On the Solar Work of the Stockholm Observatory

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Abstract

A brief report is given on the regular solar work of the Stockholm Observatory started in 1947. Besides scientific research in special fields the purpose of this work is an attempt to furnish Swedish geophysical institutions and the Royal Swedish Board of Telegraph with solar data in addition to the information given in the Ursigrams. In consequence of its high geographic latitude Sweden is exposed to aurora zone disturbances, and therefore a local and more detailed solar service has been held in high estimation in our country. The observations may be of a general interest, however, as they show that a fairly complete record of many of the principal features of solar activity can be obtained with a modest equipment. Some special methods of observation have been developed which are well adapted for this kind of work.

A. Sunspots and faculae. Every clear day at least one solar photograph is taken in the H and K region of the spectrum. For these pictures a Schott and Gen. U. G. 2 filter of 1 mm thickness is used selecting a wavelength range of 200 Å. With Ilford Lantern contrasting plates such photographs reveal many more details than images taken in say the yellow region of the spectrum. The spots are very dark and outstanding objects in the ultraviolet in consequence of their low temperature compared with that of the photosphere. Moreover, the bright faculae can be traced not only close to the limb but all over the surface of the sun. In fact, the ultraviolet pictures resemble spectroheliograms taken in the outer wings of the K line and in metallic lines and it seems that the general depression of the radiation curve in the H and K region by accumulated line absorption produces the characteristics of the low chromosphere though with less contrast than on a real spectroheliogram. Among details present on the plates dark markings sometimes of a filamentary structure resembling the dark flocculi on K 1 spectroheliograms are of a particular interest. Fig. 1 shows such dark flocculi crossing bright ones near a small spot close to the limb. It seems to the writer that this filamentary dark structure should if possible be included among the solar phenomena studied for the purpose of judging the general solar activity.

The use of the ultraviolet spectrum has another advantage when taking solar photographs and that is the improved resolution of the image. Though the Stockholm Observatory pictures are made with an objective having an aperture of only 30 mm and a focal length of only 800 mm they show a considerable number of details. With this small aperture the effect of seeing is not so important as with large instruments. By using enlargements by eyepiece solar images with a diameter of 56 mm are obtained.

B. Chromospheric faculae, flares and filaments in the Hα line. Since July 1948 a small spectroheliograph built in the instrument shop by S. LINDGREN has been in operation at the Stockholm Observatory. The instrument consists of a grating spectrograph ($f = 1\,700$ mm) of Littrow type with two symmetrically placed slits, one on each side of the tube. The whole

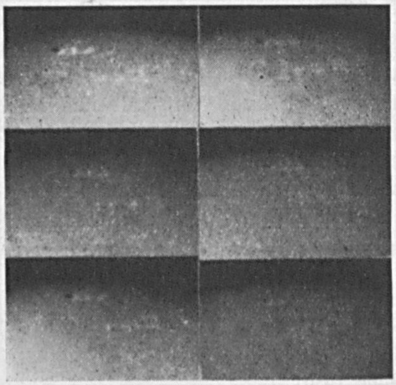

Fig. 1. Ultraviolet photographs of the sun's limb obtained in the H. and K region on April 15, 1950. Though the spectral region transmitted by the filter has a width of about 200 Å dark and bright flocculi are well visible. The times of exposure are given in U.T.

spectrograph is moved perpendicular to the incident beam of light and the speed is controlled by driving weights and an oil-damper. The grating was ruled by Professor Siegbahn's laboratory and has 720 grooves/mm and a very strong concentration of light in the first order.

The solar image used for taking spectroheliograms is as small as 22 mm. Also an image of only 16 mm has sometimes been tried. In spite of such a small size the spectroheliograms show a good number of details and it is easy to classify the sunspot groups as active ones or not active ones. Flares can in general be well detected and Hα filaments can be easily seen as well as prominences outside the limb. A spectroheliogram of the whole disc is generally obtained in about 20 seconds.

Fig. 2 shows a very typical flare of intensity 3 observed with this instrument on May 3, 1950. The observation at 9.56 U.T. was started because of a call from the Royal Swedish Board of Telegraph informing us of a fade out in the short wave communications which started at 9.40 U.T. The conditions were nearly normal again at 10.16 U.T. The striation in the images is mainly due to some dust on the slit.

