Telescope on TD-1A which were kindly extracted by Dr. Jamar from the Liege magnetic tapes. The observations are presented as lightcurves in Fig. 1.

In order to reduce the number of parameters to be obtained from TD-1 scans the geometric parameters of the model assumed as wavelength independent have been obtained

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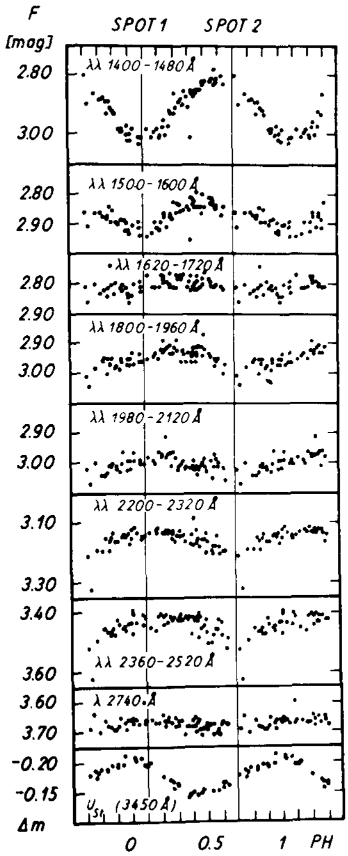

Fig. 1.
TD-1 lightcurves of
HD 170000

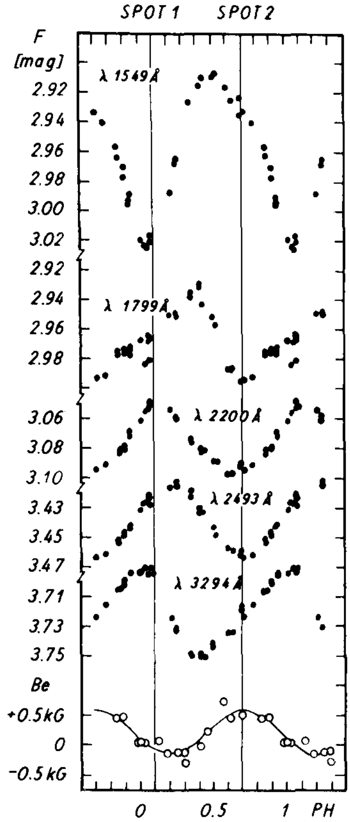

Fig. 2.
ANS lightcurves of
HD 170000

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from 29 photometric observations from ANS (kindly placed at our disposal by Dr. Wesselius) and from the ten colour photometry (MUSIELOK et al.,1980). The U lightcurve (ten colour photometry) is shown in the bottom of Fig.1. Fig.2 shows the ANS lightcurves of HD 170000 and includes the magnetic field curve from LANDSTREET, BORRA (1977). The transformation from fluxes to magnitudes was carried out using the relation:

$$m = -2.5 \, \mathrm{Log} F - 21.1 \quad .$$

<u>Results of the model computation</u>. The shape of the curves at different wavelengths suggests a two spots model. This assumption has been confirmed by the computations. The used method permits to obtain the stellar longitudes ϑ and polar distances β of the centres of the spots. The spots have been assumed to be circular and to have a uniform brightnees distribution. The radii R of the two spots, the fluxs from the unspotted surface Io and the flux densities from the spots,provided that the angle between the line of the sight and the rotation axis i and the limb darkening coefficient u are known, can also be obtained.

Period and lines width suggest $i \approx 90°$ for HD 170000. The assumed value was $i = 84°$. For $\lambda > 2000$ Å u has been taken from AL NAIMIY (1978) and for $\lambda < 2000$ Å $u = 0.9$ has been assumed. Because it is impossible to obtain β for the spots, if $i \approx 90°$, an equator symmetric model ($\beta = 90°$) has been adopted.

