

Kodaikanal Observatory.

BULLETIN No. XXIX.

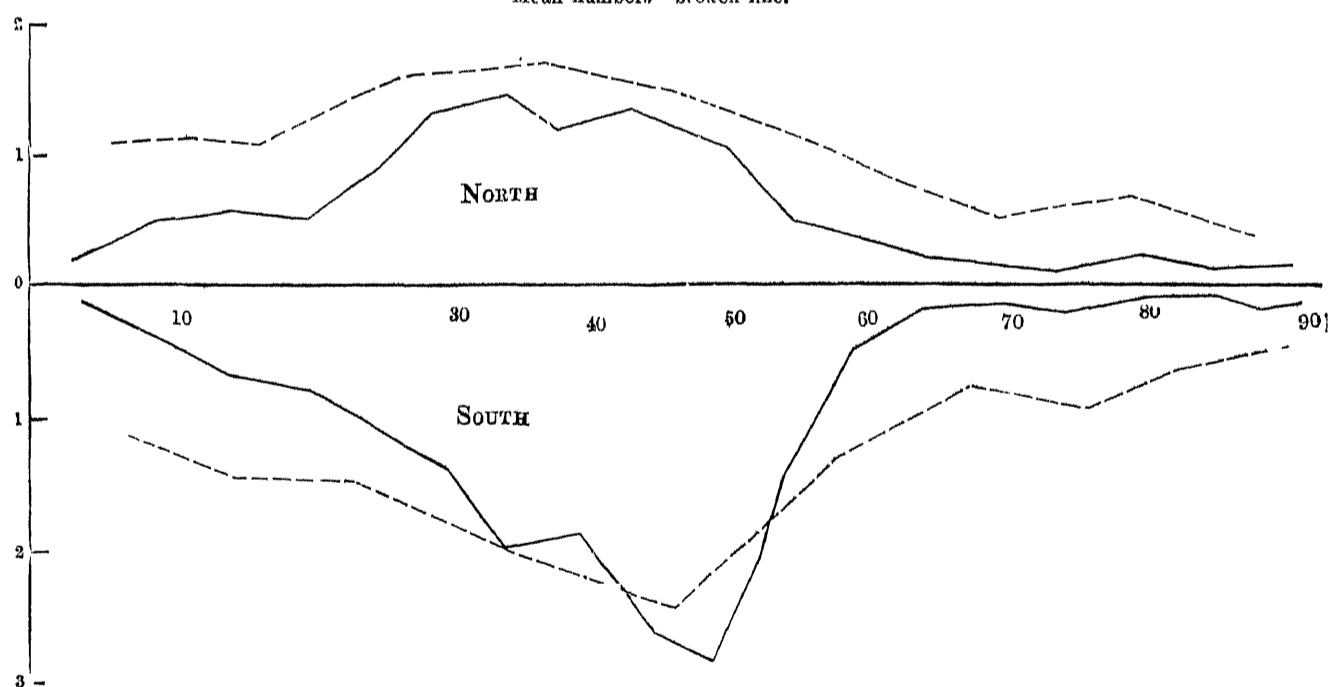
SUMMARY OF PROMINENCE OBSERVATIONS FOR THE FIRST HALF OF THE YEAR 1912.

THE detailed lists of prominences recorded at Kodaikanal and published in a series of bulletins ending with No. XXVIII, will henceforth be discontinued, and a résumé of the observations will in future be issued half-yearly. This will include full descriptions of any remarkable phenomena observed or photographed, and in addition to the summary of the observations at the sun's limb the results will be given of a study of the prominences projected on the disk as hydrogen absorption markings.

The general distribution of the prominences in latitude during the six months ending June 30, 1912 is represented in the accompanying diagram. In this the full line gives the mean daily areas for each zone of 5° of latitude and the broken line the mean daily numbers averaged for 10° intervals. The scale of ordinates represents tenths of square minutes of arc for the full line and numbers for the broken line. Both are corrected for partial or imperfect observations, the total of 173 days of observation being reduced to 159 "effective" days.

MEAN AREAS AND MEAN NUMBERS OF PROMINENCES.
JANUARY 1ST TO JUNE 30TH, 1912.

Mean areas—full line.
Mean numbers—broken line.



As is always the case the mean areas show much more marked maxima and minima than the mean numbers, because of the much greater average size of the prominences occurring in the zones of greatest activity. The figure for the mean areas closely resembles that obtained for the previous six months but

there is a general decrease of activity. The strongly marked active zone shown during the latter half of 1911 at $+20^\circ$ to $+25^\circ$ has disappeared, there has however been an increase in the zone -30° to -35° .

