

ΠΡΑΚΤΙΚΑ ΤΗΣ ΑΚΑΔΗΜΙΑΣ ΑΘΗΝΩΝ

πρακτικά της ακαδημίας από την επίσημη συνέδριο που διεξήχθη στην Αθήνα την περίοδο Ιούνιος - Ιούλιος 1978. Τα πρακτικά περιλαμβάνουν τα έργα που παρουσιάστηκαν στη συνέδριο που διεξήχθη στην Αθήνα την περίοδο Ιούνιος - Ιούλιος 1978.

ΣΥΝΕΔΡΙΑ ΤΗΣ 30^{ΗΣ} ΝΟΕΜΒΡΙΟΥ 1978

ΠΡΟΕΔΡΙΑ ΜΙΧΑΗΛ ΣΤΑΣΙΝΟΠΟΥΛΟΥ

ΑΣΤΡΟΝΟΜΙΑ.— **Study of the Inner Corona During the Solar Eclipse of June 30, 1973, by C. J. Macris and Th. G. Zachariadis***.

*Ανεκοινώθη ὑπὸ τοῦ Ἀκαδημαϊκοῦ κ. Ι. Ξανθάκη.

A B S T R A C T

In this paper we give the isophotes of the solar corona during the total eclipse of June 30, 1973. The material that we have used was obtained from the airplane Concorde at 18 km height. The study of 36 pictures taken during 1 h and 12 m did not reveal any variation in the inner corona.

1. INTRODUCTION

The total solar eclipse of June 30, 1973, of 7 minutes and 8 seconds duration, was one of the longest eclipses of the 20th century.

The total phase started with the sunrise in Guiana went north, crossed the Atlantic ocean to Mauritania, then down to Nigeria, Chad, Sudan, Kenya to end with the sunset north-east to Madagascar.

One of the programs of the «Institut d' Astrophysique de Paris» under the supervision of Dr. Koutchmy, was to take pictures of solar corona in white light (electronic corona) from the Concorde 001 super-

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sonic airplane at great heights of the terrestrial atmosphere. The purpose of the program was to take continuous pictures with a camera chamber equipped with an objective lens of satisfactory resolving power in order to study the variations of the corona during the observation which lasted for 1 hour and 12 minutes. The duration of ground observation of the eclipses is short and therefore it is difficult to observe changes in the corona.

The Concorde took off from the Canarian islands reached a height of 18 km and moved with a speed of 2 Mach remaining always in the shadow of the moon. It is the first time in the history of Astronomy that solar corona has been photographed for 72 minutes. The details of that program were published by S. Koutchmy (1975).

2. OBSERVATIONAL MATERIAL

For this study we used photographic material of the solar corona taken with the camera chamber $f = 3.000$ mm which had been installed in the concorde. The pictures were being taken every 2 minutes on Royal X pan 2000 ASA film with 1/60 sec exposure time. The 36 pictures of the inner corona taken in white light were calibrated photometrically. The above material was kindly offered to the R.C.A.A.M. by Dr. S. Koutchmy in accordance to the cooperation of the two institutes.

3. ELABORATION OF MATERIAL

The Fig. 1, taken at 11 h and 53 m while the plane was on the central line of the eclipse, was chosen for the photometric study. This study was attempted in order to determine the isophotes of the inner corona and was based on tracings taken across the diameters of the solar disk, starting with the N-S direction and rotating the film 5° for each tracing. The tracings were taken with the JOYCE - LOEBL microphotometer whose slit was 2×2 mm, which corresponded to 0.1×0.1 mm on the picture, and magnification 5.

On these tracings we measured, in solar radii, from center of the solar disk and for the various angles, the distances at which the intensity remains constant. Table 1 gives the above measurements which have

