THE STRUCTURE OF THE WHITE-LIGHT CORONA AT THE 1991 ECLIPSE

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Abstract. The total solar eclipse of July 11, 1991 was observed from "La Matanza", Baja California Sur, México, only 5 km south of the center line of totality, with several small instruments intended to obtain images of the corona during totality, and using a range of exposure times which allowed us to detect both the inner and outer corona. Relations between large and fine scale structures of the corona, the photospheric and chromospheric activity, and the presence of coronal holes are presented.

Key words: eclipses – Sun: corona

1. Observations

As one of several projects of our team to observe the total solar eclipse of July 11, 1991, we obtained a sequence of photographic images of the corona, on Ektachrome 100 emulsion, and using a Schmidt-Cassegrain telescope of 125 mm aperture and f/10, and a 135-mm camera with a 200-mm telephoto lens. We obtained a sequence of pictures with exposures ranging from 1/1000 to 1/4 s with the telescope, and from 1/500 to 2 s with the camera. The longest exposures were made at the center of totality. Seventy images were obtained in the 6m 49s of totality.

The shorter exposures gave images of the smaller streamers. The longer exposures provide images of the maximum extension of the larger streamers and contain information on the presence of fine structure in the corona.

2. Analysis of Data

With resolutions of about 15 arcsec for the telescope images, and 5 arcmin for the camera images, it was possible to identify 48 coronal streamers. Figure 1 shows the identified streamers; ten of these were identified in both sets of pictures and were classified with a letter, while the streamers resolved only in the images taken with the telescope were classified with consecutive numbers.

Three parameters were measured for each streamer in every image: position-angle, inclination-angle, and extension. The position-angle was determined from

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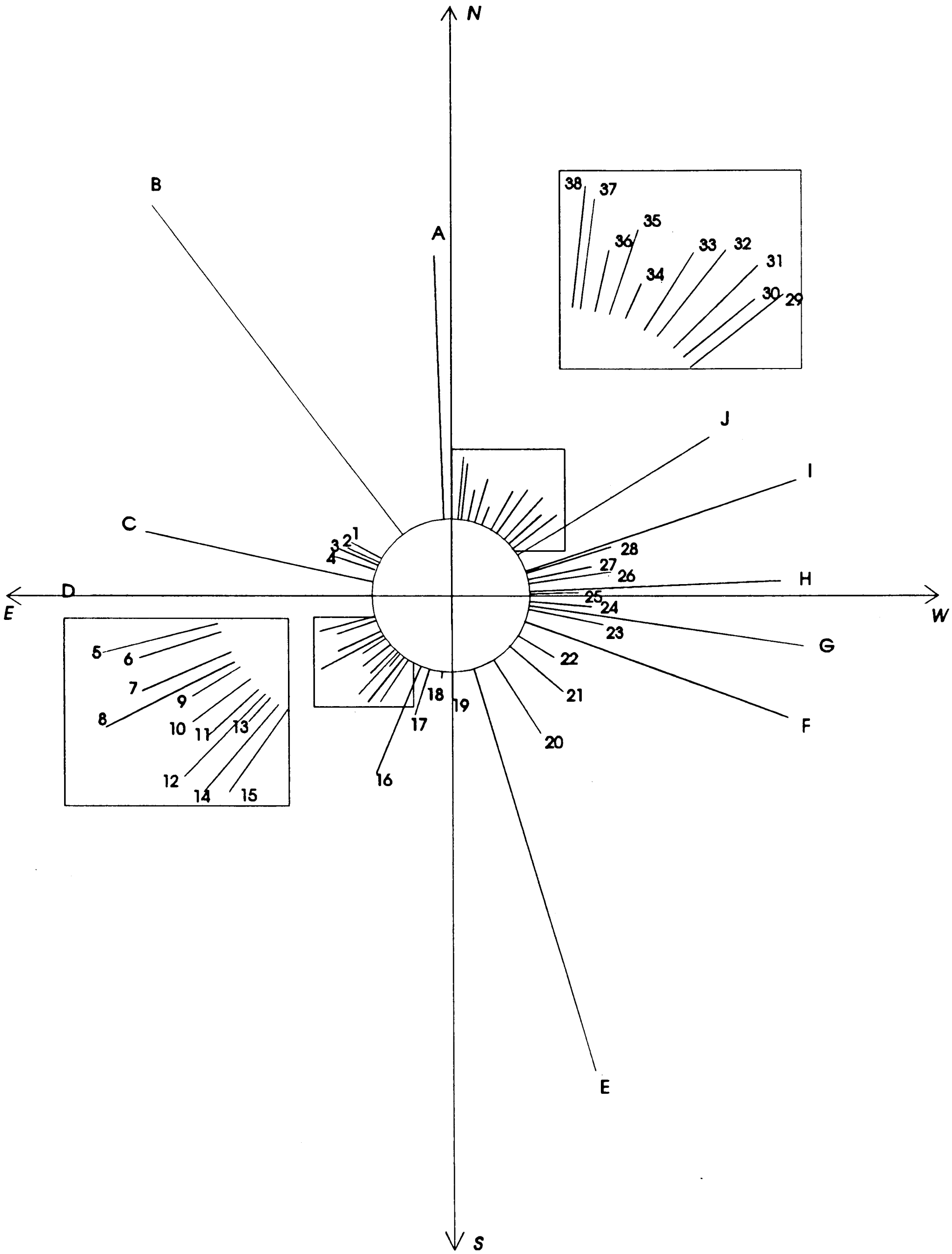

