POLARIZATION MEASUREMENTS IN THE LINE OF Fe XIV 530.3 nm DURING THE TOTAL SOLAR ECLIPSE ON JUNE 21, 2001

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ИЗМЕРЕНИЯ ПОЛЯРИЗАЦИИ ЛИНИИ Fe XIV 530.3 нм ВО ВРЕМЯ ПОЛНОГО СОЛНЕЧНОГО ЗАТМЕНИЯ 21 ИЮНЯ 2001 г., Пинтер Т., Рыбански М. – Выполнены измерения степени и направления поляризации коронарной линии поглощения 530.3 нм во время полного солнечного затмения 21 июня 2001 г. Для наблюдений были использованы 180/1700-мм телескоп, узкополосный фильтр для линии 530.3 нм, поляризационный фильтр в трех позициях и камера. Степень поляризации составляла 0 – 0.24, а направления поляризации были преимущественно радиальные.

The measurements of the degree and the direction of polarization of the 530.3 nm coronal emission line during the total solar eclipse on June 21, 2001 are described. We used for observation a telescope of 180/1700 mm, a narrow-band filter for the line of 530.3 nm, a polarizing filter in three positions, and a photographic camera. The degree of polarization was between 0 and 0.24 and the directions of polarization were mostly radial.

INTRODUCTION

The majority of the scientific community, engaged in the research of the solar corona, is convinced that motions in the corona are conditioned and controlled by an interaction of the magnetic field and the plasma. There is a problem of the interpretation of observations because it is very difficult to determine the size and the direction of the magnetic induction in the corona. The measurement of the linear polarization in some coronal emission lines provides a possibility at least to estimate the direction of polarization [5]. According to some theoretical works (see, *e.g.*, [2]), the degree of polarization should be largest for the lines of Fe XIII and Ca XV ions. Unfortunately, the Ca XV lines occur sporadically during periods of enhanced solar activity, and Fe XIII lines are outside the visual spectrum and, for their detection, a better technical equipment would be needed, usually not available to us. The most of eclipse measurements of the polarization are used the brightest emission coronal line, the 530.3 nm of Fe XIV. Theoretically, according to the paper cited the degree of polarization might reach the value of 40 % in this investigation. We could then determine quite reliably the direction of the polarizing plane, which determines the direction of magnetic lines of force as well.

The results of measurements carried out so far are controversial. The latest and most complete of uncertainties was described by Badalyan [1].

An attempt to determine the polarization in the green corona during the total solar eclipse on June 21, 2001, using a photographic method and preliminary results of the measurements of images is described in this contribution.

THE SITE, INSTRUMENTS AND OBSERVATION

The observational site was located in the area of the Petrol Institute near the city of Sumbe in Angola. The geographical coordinates were $11^\circ\, 07'\, 29''$ S and $13^\circ\, 55'\, 52''$ E. The second and the third contacts occurred at $12^h\, 36^m\, 34^s$ UT and $12^h\, 41^m\, 10^s$ UT, respectively. An objective with D/F of 120/1500 mm connected with a camera PENTACON SIX 6×6 cm was used for observation. Images were photographed on the film ILFORD HPS PLUS. Thermostated filter for the line of 530.3 nm with $FWHM$ of 0.15 nm and a polarizing filter with an option to adjust the polarizing plane in three positions with a gap of 60° was mounted in front of the camera. Fig. 1 shows the characteristics of the filter.

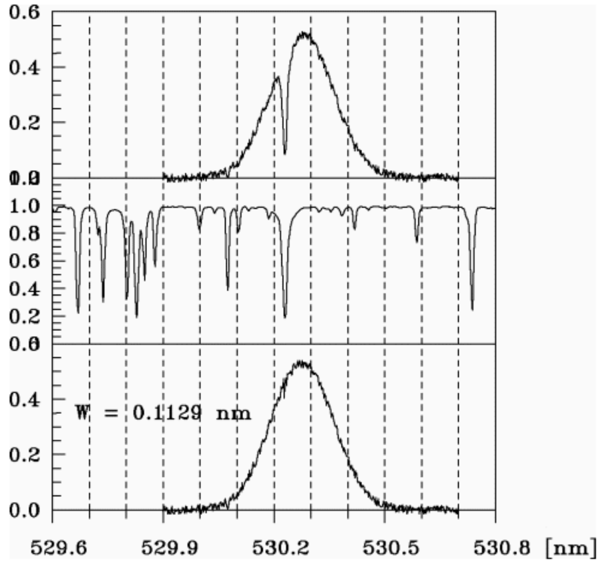

Figure 1. Characteristics of the narrow-band filter

The polarizing filter was tested using a polarizing analyzer. We succeeded in performing three non-complete series of images with the exposure time of 10 s for each position of the filter. The calibration was done to the centre of the solar disc using a neutral filter and an aperture diaphragm with various diameters. The technical breakdown of the eyepiece part of the telescope immediately before the eclipse made it impossible to focus the camera precisely. That is why the pictures obtained have a limited resolution. According to our estimation it is $30''$ and, therefore, an adequate measuring slit was used in the photometry of the film.