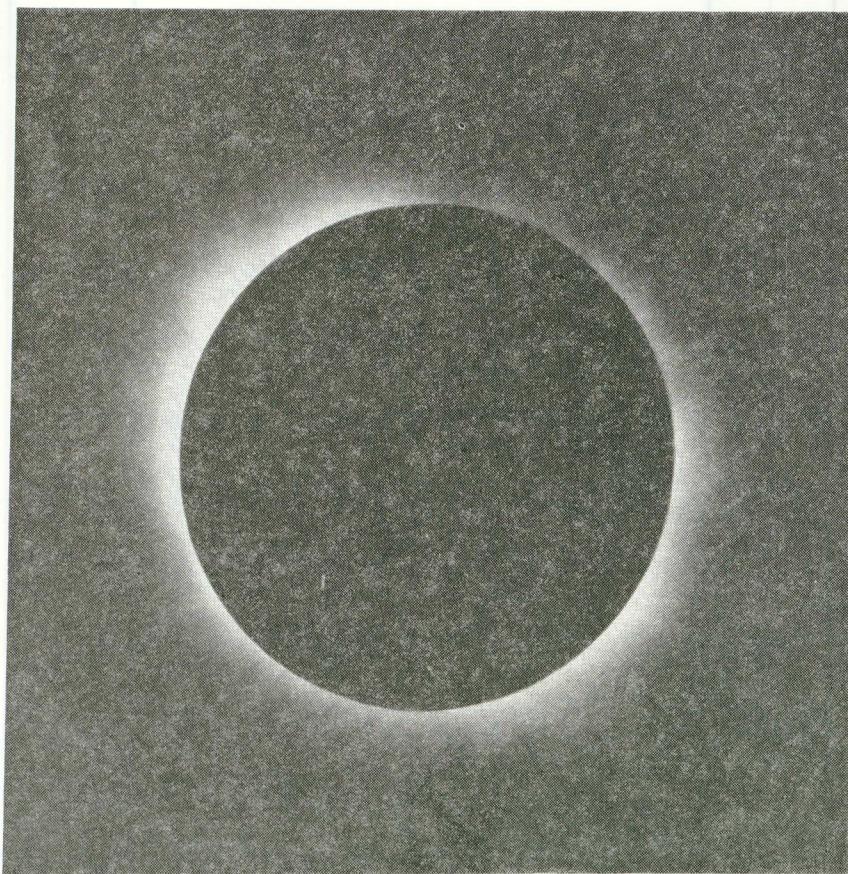


Fig. 1. Photograph of the white inner corona during the eclipse of June 30, 1973.

been used for the drawing of the isophotes of fig. 2. We also measured the log I in certain distances every 0,05 of the solar radius from the limb of the sun to $1.85 R_{\odot}$ of its center. Table 2 gives the above measurements with which we draw figure 4. Table 1 has also been used for the drawing of figure 3.

TABLE 1

Height above the solar limb in solar radii of selected coronal isophotes for individual position angles.

Position angle	Log I							
	4.0	3.9	3.8	3.7	3.6	3.5	3.4	3.3
0								
5	1.10	1.13	1.16	1.20	1.23	1.28	1.32	1.36
10	1.08	1.13	1.16	1.18	1.22	1.26	1.32	1.37
15	1.09	1.13	1.16	1.20	1.24	1.28	1.33	1.37
20								
25	1.11	1.14	1.18	1.21	1.25	1.31	1.35	1.40
30	1.10	1.14	1.18	1.23	1.26	1.31	1.36	1.41
35								
40	1.10	1.13	1.16	1.20	1.25	1.29	1.34	1.39
45	1.12	1.15	1.18	1.21	1.26	1.30	1.35	1.40
50	1.12	1.17	1.20	1.25	1.31	1.33	1.37	1.43
55	1.10	1.13	1.17	1.21	1.27	1.31	1.35	1.41
60	1.10	1.13	1.16	1.22	1.28	1.32	1.39	1.44
65	1.10	1.14	1.17	1.22	1.28	1.34	1.41	1.49
70	1.10	1.16	1.20	1.24	1.30	1.35	1.46	1.52
75	1.11	1.15	1.18	1.22	1.25	1.29	1.35	1.44
80	1.08	1.11	1.14	1.16	1.20	1.24	1.29	1.34
85	1.09	1.11	1.18	1.21	1.26	1.30	1.36	1.41

Tableau 1 (continued)

Position angle	Log I																
	4.0	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.4
90																	
95	1.10	1.12	1.15	1.19	1.25	1.29	1.35	1.41	1.46	1.55	1.60	1.67	1.75				
100	1.12	1.16	1.19	1.25	1.31	1.37	1.44	1.50	1.57	1.64	1.68	1.75					
105	1.09	1.12	1.15	1.19	1.23	1.30	1.36	1.44	1.51	1.57	1.63	1.69	1.74				
110	1.09	1.12	1.15	1.19	1.24	1.31	1.36	1.45	1.51	1.58	1.64	1.68	1.75				
115	1.11	1.15	1.18	1.23	1.29	1.34	1.40	1.48	1.54	1.61	1.66	1.72					
120	1.11	1.14	1.17	1.22	1.27	1.33	1.39	1.46	1.52	1.58	1.62	1.65					
125	1.10	1.13	1.16	1.21	1.27	1.32	1.36	1.43	1.48	1.53	1.62	1.67	1.71				
130	1.10	1.13	1.16	1.21	1.25	1.29	1.35	1.40	1.44	1.49	1.54	1.57					
135	1.09	1.12	1.16	1.19	1.23	1.27	1.30	1.34	1.37	1.43	1.49	1.54	1.57				
140	1.11	1.13	1.16	1.19	1.22	1.25	1.29	1.32	1.37	1.41	1.46						
145		1.11	1.14	1.17	1.21	1.26	1.30	1.35	1.40	1.45	1.49						
150		1.12	1.15	1.19	1.24	1.29	1.34	1.37	1.43	1.49	1.53						
155		1.11	1.15	1.19	1.22	1.24	1.30	1.35	1.40	1.45	1.52	1.55					
160		1.10	1.12	1.15	1.18	1.23	1.27	1.31	1.36	1.41	1.46	1.51	1.54				
165		1.09	1.13	1.15	1.19	1.23	1.29	1.32	1.38	1.44	1.47	1.51	1.57				
170		1.10	1.12	1.15	1.18	1.23	1.28	1.32	1.36	1.42	1.48	1.54	1.58				
175		1.12	1.14	1.18	1.22	1.26	1.32	1.37	1.42	1.47	1.51	1.61					