The polar regions show the smallest activity which is nearly constant from the poles to latitude 60° in each hemisphere; the equatorial zone is also a region of small activity extending for a few degrees only on either side of the equator. The zone of greatest mean area is situated in the southern hemisphere between the parallels 45° and 50° , and this position of maximum is the same as was found for the whole of the year 1911.

The total mean daily areas and numbers for each hemisphere are.—

		Areas.		Numbers.	
North	..	0.98	square minutes	North	8.8
South	..	1.50	Do	South	11.2
				On equator	.1
Total	.	2.48	Do.	Total	20.1

The areas indicate a decrease of 24 per cent. in the north and 13 per cent. in the south as compared with the second half of 1911, but the numbers do not show nearly so large a decrease. In the following table are given the monthly, quarterly, and half-yearly frequencies as well as the mean heights and mean extent of the prominences; the frequencies are here uncorrected for partial observations. Taking the total number of effective days as 159 the mean frequency for the six months is 20.1 as above, instead of 18.5 as given at the bottom of column 4, a decrease of only 4 per cent. as compared with the corrected figure for the previous six months.

Abstract for the first half year of 1912.

Month.	No. of days of observation.	No. of prominences.	Mean daily frequency.	Mean height	Mean extent.
January	30	856	28.5	29.0	1.03
February	29	604	20.8	28.6	1.00
March	31	569	18.4	28.9	1.13
April	29	501	17.3	26.9	1.09
May	31	455	14.7	27.0	0.99
June	28	218	9.5	30.0	1.11
First quarter	90	2029	22.5	28.8	1.05
Second quarter	83	1174	14.1	27.5	1.06
Half year .	173	3203	18.5	28.4	1.05

The frequency for the month of January is unusually high and on certain days during this month over 40 prominences were counted, the limb presenting a remarkable appearance with prominences in all latitudes, including the polar regions where they were numerous though of small size. Such activity is noteworthy considering that this month was the first entirely spotless month which has occurred since the year 1901, according to the Kodaikanal records.

Mean height.

The average apparent height of the prominences, $28''.4$ for the six months, slightly exceeds that obtained for the year 1911 as well as for the four preceding years; it is remarkable that whilst the mean areas have steadily diminished from 5.4 square minutes per diem in 1908 to 2.5 square minutes in 1912 the mean heights have remained almost constant, varying irregularly from $26''.8$ to $28''.4$. The mean numbers have also remained sensibly constant over these years so that the reduction of area, synchronising with reduction in sunspot activity, implies a diminution of breadth only or extent on the limb.

The total number of prominences recorded during the 173 observing days which attained an apparent height of 60" or more was 305, which gives a daily average slightly exceeding that for the two previous years. The month of January was also the most prolific in high prominences since 84 were recorded of 60" or more in 30 observing days during that month.

No large eruptive prominences were observed or photographed during the period under review. The highest prominence recorded was photographed on June 22 between -19° and -27° on the east limb. This was an extensive and nearly detached mass at 10 hours 31 minutes, the highest filaments reaching an altitude of 210 seconds of arc. Owing to unfavourable weather, it was not possible to secure an extended series of photographs, and the few obtained were of poor quality. The prominence appeared to be disintegrating rather rapidly, and at 11 hours 20 minutes the highest part was only 150" above the limb.

Distribution east and west of the sun's axis.

During each of the eight years since prominence observations were begun at Kodaikanal the eastern hemisphere has shown a numerical preponderance over the western.* The results for numbers and areas during the first half of 1912 are as follows:—

1912 January—June	..	..	..	East.	West.	E.—W.	Percentage east.
Numbers observed	..	..	..	1669	1528	+ 141	52.20
Total areas in square minutes	..	..	..	194.0	199.6	— 5.6	49.29

Metallic prominences.

Particulars of the metallic prominences observed are given in the following list.—

Date.	I S.T.	Base.	Latitude		Limb.	Height.	Elements giving bright lines	
			North.	South.				
January	21	8 56	1	1.5	...	W	25	Na, Mg, and pFe.
February	29	8 16	2	..	12	E	40	Na, Mg, and pFe.
March	6	8 37	...	..	11	E	60, 30	Na, Mg, and pFe, pTi, pCr, and He (6677).
March	15	8 33	2	7	.	E	15	Na, Mg, and pFe.
March	19	8 47	6	...	52	W	45	Na, Mg.
April	15	8 45	1	...	13.5	W	30	} Na, Mg, and pFe.
"	"	8 45	1.5	...	12	W	20	
June	3	8 23	5	..	8	W	15	Na, Mg, pFe, and He (6677).
June	7	8 22	..	...	9	W	40	Na, Mg, pFe, and He (6677).