C. Prominences. For a detailed study of prominences a polarizing H α monochromator is used. It is an instrument of Lyot's type independently built by the writer in 1937. The monochromator is attached to a 190 mm refracting telescope with a focal length of 2,500 mm.

A new monochromator is planned to be used on a coronagraph now being constructed. The coronagraph will be used also for spectrographic recordings of the solar corona.

D. Reports and forecasts distributed to Swedish institutions. Twice weekly reports as to sunspots and general solar activity are mailed to a number of Swedish institutions. The areas of the sunspots are measured and the groups are given a + sign when being surrounded by H α faculae (flocculi) and a — sign when no noticeable bright H α faculae are seen with our instrument. The measures are presented in a table giving "day-sectors" before and after the central solar meridian and north and south of the equator (compare fig. 3). In the table one and the same region of the sun is represented by one and the same column and in this way the change in the size of the spots can easily be traced. At the same time days

Fig. 2. A typical flare of intensity 3 observed at the Stockholm Observatory on May 3, 1950.

giving no observations in consequence of a cloudy sky are the less disturbing as an interpolation between the values on clear days can generally be made without difficulty.

In table I and table II an extract of the tables for the Stockholm Observatory sun spot areas are given for 1948 and 1949. The areas are measured in 10^{-5} of the half sphere of the sun as unit and the figures refer to the day-sector after the sun's central meridian observed at about $8^h 30^m$ a.m. U. T. (This sector is to the right of number 1 in fig. 3). The upper number in the tables refers to the north hemisphere and the lower number to the south hemisphere. When a figure is given within parentheses no observation was possible that day but the value has been obtained by extrapolation. If this is the case for several days in succession the extrapolation has been extended over several days. Zero means no spot in the day-sector after the meridian and — that a long period of cloudy weather has made the determination impossible or very uncertain. A figure without + or — sign means that no spectroheliogram has been obtained for the spot in question.

Table I and table II are fairly complete, at least for the spring and the summer, and may present useful material to geophysicists. Reference is here made to previous reports from the Research Laboratory of Electronics, Chalmers University of Technology, Gothenburg, where some of these figures have been used. Sunspot numbers or areas are generally not published from other observatories for one day-sector only and the present material may become handy if one wants to study the possible influence on terrestrial phenomena of some special spot.

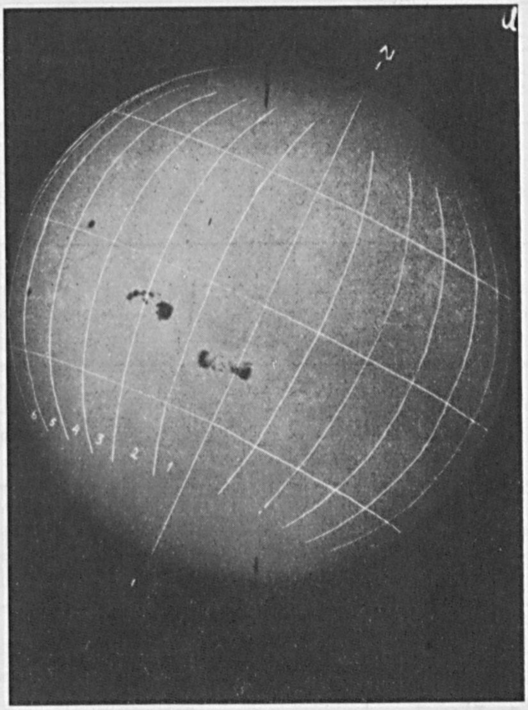

Fig. 3. Ultraviolet photograph of the sun obtained on April 25, 1950. The different sectors correspond to the rotation of the sun in 24 hours.

The solar work reported here has been carried out in collaboration with Mr L. Dahlmark (1948—1949) and Mr H. Kristenson (1949). The latter was in charge of the solar section during the writer's stay at the High Altitude Observatory in Boulder, Colorado, in 1949. Both these scientists have taken a very active part in the observations and reductions and contributed with several improvements in the methods of observation. The work has been supported by grants given by the Swedish Council of Scientific Research.