Fig. 1. Streamers identified at the total solar eclipse of July 11 1991, with maximum extension.

the north solar pole in the eastward direction. The angle was measured at the mid-point of the streamer base on the lunar limb. The inclination angle was measured from the normal to the position angle, and the extension is measured in $R_{\odot}$.

For comparison with the coronal streamers observed during the eclipse, the solar activity was reviewed on visible and Hα observations made by ourselves both one Carrington Rotation before and after the eclipse. In addition, the Solar Geophysical Data tabulations were used to check the large-scale magnetic fields, and He I 10830 Å data from the National Solar Observatory-Kitt Peak for coronal-hole activity.

The main problem was to infer the activity present on the solar hemisphere which is not visible from the earth. The persistence of sunspot groups and Hα features was noted from daily observations spanning the three Carrington rotations. However some uncertainty exists in the possible disappearance of active regions or the emergence of ephemeral regions (ER). Based on this persistence, and the activity present in the visible hemisphere, we selected 16 solar features as possible sources of the coronal streamers.

To study the relationships, a radial vector was extended from the center of the solar disk to the limb, passing through the source selected in accordance with its position at the time of the eclipse. The position angle of the vector was also measured from 0 to 360 degrees in an eastward direction from the north solar pole.

Comparing the position angles projected from the sources with the position angles of the streamers, it was possible to relate fourteen of the 48 streamers with fifteen of the 16 sources selected. These are listed in Table I with their identification, position angles, and maximum extension in $R_{\odot}$. The sources were identified with a roman number.

3. Discussion and Conclusion

Streamer B, one of the most prominent during the eclipse, was not related with any special solar feature. We consider as a possible explanation the drift of sectors of different magnetic polarity near to the north solar pole – the first north polar coronal hole that appeared after the reversal of polarity of cycle 22 (which occurred during 1990) was in development there (Sanchez-Ibarra and Barraza-Paredes, 1992). Streamer B in fact consisted of two streamers superposed, and streamer A was at the limit of the north polar coronal hole, perhaps having the same origin as streamer B.

The other streamers could be related with ephemeral regions and the large-scale magnetic field of the photosphere.

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TABLE I
Identified Streamers and their Relation to the Sources

Streamer	PA Degrees	Max. Extension (L)	Source
A	1.90	3.40	
B	36.73	5.36	
1	61.13	0.46	I
3	67.30	0.56	II
4	71.17	0.53	II
C	77.57	3.00	
D	91.03	3.60	
6	109.30	0.50	III
7	116.00	0.67	IV
18	173.50	0.06	V
E	196.42	5.36	VI
22	242.10	1.16	VII
F	249.88	3.64	VII
G	261.61	3.60	
H	272.34	3.24	
26	278.80	1.08	VIII
27	281.90	0.85	IX
28	287.50	1.14	X
I	288.60	3.76	XI
J	301.78	2.88	XII
29	308.00	0.73	XIII

Listed below is the identification of each source with the NOAA/USAF number if it was a sunspot group; with a position angle if a prominence; and with its Carrington heliographic coordinates at the meridian passage if a filament. The sources were:

Source I. 6685; region with moderate activity that was in the invisible hemisphere.

Source II. λ=N15°, L=95°; filament present in a quiet region.

Source III. 6686,6729; two regions in a sector with moderate activity.

Source IV. 6728; another sunspot group in the sector of 6729.

Source V. PA=171°; small quiet prominence visible the day of the eclipse.

Source VI. PA=196/199 ; a prominence with two peaks. Not defined as one or two prominences.

Source VII. PA=240°; small quiet prominence.

Source VIII. PA=279°; the west big prominence called "seahorse".

Source IX. 6714; small sunspot group in a region with high activity one rotation before the eclipse date.

Source X. 6709; sunspot group in the same region of 6714.

Source XI. 6711; sunspot group in the same region of 6714.

Source XII. 6701; sunspot group disappeared but active region persisted.

Source XIII. λ=N35° L=308°; filament associated with region 6701.

References

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Solar-Geophysical Data: 1991, NOAA World Data Center A for Solar-Terrestrial Physics.