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Polarization and intensity studies of the August 11, 1999 solar corona

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Abstract. Four series of coronal images have been obtained by the expedition of Abastumani Astrophysical Observatory during the August 11, 1999 total solar eclipse with the help of the photographic mirror-lens polarimeter (D=150 mm, F=1000 mm). Each series includes three images corresponding to three positions of the polarization analyzer. The position of the solar disk center relative to the Moon's center has been determined beforehand. In addition, the background skylight polarization and intensity are calculated. All measurements are absolute given in units of the sun's average surface brightness. Equatorial electron densities and temperatures are determined. Our data are compared with previous absolute measurements.

During the August 11, 1999 total solar eclipse eight research experiments were carried out by the joint Georgian-Turkish expedition in Turkey (Turhal). Along with the electropolarimetry of the white corona, a special interest was paid to photographic polarization as well. The basic parameters of this eclipse for Turhal are given in paper (Kulijanishvili et al. 1999) together with detailed information on the apparatus, photographic material and exposures. The present paper contains treatment data on the August 11, 1999 solar eclipse polarization performed with the portable photographic polarimeter of an original construction. The values of intensity in terms of calibration observational data are expressed in absolute units i.e., in those equal to 10-8-th part of the solar disk total surface brightness B. For reference of the intensity relative values to absolute ones, Saito's F-corona model (Saito 1970) was used together with direct measurements of the solar disk calibration photographs. The photographic material was treated by the assemblies of instruments consisting of a microphotometer MF-4, an original measuring electronic unit and a computer IBM PC. For filing as well as for a subsequent treatment of the values a special software in the TURBO PASCAL 7 language was developed.

Using the original method the value of the total intensity of the instrument scattered light and the sky background I_{A+S} is estimated. At eclipse observations this is rather a complicated experimental task due to weak brightness. Besides, the linear dependence for fixed distances from the solar disk center between the values of $I(\Theta)$ and $Q'K(\Theta)$, where $Q'K(\Theta) = P_K K(\Theta)$, enables to determine the intensity value $F + I_{A+S}$ graphically over all the position angles. Intensity I_{A+S} was evaluated from $F + I_{A+S}$. At 1.6 R (where R is solar radius) it appeared to be $5.0{\cdot}10^{-9}$ B.

The techniques for separating the contribution of the F- and K-coronas have been extensively discussed in the literature (van de Hulst 1950, Ney et al. 1961) and not be repeated. The intensity of the K+F, K, and F components of the equatorial corona were estimated and compared with the intensity of the K+F polar corona. The equatorial region is defined as $40^0 - 140^0$ and $220^0 - 320^0$ from the north pole of the sun following the analysis of von Kluber (1958). The separation of the F and K components was not carried out over the polar regions since the calculation depends on symmetry of the corona which is obviously not the case at polarlatitudes.

r	$N_e(r)$	$K+F$	K	F	$N_e(r)$
1.1	132 10^6	45.8 10^{-8}	132.9 10^{-8}	13.0 10^{-8}	160 10^6
1.2	58	94.8	83.0	11.9	70.8
1.3	31	67.0	56,0	10.9	37.6
1.4	18.4	49.4	39.6	9.8	-
1.5	12.2	38.2	29.1	9.1	14.8
1.6	7.8	29.4	21.2	8.2	-
1.7	5.9	23.1	15.7	7.4	7.1
1.8	3.8	18.5	11.8	6.7	-
1.9	2.3	15.6	9.2	6.4	-
2.0	2.0	13.7	7.5	6.2	2.8

Table 1.

The values of electron densities Ne(r), polarization degree P and the intensities of K+F, K and F-coronas, expressed in the absolute unites for the equatorial regions ($40^0 - 140^0$ and $220^0 - 320^0$) of the August 11, 1999 solar corona, are given in Table 1.

In the last column of Table 1 the values of Ne(r) for the equatorial regions at maximum phase of the solar corona according to van de Hulst (1950) model are also presented for comparison. As we can see from Table 1 our values of the electron densities are slightly lower than theoretical ones in van de Hulst's model. This disagreement in the values proves that the "premaximum" type of the August 11, 1999 solar corona was less bright than the "maximum" phase corona in the van de Hulst's model.

As for the temperature in the mid coronal layers (1.1 R-2.0 R) it turned out that in the same equatorial regions the model of hydrostatic distribution of the density with T=const is not quite accurate for the August 11, 1999 corona and there is a temperature gradient in this area. For $r_1 = 1.3$R and $r_2 = 1.8$R $T_1 = 1.25{\cdot}10^6$ K and $T_2 = 1.07{\cdot}10^6$ K respectively. These findings are in a good agreement with those of other researchers. In particular, it should be noted that a non-hydrostatic equilibrium behavior in the mid-corona layers was as well marked in paper (Ney, et al. 1961) giving the temperature gradient of $6{\cdot}10^5$ K/R. By our estimations a proper value for the August 11, 1999 corona is $4{\cdot}10^5$ K/R.

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References

Hulst, H.C. 1950 *Bull. Astron. Inst. Neth.* **11**, 135.

Kluber, H. 1958 *M.N.*, **118**, 201.

Kulijanishvili, V. I., Ambartsumian, An. A., Borchkhadze, T. M., Goderidze, E. K., Javakhishvili, G. Sh., Japiashvili,V. P., Ozkan, M. T., Esenoglu, H. H., Kara, M., Saygac, T. 1999 *Nat. Astr. Meeting in Sol. Ph., Moscow, Troitsk,* **399**, L15–L18.

Ney, E.P., Huch, W.F., Kellogg, P. J., Stein,W. and Giellet, F. 1961 *ApJ*, **133**, 616.

Saito, K. 1970 *Ann. Tokyo Astron. Obs.*, **12**, 53.