Tableau 1 (continued)

Position angle	Log I									
	4.0	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1
180	1.10	1.12	1.15	1.19	1.23	1.27	1.32	1.36	1.42	1.49
185	1.10	1.12	1.14	1.17	1.22	1.27	1.31	1.38	1.44	1.51
190	1.11	1.14	1.17	1.21	1.27	1.32	1.37	1.44	1.51	1.57
195	1.10	1.12	1.14	1.17	1.22	1.27	1.32	1.38	1.44	1.52
200		1.12	1.14	1.17	1.21	1.28	1.33	1.39	1.45	1.52
205	1.10	1.13	1.16	1.19	1.24	1.29	1.34	1.40	1.47	1.55
210	1.09	1.11	1.13	1.17	1.20	1.25	1.30	1.36	1.43	1.49
215	1.11	1.13	1.15	1.18	1.22	1.27	1.31	1.36	1.43	1.49
220	1.10	1.12	1.14	1.16	1.20	1.24	1.29	1.35	1.40	1.46
225	1.09	1.11	1.13	1.14	1.17	1.19	1.24	1.28	1.34	1.40
230	1.10	1.12	1.14	1.17	1.19	1.22	1.26	1.30	1.37	1.43
235	1.11	1.14	1.16	1.19	1.21	1.25	1.29	1.32	1.38	1.44
240		1.10	1.13	1.16	1.20	1.25	1.32	1.37	1.44	1.49
245	1.09	1.11	1.13	1.16	1.19	1.22	1.26	1.31	1.36	1.43
250	1.11	1.12	1.15	1.18	1.21	1.24	1.27	1.31	1.34	1.41
255	1.12	1.13	1.16	1.19	1.21	1.25	1.28	1.31	1.36	1.41
260	1.13	1.16	1.18	1.20	1.23	1.26	1.29	1.32	1.36	1.41
265	1.14	1.17	1.19	1.21	1.25	1.28	1.32	1.34	1.38	1.43

Tableau 1 (continued)

Position angle	Log I										2.4
	4.0	3.9	3.8	3.7	3.6	3.5	3.4	3.3	3.2	3.1	
270	1.17	1.19	1.22	1.25	1.27	1.29	1.32	1.36	1.40	1.46	1.51
275	1.14	1.16	1.18	1.20	1.23	1.25	1.28	1.32	1.36	1.43	1.47
280	1.12	1.14	1.16	1.19	1.21	1.24	1.26	1.30	1.33	1.39	1.42
285	1.10	1.11	1.13	1.15	1.17	1.21	1.24	1.28	1.32	1.37	1.42
290	1.11	1.13	1.15	1.19	1.21	1.24	1.28	1.32	1.38	1.43	1.47
295	1.11	1.14	1.15	1.18	1.21	1.24	1.27	1.32	1.37	1.44	1.50
300	1.11	1.14	1.17	1.21	1.24	1.26	1.32	1.36	1.43	1.50	1.56
305	1.11	1.14	1.17	1.19	1.22	1.25	1.30	1.34	1.41	1.47	1.52
310		1.10	1.14	1.17	1.20	1.23	1.27	1.33	1.40	1.46	1.52
315	1.09	1.11	1.14	1.16	1.19	1.23	1.29	1.34	1.41	1.46	1.52
320		1.10	1.13	1.15	1.19	1.21	1.27	1.33	1.36	1.42	1.47
325		1.10	1.12	1.15	1.18	1.21	1.25	1.29	1.33	1.37	1.41
330	1.13	1.14	1.17	1.19	1.22	1.26	1.30	1.34	1.38	1.42	1.46
335		1.10	1.13	1.15	1.19	1.23	1.27	1.30	1.34	1.40	1.44
340		1.10	1.13	1.16	1.20	1.24	1.28	1.32	1.36	1.39	1.44
345	1.11	1.13	1.16	1.19	1.22	1.25	1.27	1.30	1.33	1.37	1.42
350		1.12	1.15	1.18	1.21	1.24	1.26	1.30	1.35	1.41	1.46
355		1.11	1.14	1.17	1.20	1.24	1.29	1.33	1.38	1.43	