Stockholm Observatory, Saltsjöbaden.
June, 1950.

Table I. 1948.

Sunspot areas in the day-sector after the Sun's central meridian together with signs of active groups + or non active groups —. Interpolated values are given within parentheses.

	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	—	(0)	0	2	(0)	32	(18)	0 —	0 (—)	11 +	(4) (+)	(8) +
	—	(0)	20	0	(35)	0	(0)	2 —	0 (—)	4 —	(0) (—)	(0) —
2	—	(0)	1	17	10	38	0	0 —	(0) (—)	5 (—)	(2) (—)	3 —
	—	(0)	5	5	0	0	0	16 +	(0) (—)	0 (—)	(0) (—)	0 —
3	—	0	72	0	(40)	55	4	(0) (—)	21 —	0 —	(0) (—)	(0) (—)
	—	0	0	0	(2)	0	1	(50) (—)	0 —	0 —	(0) (—)	(0) (—)
4	—	(0)	9	0	0	2	0	0 —	19 (+)	0 —	17 (+)	(0) (—)
	—	(10)	8	106	0	2	5	27 +	36 (+)	0 —	0 (—)	(1) (—)
5	—	(0)	0	26	1	0	0	0 —	(0) (—)	0 —	4 —	0 —
	—	(21)	0	9	0	0	2	4 —	(5) (—)	0 —	0 —	0 —
6	—	(2)	0	(5)	0	4	0	0 —	0 (—)	0 —	(0) (—)	0 (—)
	—	(17)	4	(0)	0	14	0	2 +	0 (—)	0 —	(0) (—)	6 (—)
7	(0)	0	0	(0)	15	0	0	0 (—)	0 (—)	4 +	0 —	(0) (—)
	(0)	0	2	(0)	0	2	0	0 (—)	1 (—)	0 —	0 —	(16) (—)
8	(0)	(0)	(0)	0	33	0	0	13 (—)	0 —	0 —	0 —	(1)
	(0)	(0)	(0)	0	0	0	0	45 (+)	0 —	0 —	0 —	(0)
9	(0)	(0)	(3)	0	0	0	0	2 (—)	0 (—)	0 —	14 +	0
	(0)	(19)	(0)	35	0	22	0	53 (+)	0 (—)	0 —	0 —	0
10	(0)	(0)	0	0	0	0	0 —	0 (—)	1 —	0 —	(2) (—)	(7)
	(20)	(2)	0	4	85	7	12 —	9 (—)	0 —	0 —	(16) (+)	(0)
11	0	0	0	20	45	0	14 +	0 (—)	0 —	(0) (—)	0 (—)	(0)
	0	0	0	3	51	2	4 —	0 (—)	0 —	(12) (+)	4 (+)	(26)
12	(0)	(0)	0	8	10	0	42 +	(14) (—)	0 (—)	0 (—)	27 —	0
	(0)	(1)	0	8	50	15	0 —	(0) (—)	0 (—)	23 (+)	0 —	0
13	(0)	(0)	0	(9)	0	0	21 (+)	0 —	(0) (—)	(4) (—)	0 (+)	(0)
	(5)	(0)	0	(15)	110	12	0 (—)	0 —	(0) (—)	(0) (—)	3 (+)	(40)
14	(0)	(0)	0	1	16	7	(10) (—)	0 —	(0) (—)	1 —	(0) (—)	(0)
	(6)	(0)	0	67	0	47	(0) (—)	0 —	(0) (—)	5 +	(0) (—)	(68)