Only nine prominences of this type were recorded, two in the northern and seven in the southern hemisphere. Most of these were associated with sunspot disturbances and occurred in regions of calcium flocculi. An exception was that of March 19th on the west limb in latitude -52° . This showed the usual sodium and magnesium lines reversed but no others. The prominence richest in bright lines was that of March 6th in latitude -11° E. The following lines were recorded:—

λ Rowland,	Origin.	High or low level line according to Fowler.
4924.107	pFe	High level.
4930.486	Fe	.. ..
5018.629	pFe	High level.
5167.678 b_4	Mg	.. ..
5169.220 b_3	pFe	.. ..

* Kodaikanal Observatory Bulletin No. XXVIII.

λ Rowland.	Origin.	High or low level line according to Fowler.
5172·856 b_2	Mg .. .. .	.. .. .
5183·791 b_1	Mg .. .. .	.. .. .
5188·863	p Ti .. .. .	.. .. . High level.
5195·113	Fe .. .. .	.. .. .
5206·215	Cr—Ti .. .. .	.. .. . Low level.
5208·596	Cr .. .. .	.. .. . Do.
5227·043	Fe—Cr .. .. .	.. .. .
5233·112	Fe .. .. .	.. .. .
5234·791	p Fe .. .. .	.. .. . High level.
5270·558	Fe .. .. .	.. .. . Low level.
5276·169	p Fe .. .. .	.. .. . High level.
5284·281 .. .. .	.. .. .	.. .. . Do.
5316·790	p Fe .. .. .	.. .. . Do.
5890·186 D_2	Na .. .. .	.. .. .
5896·155 D_1	Na .. .. .	.. .. .

This prominence was a brilliant eruptive jet in a group of fainter prominences and appears to have occupied the exact position of a newly forming spot, No 6977 of the Greenwich numeration. The prominences of April 15 at -12° W. and $-13^\circ.5$ W. were associated with spot group No. 6980 and may be considered as a return of the former since they occurred in the same mass of calcium flocculi which gave rise to both spot groups.

The prominence of June 3 at -8° W. occurred in a newly-formed spot group, Greenwich No. 6990. This outburst in the same zone of latitude as those described above was however about 40° of longitude in advance of the old disturbance first seen on March 6th. The relative positions of the old and new disturbances are well shown in the calcium spectroheliograms obtained on the last day of May and the first days of June when the old disturbance still persisted as scattered flocculi.

The distribution of the metallic prominences in latitude was as follows:—

	Number observed.	Mean latitudes.	Extreme latitudes
North	2	4.2	$1-7$.
South	6	17.1	$7-47$

Displacements of the hydrogen lines.

Prominences showing displacements of the hydrogen lines, probably due in most cases to movements in the line of sight, were few in number in comparison with previous years, and the displacements were for the most part slight in amount. The list below includes all the disturbances of this character that were observed:—

Date.	L.S.T	Latitude.	Line.	Amount and direction of shift.		Remarks.
				Red.	Blue	
1912	H. M.	°				
January 5	9 15	+ 82 W.	C	Slight.		
„ 10	19	+ 39 W.	C	„		
„ 22	26	+ 9.5 W.	C	„		
„ 26	8 15	- 84 W.	C	„		
February 10	8 26	+ 74 E.	C	„		
„ 18	8	- 80 E.	C	„		
„ 23	48	- 82 E.	C	„		

Date.	I.S.T.	Latitude.	Line.	Amount and direction of shift.		Remarks.
				Red.	Blue.	
1912.	H. M.	°				
February 27	32	-- 11 W.	C	Slight.		
March 5	8 48	- 63 W.	C	"		
" 6	37	- 11 E.	C	"		Metallic prominence (spot No. 6977).
" 15	33	+ 7 E.	C	"		Metallic prominence.
" 20	9 50	- 68 W.	C	"		
" 23	7 57	- 81 E.	C		Slight.	
April 2	8 37	- 58.5 E.	C	Slight.		
" 5	52	+ 81.5 E.	C	"		
" 8	21	- 78 W.	C	"		
" 8	14	- 41.5 W.	C	"		
" 8	55	+ 51.5 W.	C	"		
" 16	16	- 12 W.	F	3Å		Associated with spot group No. 6980.
" 20	35	- 70.5 W.	C	0.5Å		
May 9	8 37	+ 86.5 W.	C		Slight.	
" 12	10	- 72 E.	C	Slight.		
" 22	19	- 79 E.	C	"		
June 1	8 29	- 8.5 W.	C	"		
" 3	23	- 8.0 W.	C	1Å		Associated with spot No. 6990.
" 23	10 6	- 70.5 W.	C	Slight.		

