

1999 SOLAR ECLIPSE CORONA IN POLARIZED WHITE LIGHT Preliminary Results

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ABSTRACT

This paper deals with the preliminary results of August 11, 1999 white-light polarization observations carried out in Turkey (Turhal). The corona was photographed in three positions of the polaroid differing by 60° , and the twelve pictures were obtained. All the films are analyzed by means of image processing technique. After coronal holes are identified in Solar Geophysical Data and from the corona observations, distributions of polarization degree and brightness in these holes are obtained and the results are discussed.

1. INTRODUCTION

The solar corona is hot and diluted plasma above the solar atmosphere which extends very far from the sun. Its light is very faint relative to the visible disk of the Sun within one solar diameter from the visible disk. The sky brightness exceeds that of corona by 3 to 5 orders of magnitude. Therefore exception of solar eclipses, the corona is normally invisible. In spite of many space based observations, total solar eclipses provide unique conditions for a study of the solar corona. The structure of the solar corona is not only interesting but it also plays an important part in the physics of solar-terrestrial relationships.

The last total solar eclipse of the millenium occurred shortly before the cycle maximum 23 on the date of 11 August 1999 were observed in two different sites in Turkey. Istanbul University Observatory Research and Application Center organized a detailed site inspection with the collaboration of V. Kulijanishvili from Georgian Academy of Sciences. Total twelve experiments in Turhal (district of Tokat) and in Elaz were performed with the collaboration of Turkish and Georgian observation teams.

One of the experiments made in Turhal town is related to white-light corona observations. As it is well known, the basic knowledge on the structure of the solar corona comes from photographs taken in white-light at total solar eclipses. In this paper, we present some results obtained from coronal holes.

2. THE OBSERVATIONS

2.1. Observing Conditions

In this section the detailed data on the observing site and the eclipse are given. The geographic coordinates of the observing site at Turhal town were

Longitude: $36^\circ 06' E$

Latitude: $40^\circ 24' N$

Altitude: 493 meters above the sea level.

The following data of the eclipse are valid for this site

Beginning of totality: $11^h 28^m 29^s UT$

End of totality: $11^h 30^m 44^s UT$

Duration of totality: $2^m 15^s UT$

Ratio of semi-diameters of the apparent sun and moon : 1.028

Position angle of second contact: 109° from celestial N to E

Position angle of third contact: 294° from celestial N to E

Width of the totality: 112 km

Distance of the site from the central line: 16.9 km

Altitude of the eclipsed sun: 64° to 42°

Positions of the north pole of the sun's rotation axis:

$P = + 14.53$ from the celestial north to east

$B_o = + 6.42$ in front of the celestial plane

2.2. White-Light Corona Observations

The observations were performed by the expedition of Istanbul University Observatory Research and Application Center under very good weather conditions. A telescope with the objective ($D = 13$ cm, $F = 150$ cm) on parallactic mount was used to observe the polarization the white-light corona. The telescope was equipped with a camera of 6×6 cm and a polaroid of 45 mm diameter installed in front of it. The film Kodak T-max was used. The corona was photographed in three positions of the polaroid differing by 60° , and the four sets of pictures were obtained with different exposure times. Detailed exposures times are given in Table 1.

Table 1. A list of exposures times

No of frame	Angles of polarization analyzer	Exposure time (in second)
1	0	1/60
2	60	1/60
3	120	1/60
4	120	1/15
5	60	1/15
6	0	1/15
7	0	$\frac{1}{4}$
8	60	$\frac{1}{4}$
9	120	$\frac{1}{4}$
10	120	$\frac{1}{2}$
11	60	$\frac{1}{2}$
12	0	$\frac{1}{2}$

3. REDUCTIONS OF THE OBSERVATIONS

Figure 1. represent relative positions of the centers of the apparent sun and moon in the course of totality phase. The sun's center is fixed in the figure while the moon center moves on a straight line through point of second contact and point of third contact. Numbers 1,2,3,...12 on the line of the moon center indicate the relative positions of the moon center when the exposures were given.. This diagram was used in the course of data reduction to shift the coordinate origin from the moon center to the sun's one.