15	0	0	53	0	3	3	18 (+)	1 —	1 (—)	(0) (—)	(0) (—)	(0)
	0	1	22	27	0	1	0 (—)	9 —	0 (+)	(34) (+)	(0) (—)	(60)
16	0	0	(25)	0	0	11	35 +	0 —	(0) (—)	3 (—)	0 (—)	(0) (—)
	0	0	(11)	20	50	0	0 —	11 —	(32) (+)	0 (—)	13 (+)	(0) (—)
17	0	0	(0)	80	0	47	6 (—)	0 —	0 —	1 —	(0) (—)	3 (—)
	0	0	(0)	2	9	0	7 (—)	1 —	3 —	0 —	(0) (—)	24 (+)
18	(18)	0	(0)	2	0	66	0 —	(1) (—)	0 (—)	(65) (—)	0 (—)	3 —
	(1)	34	(0)	4	0	0	0 —	(6) (—)	120 (+)	(0) (—)	59 (—)	0 —
19	0	0	(0)	7	0	37	0 —	20 —	1 (—)	(15) (+)	0 —	(30) (+)
	8	0	(0)	0	5	0	0 —	24 —	51 (+)	(20) (+)	43 +	(0) (—)
20	(0)	0	0	0	0	0	0 (—)	(0) (—)	18 +	0 —	(5) (—)	12 (—)
	(0)	0	0	5	0	0	0 (—)	(0) (—)	2 —	9 +	(0) (—)	9 (+)
21	(0)	(14)	(0)	31	0	6	0 (—)	25 —	17 (+)	0 (—)	12 (+)	98 +
	(0)	(0)	(0)	7	0	0	23 (+)	0 —	0 (—)	0 (—)	0 (—)	0 —
22	(0)	(3)	0	22	0	0	0 (—)	5 (—)	20 +	0 —	0 —	0 (—)
	(0)	(7)	0	18	0	0	4 (—)	14 (—)	2 —	0 —	0 —	0 (—)
23	(0)	0	0	0	1	0	0 —	23 (—)	16 (+)	0 (—)	0 —	0 —
	(0)	1	0	9	0	0	12 —	12 (—)	30 (+)	2 (—)	0 —	0 —
24	—	(3)	0	0	27	0	1 —	20 —	0 —	0 —	0 +	(0) (—)
	—	(3)	0	13	0	0	2 —	0 —	11 +	19 +	5 +	(103) (+)
25	—	0	0	8	0	(2)	20 —	27 —	(0) (—)	(1) (—)	(0) (—)	(0) (—)
	—	0	0	0	1	(4)	0 —	0 —	(3) (—)	(9) (+)	(0) (—)	(72) (—)
26	—	0	0	94	0	2	2 (—)	11 (—)	0 —	0 —	0 —	18 —
	—	0	0	0	0	78	6 (+)	0 (—)	6 —	0 —	0 —	0 —
27	—	0	0	29	0	0	64 +	15 +	(0) (—)	0 (—)	0 —	0 (—)
	—	0	0	1	0	23	1 —	17 +	(0) (—)	0 (—)	0 —	0 (—)
28	—	0	0	0	0	3	7 +	0 —	4 (—)	60 (+)	(11) (+)	0 —
	—	0	0	0	13	0	0 —	0 —	3 (—)	4 (—)	(0) (—)	0 —
29	—	0	12	0	0	4	0 —	0 —	22 (+)	0 —	10 —	(0) (—)
	—	6	0	7	0	0	0 —	0 —	1 (—)	0 —	0 —	(0) (—)
30	—		15	(24)	(0)	120	12 +	0 —	2 —	5 +	(1) (—)	2 —
	—		0	(8)	(4)	0	0 —	0 —	14 —	0 —	(0) (—)	31 —
31	(0)		25		(12)		32 (+)	0 —		0 —		(31) (+)
	(0)		1		(0)		0 (—)	15 +		0 —		(21) (+)

Table II. 1949.

Sunspot areas in the day-sector after the Sun's central meridian together with signs of active groups + or non active groups —. Interpolated values are given within parentheses.