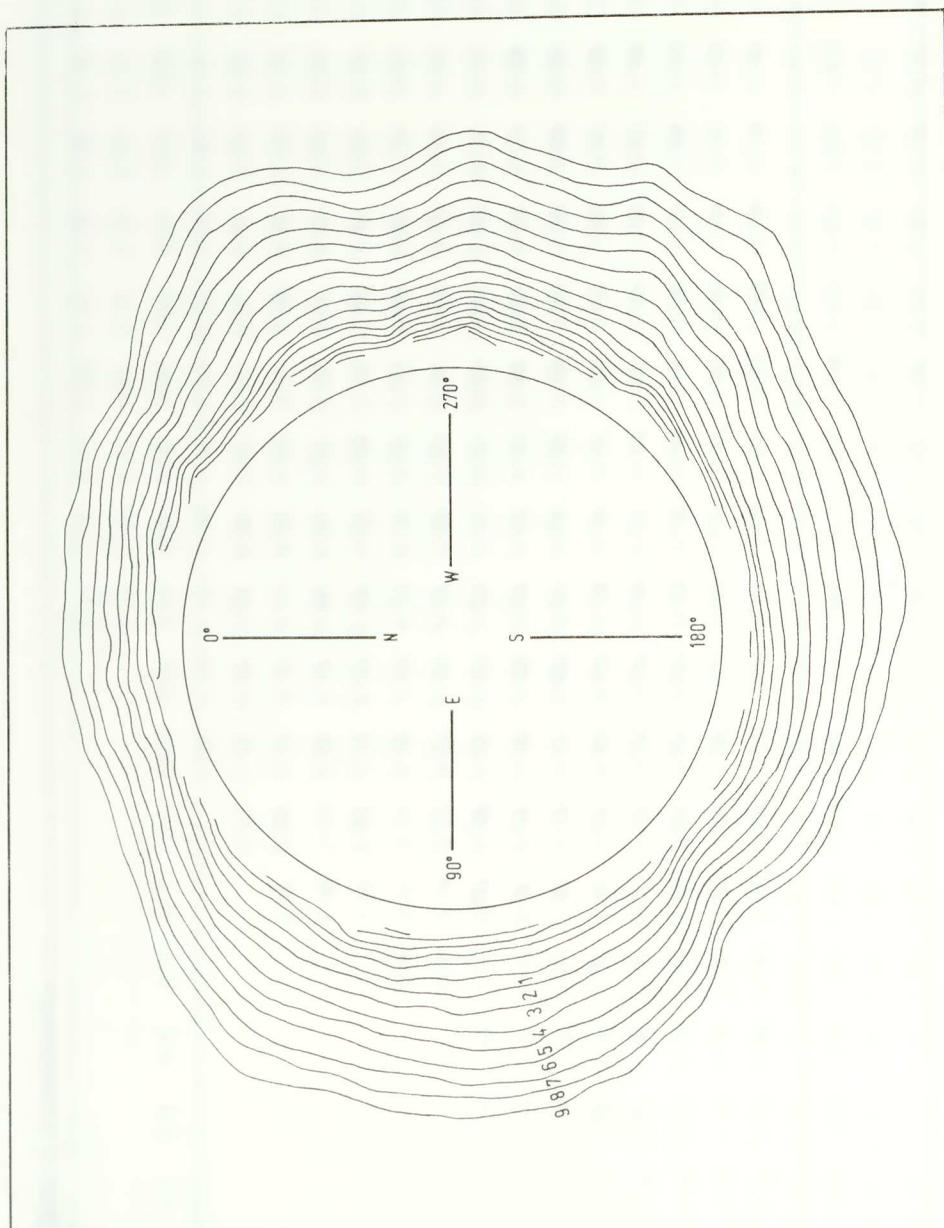


Fig. 2. The isophotes of the inner corona.

ΤΑΒΛΕ 2

The absolute intensities of the corona at individual position angles for selected height above the solar limb.