It is to be noted that out of twenty-six disturbances twenty-four gave shifts towards the red end of the spectrum and only two towards the blue. It is also remarkable that a large proportion (fourteen) were met with in high latitudes between the limits 68° and 80°, only seven being observed in low latitudes between 7° and 17° and five in middle latitudes between 39° and 63°. Sixty-nine per cent. of the whole number were in the southern hemisphere and the largest displacements were associated with sunspot disturbances.

The preponderance of displacements towards the red is a remarkable feature; it is much greater during this period than in previous years, but taking the whole series of observations since prominence records began at Kodaikanal in 1904 there is found to be a very marked preponderance of shifts towards the red. Up to the end of 1911, 515 displacements have been recorded of which 305 or 59.2 per cent. were towards the red. In recording these displacements it is impossible to distinguish between symmetrical widening of the lines due to increased density of the hydrogen, and symmetrical widening in both directions due to motions in the line of sight, or pressure shifts combined with motion shifts. When the line is bodily shifted from its true position there is little doubt in ascribing it to motion, but in the majority of cases the line is widened on one or both sides, or a sharp wedge-shaped point projects from the line in one or both directions. If all the cases of symmetrical widening were classed separately and deducted from the total number observed, the proportion of displacements towards the red would be increased to 62.4 per cent.

If this tendency towards the red is to be ascribed to motion it appears to involve an effect due to some influence of the earth, and one hesitates to dismiss this as altogether improbable in view of the remarkable preponderance of eastern over western prominences, and the apparent influence of the earth on sunspot phenomena discovered by Mrs. Maunder. On the other hand it is easy to ascribe this tendency to an effect of pressure if we could be sure that pressures of the order required are possible above the photospheric level.