	Jan.	Febr.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1	0 (—) 0 (—)	0 — 20 —	57 + 0 —	1 — 0 —	0 — 0 —	(80) (+) (0) (—)	3 (—) 0 (—)	0 — 76 +	8 + 8 —	0 — 2 —	(5) (+) (0) (—)	5 (—) 0 (—)
2	(0) (—) (0) (—)	(0) (—) (39) (+)	0 — 0 —	0 — 4 —	8 + 20 —	(6) (+) (8) (+)	20 (+) 0 (—)	0 — 39 +	8 — 0 —	0 — 0 —	(0) (—) (0) (—)	(6) (—) (0) (—)
3	(12) (+) (0) (—)	(0) (—) (10) (+)	0 — 0 —	13 — 0 —	9 + 0 —	0 — 0 —	13 (+) 0 (—)	0 — 0 —	0 — 0 —	0 — 3 +	0 (—) 0 (—)	(0) (—) (2) (—)
4	(0) (—) (0) (—)	0 — 0 —	82 (+) 40 (+)	(18) (+) (12) (+)	0 — 0 —	15 + 0 —	0 — 6 +	0 — 4 +	(0) (—) (0) (—)	0 — 3 —	26 + 0 —	(23) (+) (0) (—)
5	0 — 0 —	65 + 105 —	(28) (—) (0) (—)	(14) (—) (8) (—)	18 — 0 —	0 — 0 —	0 — 0 —	7 + 0 —	0 — 11 +	(5) (—) (15) (+)	18 — 0 —	(11) (—) (12) (—)
6	(0) (—) (0) (—)	0 (—) 70 (+)	(0) (—) (2) (—)	3 (—) 0 (—)	59 + 0 —	36 (+) 0 (—)	0 — 2 —	5 — 0 —	41 + 16 —	8 — 36 +	(20) (+) (0) (—)	0 — 0 —
7	(0) (—) (0) (—)	4 — 19 +	(1) (—) (10) (+)	11 + 5 —	0 — 0 —	2 — 0 —	0 — 0 —	(0) (—) (0) (—)	7 + 0 —	190 + 30 —	(0) (—) (0) (—)	0 — 0 —
8	(2) (—) (0) (—)	(0) (—) (15) (—)	(2) (—) (0) (—)	(0) (—) (0) (—)	2 (+) 1 (—)	0 — 3 +	0 — 0 —	0 (—) 0 (—)	12 (+) 0 (—)	(34) (+) (0) (—)	20 (—) 40 (—)	0 (—) 6 (—)
9	0 — 14 —	(0) (—) (30) (+)	60 + 0 —	(6) (—) (0) (—)	0 — 0 —	0 — 0 —	0 — 1 —	0 — 0 —	0 — 48 —	0 — 0 —	(6) (—) (36) (+)	0 — 21 +
10	0 (—) 36 (+)	(10) (—) (0) (—)	2 — 1 —	0 — 0 —	5 — 0 —	0 — 0 —	0 — 0 —	0 — 0 —	0 — 28 +	0 — 0 —	(1) (—) (1) (—)	(11) (—) (8) (—)
11	(0) (—) (18) (—)	(0) (—) (0) (—)	0 — 20 +	0 — 0 +	0 (—) 0 (—)	0 — 0 —	0 — 1 —	0 — 0 —	(8) (+) (0) (—)	1 — 0 —	0 (—) 0 (—)	(7) (+) (24) (+)
12	0 (—) 0 (—)	11 + 20 —	(0) (—) (4) (—)	(0) (—) (22) (+)	0 — 33 +	0 (—) 3 (—)	1 — 4 +	25 + 0 —	(1) (—) (0) (—)	0 — 3 —	(0) (—) (0) (—)	0 — 0 —
13	0 — 8 —	(1) (—) (0) (—)	11 — 0 —	(18) (—) (0) (—)	0 — 0 —	0 — 0 —	0 (—) 0 (—)	0 — 0 —	0 — 12 —	(16) (—) (0) (—)	0 (—) 0 (—)	(0) (—) (0) (—)
14	0 (—) 0 (—)	(0) (—) (24) (—)	30 — 17 —	(0) (—) (0) (—)	0 — 0 —	0 — 1 —	0 — 11 —	(0) (—) (0) (—)	0 — 0 —	12 + 12 + 	(25) (+) (20) (+)	(0) (—) (0) (—)