Position angle	Height above the solar limb in R_\odot															
	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80	1.85
0	3.16	3.01	2.88	2.74	2.66	2.55	2.42									
5	3.15	3.00	2.84	2.73	2.60	2.49	2.42									
10	3.16	3.01	2.88	2.76	2.66	2.52	2.45									
15	3.11	2.96	2.83	2.71	2.59	2.49										
20	3.11	2.98	2.84	2.73	2.59	2.49										
25	3.09	2.91	2.79	2.70	2.55	2.45										
30	3.20	3.02	2.87	2.73	2.60	2.49										
35	3.27	3.14	2.98	2.84	2.66	2.55	2.42									
40	3.36	3.20	3.06	2.93	2.79	2.66	2.49									
45	3.41	3.24	3.10	3.01	2.87	2.76	2.68	2.55								
50	3.46	3.33	3.20	3.10	2.96	2.89	2.75	2.66	2.55	2.42						
55	3.47	3.34	3.22	3.12	3.03	2.93	2.81	2.70	2.62	2.52	2.45					
60	3.47	3.33	3.22	3.12	3.01	2.95	2.89	2.79	2.68	2.60	2.49	2.42				
65	3.50	3.37	3.24	3.15	3.05	2.98	2.91	2.81	2.75	2.66	2.58	2.49	2.45			
70	3.49	3.39	3.28	3.18	3.09	2.98	2.89	2.81	2.74	2.66	2.59	2.49	2.42			
75	3.56	3.49	3.33	3.20	3.08	2.99	2.90	2.80	2.73	2.66	2.60	2.49	2.42			
80	3.65	3.45	3.29	3.16	3.08	2.98	2.89	2.80	2.72	2.64	2.60	2.49				
85	3.62	3.46	3.30	3.20	3.08	2.99	2.90	2.81	2.76	2.68	2.60	2.49	2.45			

Tableau 2 (continued)

Position angle	Height above the solar limb in R_\odot														
	1.10	1.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
90	3.55	3.39	3.27	3.19	3.08	2.98	2.91	2.85	2.76	2.68	2.58	2.52	2.49		
95	3.57	3.41	3.27	3.18	3.11	3.02	2.93	2.86	2.79	2.73	2.66	2.55	2.45		
100	3.56	3.51	3.26	3.17	3.09	3.01	2.94	2.87	2.80	2.72	2.62	2.55	2.42		
105	3.57	3.43	3.27	3.18	3.11	3.02	2.96	2.88	2.80	2.72	2.66	2.55	2.49		
110	3.56	3.41	3.27	3.17	3.08	3.01	2.91	2.84	2.74	2.68	2.59	2.52	2.42		
115	3.52	3.39	3.24	3.16	3.05	2.98	2.90	2.81	2.74	2.68	2.59	2.52	2.45		
120	3.55	3.35	3.22	3.16	3.04	2.96	2.89	2.80	2.72	2.62	2.55	2.42			
125	3.47	3.33	3.20	3.12	3.02	2.91	2.84	2.75	2.66	2.52	2.42				
130	3.48	3.33	3.19	3.09	2.98	2.89	2.79	2.68	2.58	2.42					
135	3.46	3.31	3.16	3.03	2.89	2.76	2.66	2.49							
140	3.39	3.20	3.03	2.89	2.73	2.65	2.52								
145	3.34	3.13	3.01	2.91	2.80	2.68	2.58	2.49							
150	3.36	3.19	3.08	2.96	2.87	2.73	2.62	2.55	2.49						
155	3.43	3.26	3.15	3.01	2.89	2.79	2.68	2.60	2.52	2.42					
160	3.49	3.29	3.18	3.05	2.92	2.80	2.73	2.60	2.49						
165	3.49	3.29	3.16	3.03	2.93	2.84	2.73	2.62	2.52	2.42					
170	3.45	3.27	3.14	3.03	2.93	2.80	2.73	2.62	2.55	2.45					
175	3.46	3.30	3.15	3.03	2.95	2.84	2.73	2.66	2.52	2.45					

Tableau 2 (continued)

Position angle	Height above the solar limb in R_\odot														
	4.10	4.15	1.20	1.25	1.30	1.35	1.40	1.45	1.50	1.55	1.60	1.65	1.70	1.75	1.80
180	3.47	3.27	3.16	3.02	2.91	2.81	2.73	2.62	2.57	2.45					
185	3.44	3.27	3.14	3.02	2.93	2.84	2.75	2.68	2.60	2.70					
190	3.41	3.23	3.11	3.01	2.92	2.84	2.76	2.68	2.60	2.52					
195	3.46	3.23	3.15	3.03	2.92	2.85	2.76	2.68	2.60	2.55					
200	3.46	3.23	3.12	3.02	2.93	2.85	2.76	2.70	2.62	2.55					
205	3.49	3.30	3.17	3.07	2.95	2.89	2.79	2.72	2.64	2.57					
210	3.51	3.35	3.17	3.08	2.98	2.90	2.81	2.74	2.66	2.60					
215	3.62	3.41	3.24	3.13	3.04	2.95	2.85	2.76	2.70	2.62					
220	3.70	3.45	3.30	3.19	3.08	2.99	2.89	2.80	2.71	2.64					
225	3.82	3.57	3.37	3.27	3.15	3.05	2.97	2.87	2.77	2.71					
230	3.86	3.66	3.46	3.30	3.20	3.13	3.06	2.97	2.85	2.77					
235	3.94	3.74	3.55	3.37	3.24	3.15	3.04	2.93	2.85	2.81					
240	3.82	3.62	3.50	3.38	3.32	3.23	3.15	3.06	2.98	2.85					
245	3.93	3.74	3.55	3.43	3.30	3.20	3.12	3.08	3.01	2.93					
250	4.06	3.80	3.60	3.47	3.31	3.12	3.10	3.01	2.94	2.86					
255	4.07	3.80	3.64	3.47	3.30	3.18	3.10	2.99	2.91	2.81					
260	4.12	3.90	3.70	3.52	3.35	3.22	3.11	3.00	2.91	2.81					
265	4.17	3.96	3.74	3.59	3.45	3.27	3.16	3.06	2.98	2.89					