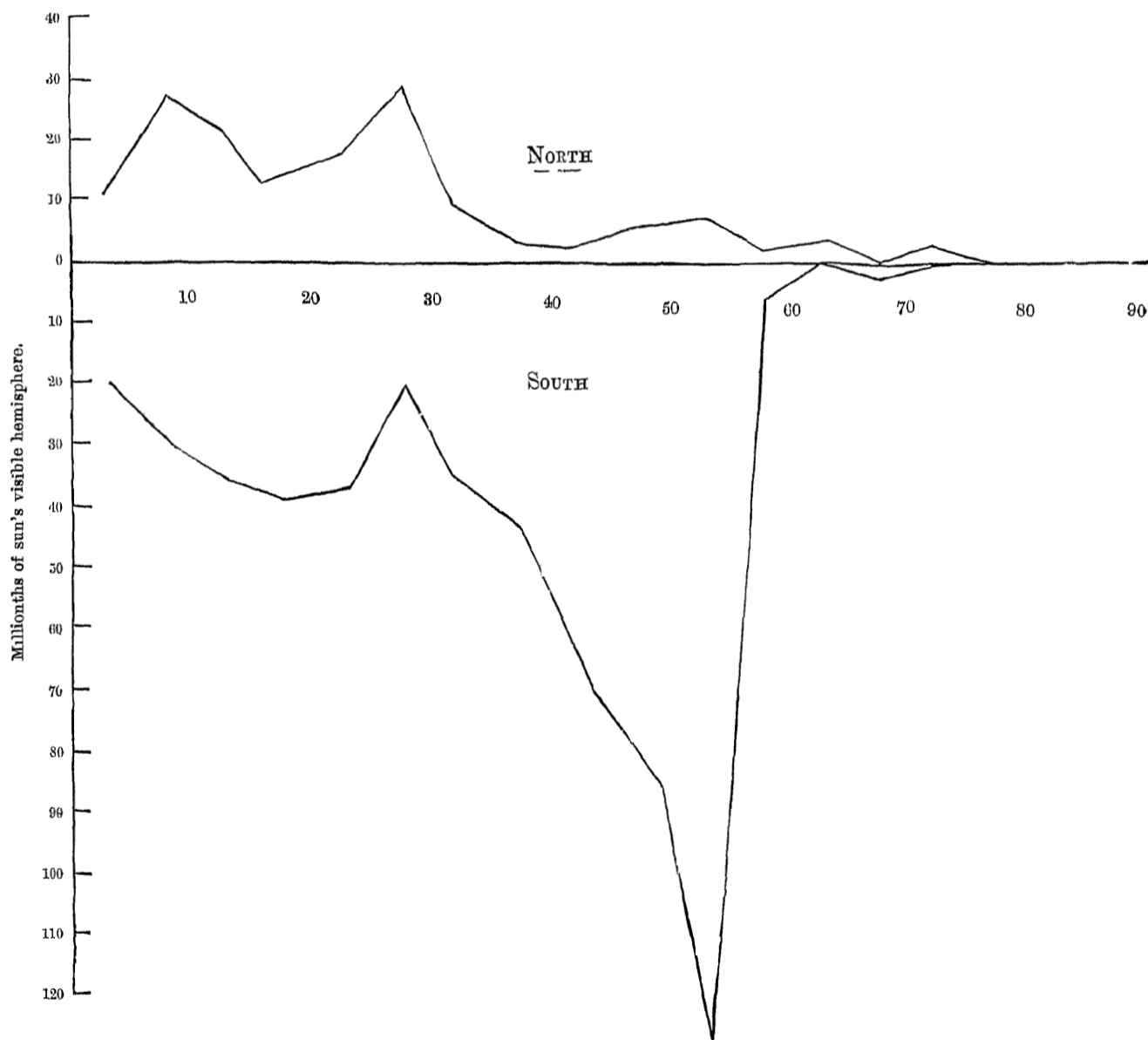
These disturbances show on the whole a very marked preference for the eastern limb although the small number recorded during 1912 predominate on the west limb. Of the 515 displacements observed up to the end of 1911, 298 or 57.9 per cent. were on the east limb, a preponderance of which only a small part may be ascribed to the greater frequency of prominences on that limb. It appears that prominences are not only more numerous on the east limb than on the west but they are decidedly more active on the east limb.

Prominences projected on the disk as absorption markings.

Photographs of the sun's disk in H α light have been obtained since April 1st, 1911 with the autocollimating grating spectroheliograph. During nine months of 1911 photographs were obtained on 161 days and during the first six months of 1912 on 89 days. The distribution in latitude of the absorption markings which appear in a large proportion of the plates during these two periods is shown in the accompanying diagrams in which the mean areas, corrected for foreshortening, are given for each zone of 5° of latitude.