15	0 — 0 —	3 — 12 +	0 — 2 —	(0) (—) (2) (—)	2 — 0 —	0 — 0 —	50 + 6 +	28 — 0 —	17 — 0 —	0 — 0 —	0 — 3 +	(0) (—) (0) (—)
16	(0) (—) (19) (+)	45 — 0 —	(0) (—) (36) (+)	18 + 0 —	0 — 0 —	1 — 0 —	28 (—) 0 (—)	7 (—) 0 (—)	0 — 0 —	(0) (—) (2) (—)	36 (—) 0 (—)	(0) (—) (0) (—)
17	40 (+) 0 (—)	21 — 80 +	46 — 0 —	27 + 19 —	5 + 0 —	(0) (—) (56) (+)	(0) (—) (0) (—)	0 — 0 —	0 — 120 +	51 + 6 —	(35) (+) (0) (—)	(17) (+) (12) (+)
18	5 (—) 7 (—)	0 — 0 —	3 — 0 —	30 + 33 —	0 — 18 —	(0) (—) (0) (—)	0 — 0 —	5 — 0 —	18 (+) 0 (—)	(7) (—) (0) (—)	(0) (—) (0) (—)	(0) (—) (0) (—)
19	(0) (—) (0) (—)	(78) (+) (3) (—)	75 — 75 —	0 (—) 0 (—)	9 + 5 +	0 (—) 0 (—)	0 — 0 —	40 + 0 —	10 — 0 —	(0) (—) (1) (—)	— —	(0) (—) (0) (—)
20	2 — 70 —	10 — 0 —	16 + 10 —	(0) (—) (0) (—)	1 — 0 —	0 — 0 —	(0) (—) (0) (—)	85 + 3 —	(0) (—) (5) (+)	0 — 0 +	— —	(6) (+) (0) (—)
21	6 (—) 0 (—)	(1) (—) (64) (+)	0 — 55 +	5 + 0 —	0 — 3 —	0 (—) 0 (—)	9 (—) 6 (—)	9 — 2 —	5 — 28 —	0 (—) 0 (—)	— —	0 — 0 —
22	(145) (—) (5) (—)	4 — 19 —	(0) (—) (0) (—)	0 — 7 —	0 — 8 —	0 — 0 —	(17) (—) (0) (—)	0 — 0 —	0 — 7 —	0 — 0 —	— —	41 + 4 —
23	(70) (+) (0) (—)	0 — 0 —	0 — 0 —	10 — 3 —	0 — 5 +	6 + 0 —	74 + 0 —	62 + 0 —	3 — 0 —	(6) (+) (0) (—)	— —	0 — 2 —
24	(5) (—) (0) (—)	0 — 0 —	0 — 0 —	10 — 0 —	30 + 6 +	0 — 14 —	0 — 2 —	65 + 8 —	0 — 20 +	(0) (—) (0) (—)	— —	(0) (—) (0) (—)
25	0 (—) 0 (—)	11 + 0 —	0 — 0 —	0 — 23 —	3 — 0 —	3 — 0 —	0 — 0 —	25 + 0 —	0 — 0 —	5 — 0 —	— —	(20) (—) (0) (—)
26	2 — 0 —	0 — 0 —	(19) (—) (0) (—)	13 + 6 —	0 — 0 —	28 (—) 0 (—)	0 — 21 +	0 — 0 —	(8) (+) (0) (+)	(10) (+) (8) (+)	(0) (—) (0) (—)	(0) (—) (0) (—)
27	(0) (—) (0) (—)	37 (—) 0 (—)	19 — 0 —	18 — 10 +	(0) (+) (0) (—)	(75) (+) (0) (—)	0 — 0 —	0 — 37 +	(0) (—) (24) (+)	0 (—) 0 (—)	(70) (+) (0) (—)	— —
28	0 (—) 0 (—)	43 + 0 —	0 — 0 —	0 (—) 7 (+)	0 — 0 —	0 — 0 —	(14) (+) (0) (—)	14 — 9 —	0 — 0 —	0 — 0 —	(0) (—) (2) (—)	— —
29	(0) (—) (0) (—)		0 — 0 —	0 — 0 —	10 — 0 —	0 — 60 —	(0) (—) (0) (—)	0 — 7 —	0 — 0 —	24 + 0 —	6 — 13 —	— —
30	0 (—) 7 (—)		0 — 4 —	6 — 0 —	(0) (—) (9) (+)	6 — 0 —	(3) (—) (0) (—)	(0) (—) (0) (—)	0 — 0 —	(0) (—) (0) (—)	(0) (—) (0) (—)	— —
31	0 — 12 —		28 — 0 —		0 — 0 —		0 — 98 +	1 — 14 +		(3) (+) (0) (—)		— —