Tableau 2 (continued)

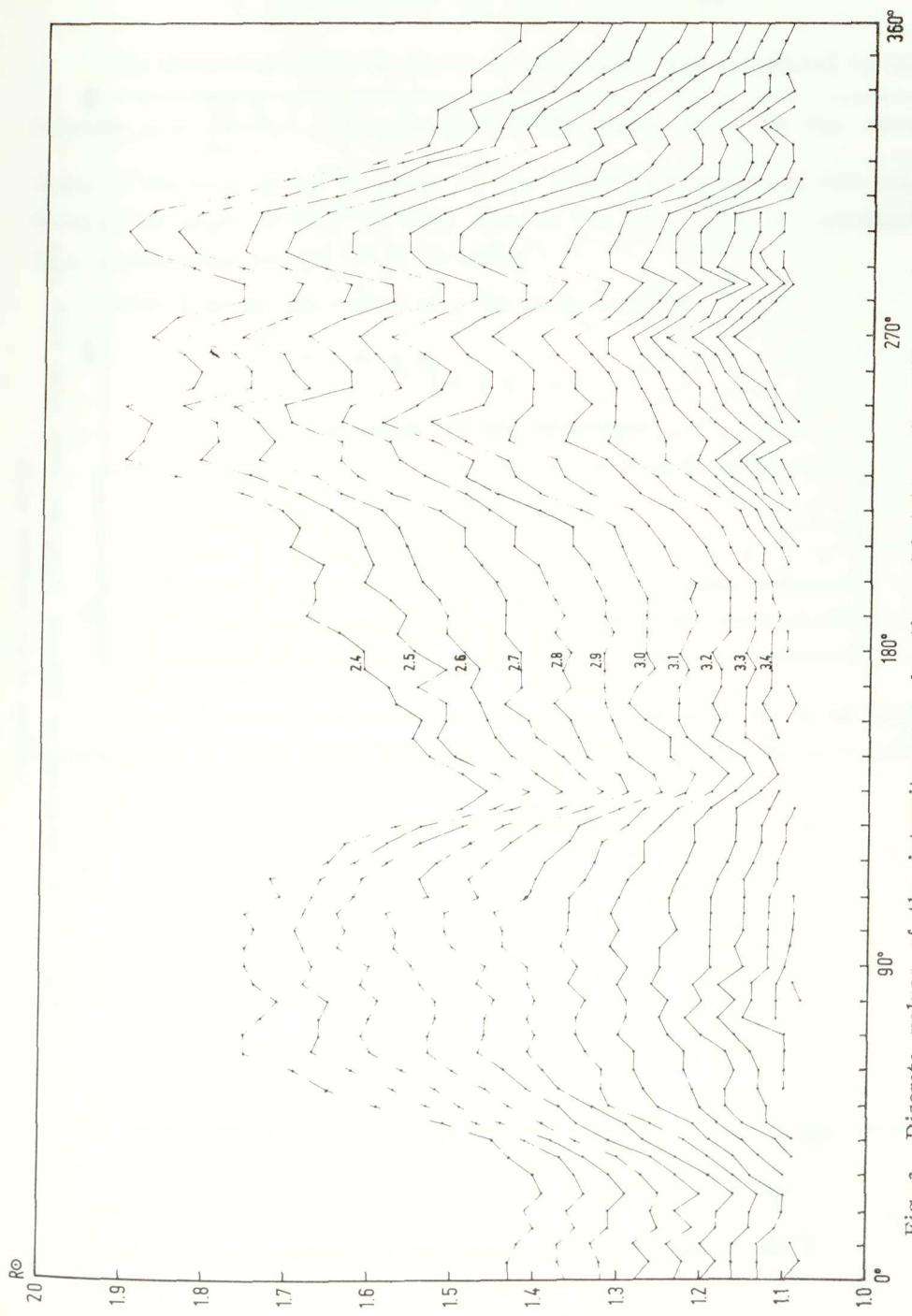


Fig. 3. Discrete values of the intensity as a function of height and position angle. The numbers on the curves represent the logarithm of the intensity.