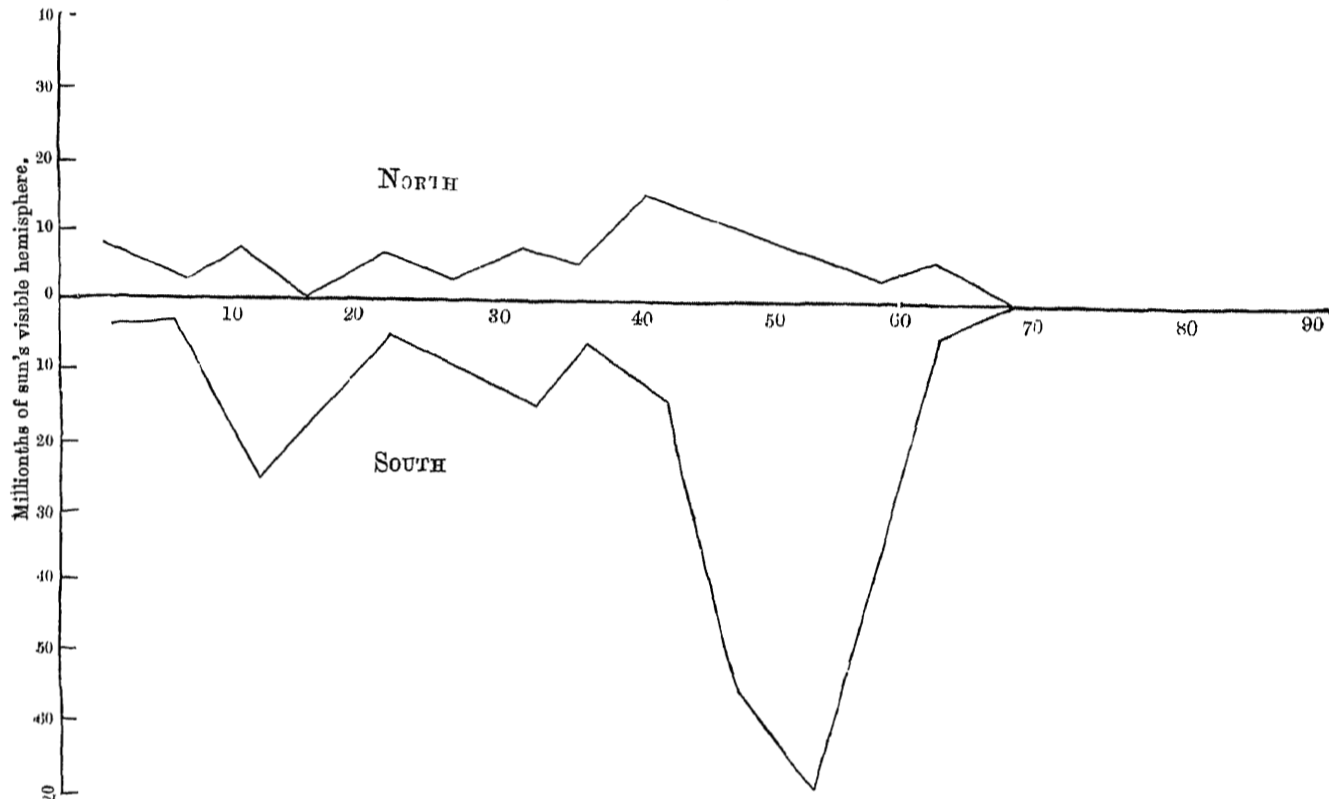
MEAN AREAS OF H α ABSORPTION MARKINGS.
APRIL 1ST TO DECEMBER 31ST, 1911

Total mean area for North hemisphere 162.9 millionths.
Do. do. South hemisphere 706.1 millionths.



MEAN AREAS OF $H\alpha$ ABSORPTION MARKINGS.
JANUARY 1ST TO JUNE 30TH, 1912.

Total mean area for North hemisphere 81.4 millionths.
Do. do. South hemisphere 251.7 millionths.



There is a general similarity of these curves with the prominence distribution curves for the same periods (see page 1, and Kodaikanal Observatory Bulletin No. XXVI, p. 499). The maximum in the southern hemisphere in the zone 45° — 55° and the minimum in the polar regions is the same for prominences and absorption markings, and there is a tendency towards reduced activity at the equator in both. An exact correspondence in the details of the curve is not to be expected on the assumption that the absorption markings are prominences projected on the disk, because, while it seems to be true that every absorption marking is associated with a prominence, only a comparatively small proportion of the prominences indicate their presence on the disk by absorption phenomena.

The high latitude zone of activity between 45° and 55° in the southern hemisphere has produced by far the largest proportion of prominences which show as absorption markings, and these markings tend to form more or less connected chains extending across the disk, a feature which had previously been inferred from the fact that the high latitude prominences at the limb had frequently been observed for many days in succession in nearly the same position angle, and often on both east and west limbs at the same latitude.

The activity in low latitudes, between 5° and 15° north and south in 1911, and between 10° and 15° south in 1912, is closely connected with sunspot disturbances which were prevalent in those regions in both hemispheres in 1911, and in the south only in 1912. A spot disturbance is almost always accompanied by absorption markings, generally of a sharply defined linear character, often curiously sinuous, whilst in the higher latitudes the markings may be described as irregular blotches.

Comparing the two periods under review the general distribution is much the same except that the low latitude activity in the north during 1911 has practically disappeared in 1912. There is a great reduction of mean area in 1912, the totals for the two periods being 869 millionths of the visible hemisphere *per diem* in 1911 and 333 millionths *per diem* in 1912. This reduction is partly connected with the reduction in the number of spots, but the high latitude zones have also shown much smaller mean areas in 1912. The general

reduction is also shown by a comparison of the number of days when no dark markings were found on the plates, this during the first period was 14 per cent. of the whole number and during the second 45 per cent.

Markings on the $H\alpha$ spectroheliograms which are brighter than the general background have also been frequently photographed. These have invariably been associated with spot disturbances and are the same as have been recorded visually from time to time in the neighbourhood of spots.

KODAIKANAL,
25th November 1912.

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