The differences between the parameters of the mean geometric models obtained from the different photometric observational sets (ANS , TD-1, 10 colour) are small and do not influence qualitatively the final results. We accepted the mean geometrical model from the ANS observations, given by the following parameters:

spot 1	$\vartheta_1 = 36°$	$\beta_1 = 90°$	$R_1 = 70°$
spot 2	$\vartheta_2 = 251°$	$\beta_2 = 90°$	$R_2 = 80°$.

The vertical lines in Fig.1 and 2 illustrate the phase positions of the spots.

These parameters were used in the analysis of TD-1 scans. The fluxes of the two spots and of the rest surface were separated and plotted with 20 Å wavelength steps in Fig.3. The upper part of Fig.3 shows the spectral energy distribution of the "unspotted" star HD 170000, of spot 1 (star with the spectrum of spot 1), and of the comparison star HD 207971 (selected by JAMAR et al.,1978) fitted at λ 2740 Å. In the lower part of Fig.3 the comparison of the "unspotted" star and of spot 2 is given.

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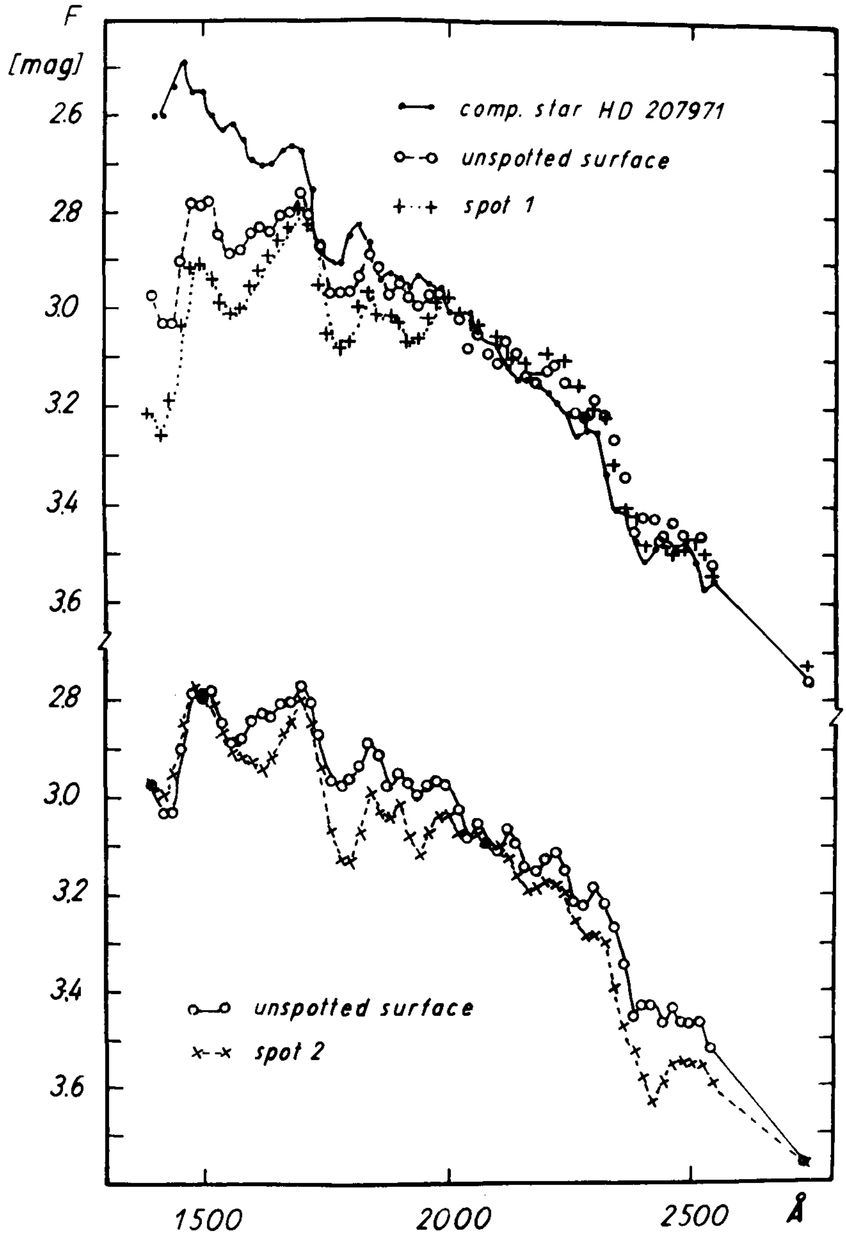