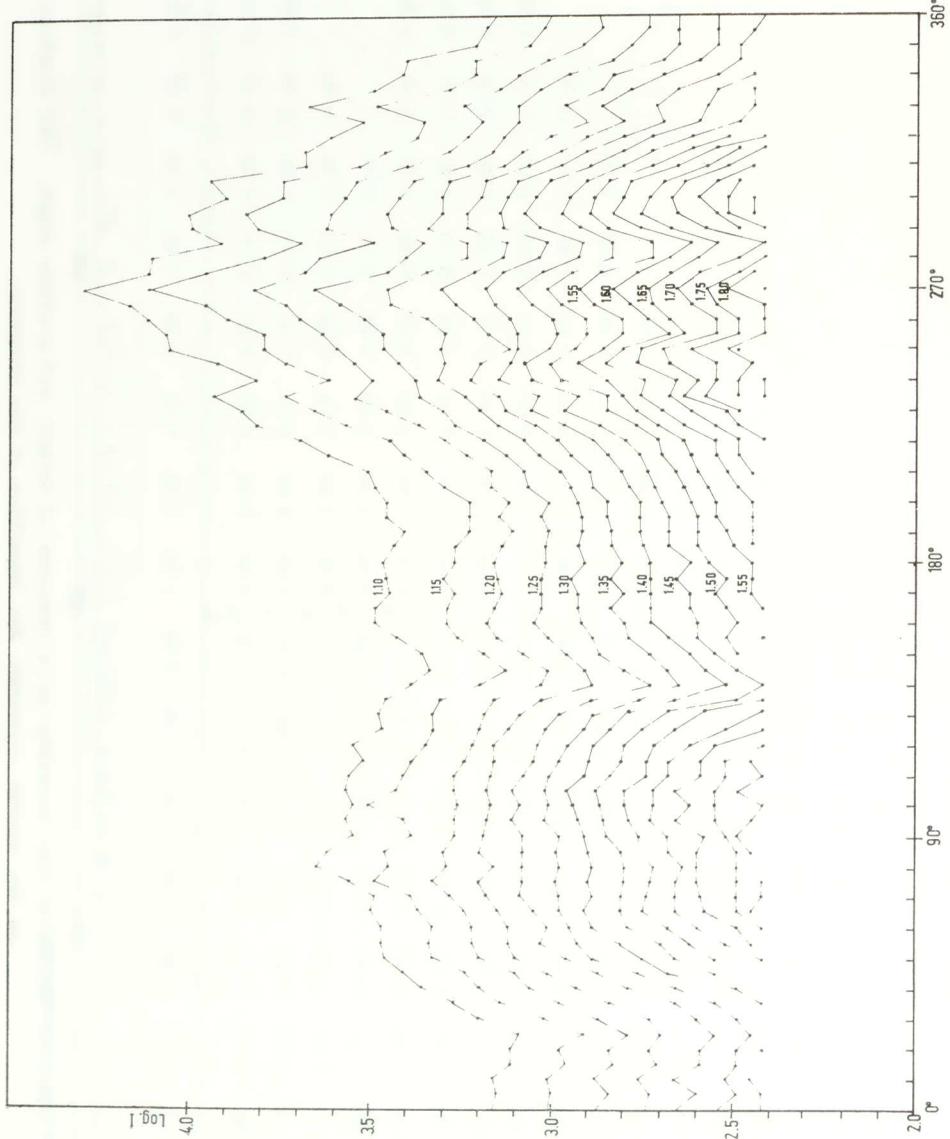


Fig. 4. The intensity for different distances from solar limb as a function of the position angle.

4. FLATTENING OF THE ISOPHOTES

The flattening of the isophotes of the corona was calculated by the relation $\varepsilon = \frac{\overline{\Delta_{E-W}}}{\overline{\Delta_{N-S}}} - 1$ (Lundendorff 1928) where $\overline{\Delta_{E-W}}$ is the mean value of the axis of the isophote in the E-W direction and two axes forming an angle of 22.5° on both sides of the first. $\overline{\Delta_{N-S}}$ is calculated in a similar way for the N-S direction.

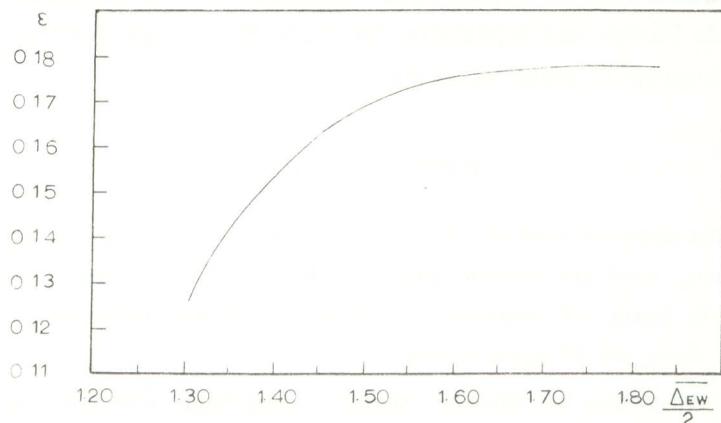
Table 3 gives the values of ε for each isophote.