MEASUREMENT AND CALCULATION METHODS

The frames obtained were measured using a self-recording digital microphotometer. The width of the measuring slit was 3×10 mm, which by a twenty-fold magnification, corresponds to 0.15×0.5 mm on the film. The gradation curve was constructed according to [6] using an equation in the form: $I = a(T_0/T - 1)^{1/3}$, where T_0 is the transmittance at non-exposed position of the film and T is transmittance at the measured position. The constant a equals of 3.024 and the intensities I are estimated in millionths of the intensity of the centre of the solar disc in the corresponding position in the spectrum.

Fig. 2 contains resultant intensities, reduced by a contribution of K + F corona.

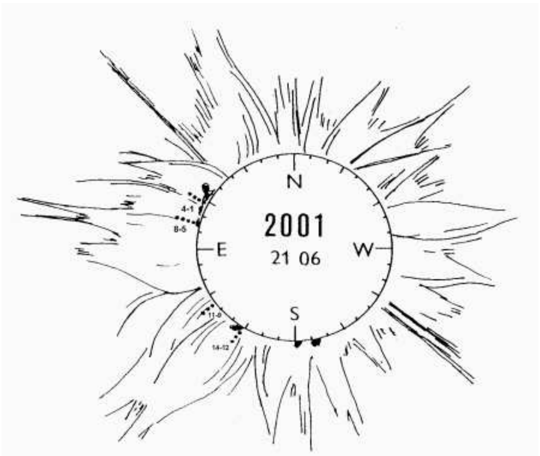

Figure 2. Structure of the solar corona on June 21, 2001

The results of measurement of polarization in the selected points. Here ρ is a distance from the centre of the solar disc; φ is a positional angle where the polarization was measured; I_{K+F} means the intensity of the white-light corona; I_1, I_2 and I_3 are intensities of the corona in three positions of the polarizing filter; I is a sum of these intensities; p[%] is the degree of polarization and $\varphi\ p_{max}$ is a positional angle where the polarization was maximal

N	ρ	φ	I_{K+F}	I_1	I_2	I_3	I	p, %	$\varphi\ p_{max}$
1	1.074	62.4°	1.40	7.0	11.3	14.7	33.0	41	331.5°
2	1.124	62.5	0.55	11.3	11.0	13.4	35.8	13	296.3
3	1.152	62.8	0.25	9.6	12.7	12.0	34.3	16	351.4
4	1.247	61.5	0.13	8.3	8.3	6.1	22.6	20	303.7
5	1.107	73.5	0.15	9.4	13.8	13.0	36.3	23	349.8
6	1.127	73.6	0.81	12.7	13.4	13.0	39.1	3	0.9
7	1.155	73.6	0.55	11.3	12.0	12.3	35.6	5	334.9
8	1.214	73.7	1.40	10.4	11.3	8.9	30.7	14	271.1
9	1.118	126.9	0.40	6.5	7.2	5.5	19.2	15	267.1
10	1.159	126.6	0.15	6.3	6.5	5.2	18.0	14	296.2
11	1.198	125.7	0.12	5.8	3.4	2.4	11.5	53	336.4
12	1.125	148.3	0.32	6.2	6.5	7.5	20.2	12	316.9
13	1.154	148.2	0.41	5.3	7.0	6.5	18.8	16	353.1
14	1.192	148.3	0.10	3.3	4.3	4.3	11.9	17	345.0

The intensities of the K + F corona were obtained from the photographic photometry of another experiment. In the process of reduction, the polarization of this component of the coronal emission according to tables of [3] for the corresponding inclination of the polarizing plane of the filter was considered. The direction of the polarization of the K corona are assumed to be tangential, F corona contributing to the total intensity as it follows from the tables [3], the radiation being non-polarized. Consequently, we only calculate pure radiation of the emission corona of 530.3 nm. The data were averaged before calculation of the degree and the direction of polarization so as to have only one value for a square of $30'' \times 30''$. The polarization was estimated only for the intensities exceeding the value of $3 \cdot 10^{-7}$ of the intensity of the centre of the solar disc, because, according to [4], the accuracy of the estimation of the polarization depends on the photometric precision and the respective value is a limit for reliability. The degree of polarization was determined according to the formula:

$$p = 2\frac{\sqrt{(I_1 - I_2)I_1 + (I_2 - I_3)I_2 + (I_3 - I_1)I_3}}{I_1 + I_2 + I_3}, \qquad (1)$$

and the direction of the polarizing plane according to the formula:

$$\tan 2\alpha = \sqrt{3}\frac{I_2 - I_1}{2I_1 - I_2 - I_3}. \qquad (2)$$

The results listed in Table show that the degree of polarization varies between 3 and 53%.

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