The reduction of the films was carried out using PDS scanning isodensitograph in Institute of Astronomy, Bulgarian Academy of Sciences. The scanning was made by 20 micron steps. The matrices of densities, consisting of 2100×2100 pixels, were recorded. In the next step, we performed some calibration in order to establish the characteristic curve of the emulsion, i.e. the relation between the recorded densities and the logarithm of the intensity which produced it. In this way using the fit equation of the characteristic curve, the complete set of densities were converted to relative intensity

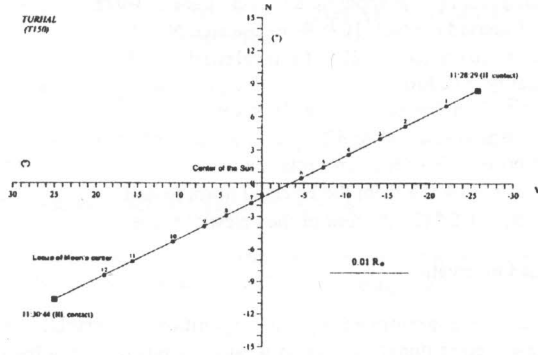


Figure 1. The apparent locus of the moon's center relative to the sun's center around totality.

Simultaneous analysis of the three polaroid components provide us with values of polarization degree and brightness in the two coronal holes in every measured pixel on the images by the use of the equations of Billings (1966).

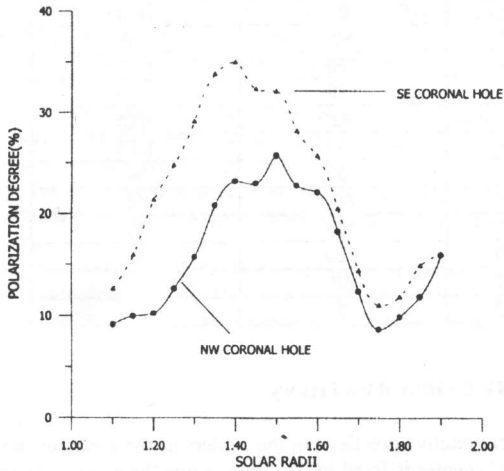


Figure 2. Comparison of the polarization degrees inside NW and SE coronal holes.

4. THE RESULTS

The positions and contours of coronal holes, derived from the Kitt Peak $\lambda 10830$ spectroheliograms and from the Sacramento Peak Fe XIV synoptic charts can be seen from the Preliminary Report and Forecast of Solar Geophysical Data and from the Solar-Geophysical Data Promt Reports. We determined two extremely large holes from these charts. The first hole of negative polarity in 15 degrees latitude zone at position angle 315° is near to the north-west limb, the second one of positive polarity in 25 degrees latitude zone at position angle 115° is located on the south-east quadrant. The distributions of polarization degrees corresponding to these holes are shown Figure 2. In Figure 3 we plot the brightness distributions in the coronal holes as a function of solar radii. For $r = 1.1$ up to $r = 1.9 R_\odot$ the intensity inside the NW hole is reduced by a factor 3.1×10^5 , compared with the intensity in the SE hole. The reason for this is that since this hole are located on the disk, we can not see it during the eclipse and instead of it we observe the scattered corona light.

On the other hand, the NW CH seems to be a quite remarkable feature at this time of the solar cycle. Rusin and Rybansky (1985) and Rusin and Markova (1994) observed a large CH during February 16, 1980 and July 22, 1990 eclipses around the cycle maxima. Our maximum brightness value of 1.25×10^{-6} found in the NW CH is in good agreement with the integral brightness value of 1.32×10^{-6} obtained from 1980 eclipse. Our study evidently confirms that the basic peculiarities seen in the polarization of this hole are in general good agreement the previous investigations (Dürst, 1976; Badalyan, Livshits and Sykora, 1997).

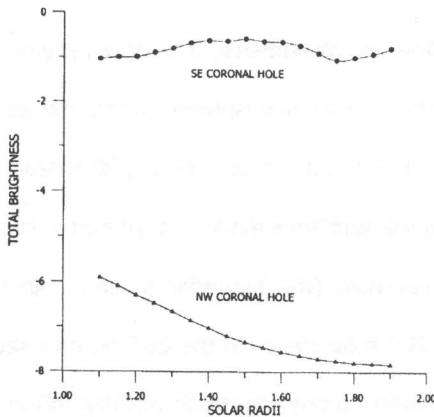


Figure 3. Mean radial distributions of the brightness for the two CH.

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