T A B L E 3

Flattening of the isophotes.

I s o p h o t e									
No	1	2	3	4	5	6	7	8	9
ε	0.126	0.145	0.152	0.165	0.173	0.176	0.178	0.180	0.177

Figure 5 shows the variation of ε as a function of $\overline{\Delta_{E-W}}$ of each isophote (van de Hulst 1953). The ellipticity is maximum for $\overline{\Delta_{E-W}} = 1.80$.

Fig. 5. The flattening of the isophotes as a function of $\overline{\Delta_{E-W}}$.

CONCLUSIONS

A detailed discription of the solar corona during the eclipse of June 30, 1973 is given by Rušin and Rybansky (1975) as well as by Waldmeier (1974). The observed corona was of intermediate type. The inner corona in the eastern limb looked like a corona in the minimum of the solar activity without any special structure. The structure on the western limb was complex and looked like a corona in the maximum of solar activity.

The study of the 36 pictures taken during 1h and 12 m did not reveal any important variation in the inner corona. No apparent movements or changes were seen. This was certified by observations in various ground stations with time difference of more than two hours. Small changes of the intensity in some regions and changes of the fine structure are due either to method errors or to the conditions under which the pictures were taken, as abrupt movements of the plane, small scale turbulences because of the movement of the plane with supersonic velocities in the terrestrial atmosphere, the influence of a big temperature gradient near the window of the plane and other secondary reasons.

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ΠΕΡΙΛΗΨΙΣ

Είς τὴν ἐργασίαν ταύτην μελετῶνται ἡ ἐλλειπτικότης τοῦ ἐσωτερικοῦ ἥλιακοῦ στέμματος κατὰ τὴν ἔκλειψιν τῆς 30ῆς Ιουνίου 1973, καθὼς ἐπίσης καὶ αἱ μεταβολαὶ τῆς δομῆς τοῦ στέμματος ἐπὶ 36 φωτογραφιῶν ληφθεισῶν εἰς χρονικὸν διάστημα 1 ὥρας καὶ 12 πρώτων λεπτῶν.

Αἱ φωτογραφίαι τοῦ ἥλιακοῦ στέμματος ἐλήφθησαν ὑπὸ τῶν παρατηρητῶν τοῦ Ἰνστιτούτου Ἀστροφυσικῆς τῶν Παρισίων διὰ φωτογραφικοῦ θαλάμου τοῦ ὅποίου ἀντικειμενικὸς φακὸς ἐστιακῆς ἀποστάσεως 3.000 mm, εἶχε τοποθετηθῆ ἐπὶ τοῦ ἀεροσκάφους Concorde 001. Τὸ ἀεροσκάφος τοῦτο κινούμενον εἰς ὕψος

18 χιλ. ἐκ τοῦ ἔδαφους τῆς Γῆς μὲ ταχύτητα 2 mach, παρέμεινεν ἐπὶ 1 ὥραν καὶ 12 πρῶτα λεπτὰ ἐντὸς τῆς σκιᾶς τῆς Σελήνης, ἔλαβε δὲ 36 φωτογραφίας τοῦ ἐσωτερικοῦ ἡλιακοῦ στέμματος εἰς λευκὸν φῶς (ἡλεκτρονικὸν στέμμα).

Ἐκ τῆς λεπτομεροῦς μελέτης τῶν 36 αὐτῶν φωτογραφιῶν ἐξήχθησαν τὰ ἀκόλουθα :

1) Δὲν ἀπεκαλύφθησαν διὰ τὸ χρονικὸν διάστημα τῶν 72 πρώτων λεπτῶν μεταβολὴν εἰς τὴν δομὴν τοῦ στέμματος ἢ μετακινήσεις ὑλικοῦ ἐντὸς αὐτοῦ.

2) Ἐχαράχθησαν αἱ ἴσοφωτοι τοῦ ἐσωτερικοῦ στέμματος ὡς δὲ δεικνύει ἡ εἰκὼν 2 ἢ μορφὴ αὐτοῦ εἶναι ἐνδιαμέσου τύπου, μεταξὺ μεγίστου καὶ ἐλαχίστου τῆς ἡλιακῆς δραστηριότητος.

3) Ἡ ἐλλειπτικότης τῶν ἰσοφώτων τοῦ στέμματος ὑπολογισθεῖσα ἐκ τῆς σχέσεως $\varepsilon = \frac{\Delta_{E-W}}{\Delta_{N-S}} - 1$ τοῦ Lundendorff δίδεται εἰς τὸν πίνακα 3. Ἡ εἰκὼν 5 δίδει τὴν μεταβολὴν τῆς ε συναρτήσει τῆς ἀποστάσεως $\overline{\Delta_{E-W}}$ ἐκάστης ἰσοφώτου.

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