Fig.3. The spectral energy distribution of the unspotted star HD 170000 in comparison with those of spot 1 and the normal star HD 207971 (upper part) and with spot 2 (lower part).

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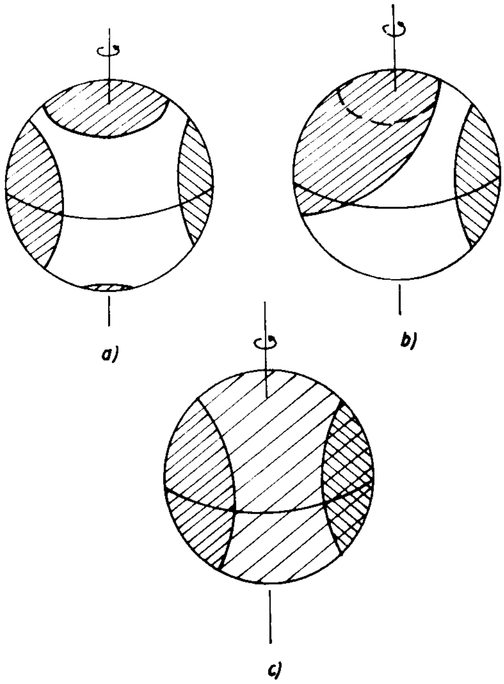

Fig.4. Schemes of the discussed models.

Discussions of the results

1) The spectral contrast distribution of the two spots (brightness relative to the unspotted surface) is quite different (Fig. 3). Spot 1 shows two spectral absorption features at λ 1420 Å and λ 1560 Å superposed by continuous darkening beginning at λ 1700 Å and a triple feature between λ 1740 Å and λ 2000 Å. The spot 2 spectrum shows a dark feature at λ 1600 Å, the same triple feature between λ 1740 Å and λ 2000 Å as spot 1, and a broad dark feature centred on λ 2400 Å. Possible sources of opacities in the UV spectrum of HD 170000 have been discussed by JAMAR (1977,1978).

2) The comparison with HD 207971 shows that the unspotted surface of HD 170000 is quite peculiar. Its spectral energy distribution is strongly correlated with that of spot 1.

3) The interpretation is clear for the accepted model. But this model is the simplest one of all possible models which are able to explain the observations. In fact, the variable part of the flux is related to rotational nonsymmetric structures, whereas rotational symmetric structures give a contribution to the constant part of the flux.
We will discuss together with the assumed model two other possible models (Fig.4).

a) The star has additional polar caps or belts with the spectral properties of spot 1. To produce the observed spectral energy distribution they must cover about 66% of the stellar disk. That is impossible because the diameter of spot 1 is about 70°.

b) The spot includes the rotation pole. Such a model fits the observations somewhat worse than the equator symmetric one, but still lies in the error range. However, this model can slightly decrease but not eliminate the peculiarity of the rest surface.

c) The most probable interpretation seems to be that HD 170000 is a star with a peculiar atmosphere. Spot 1 is a region with the same peculiarity as the rest surface, but strengthened. Spot 2 correlated with the positive magnetic pole (see Fig.2) has additional peculiarities with respect to spot 1 and the rest surface.

Although the analysis was carried out till now only for one star, the results indicate, that the simple conception often used (peculiar spots on the surface of a normal star) should be replaced by a more complex one.

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