Kodaikanal Observatory.

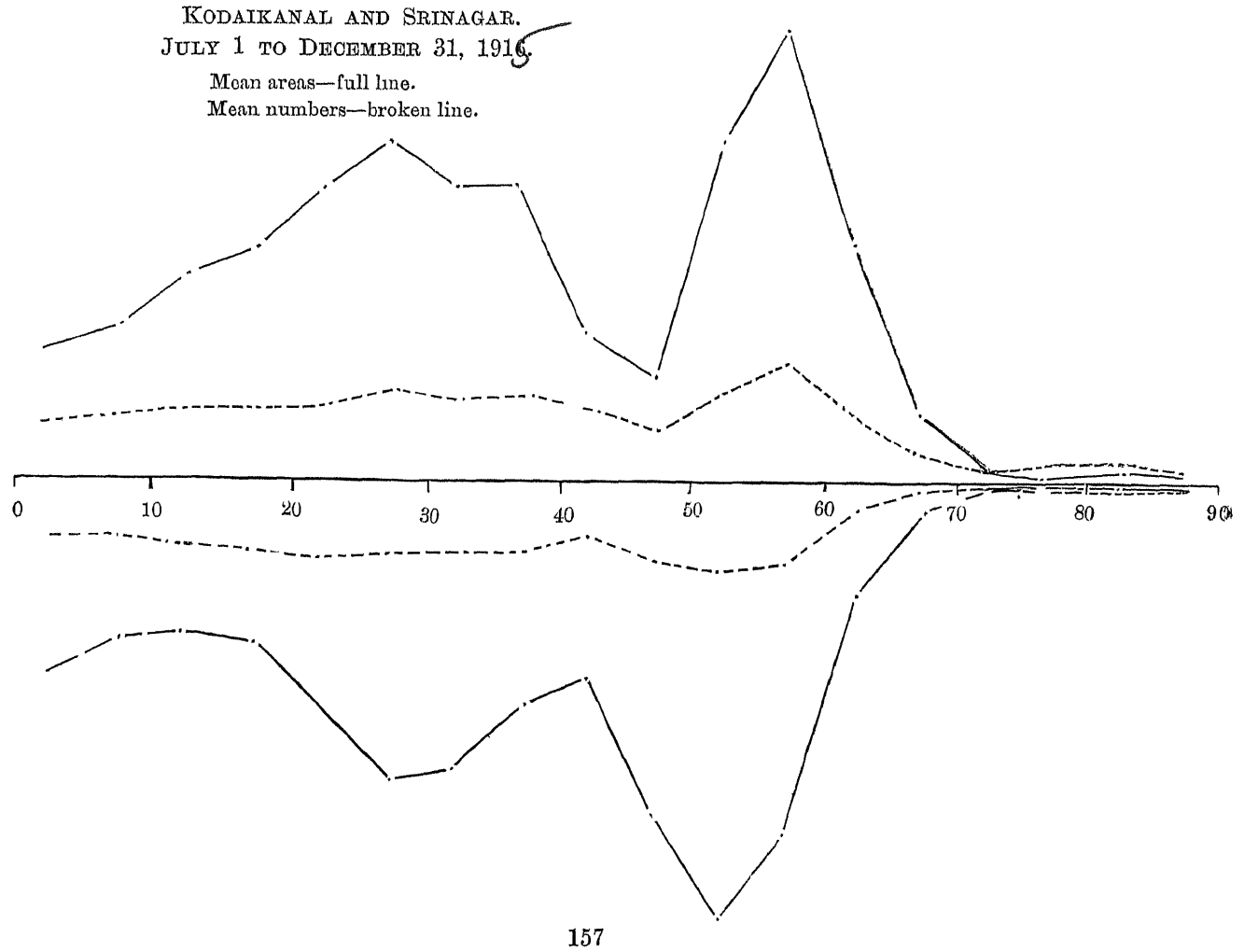
BULLETIN No. L.

SUMMARY OF PROMINENCE OBSERVATIONS FOR THE SECOND HALF OF THE YEAR 1915.

In this bulletin the prominence observations made at Srinagar since August 8 by the Kashmir expedition under Mr. J. Evershed, the Director, have been used to supplement those made at Kodaikanal. At Kodaikanal the visual observations were practically confined to displacements of the hydrogen lines and to metallic prominences, as the position angles, heights and areas can now be much more satisfactorily determined from the photographs. For those days when the Kodaikanal photographs of prominences were incomplete, imperfect or wanting, the visual observations made at Srinagar were substituted. With this aid of the Srinagar observations there were no prominence observations on only six days (all in December) between August 8 and December 31, and incomplete or imperfect observations on only three days. In the whole six months observations were made on 162 days, counted as 157 effective days.

The distribution of prominences observed and photographed during the half-year ending December 31, 1915, is represented in the accompanying diagram. The full line gives the mean daily areas and the broken line the mean daily numbers for each zone of 5° of latitude. The ordinates represent tenths of a square minute of arc for the full line and numbers for the broken line.

FIG. 1.—MEAN AREAS AND MEAN NUMBERS OF PROMINENCES, KODAIKANAL AND SRINAGAR. JULY 1 TO DECEMBER 31, 1915.



The distribution, which is practically unaffected by the inclusion of Srinagar observations, is very similar to that in the first half of the year, but there is a large reduction in the number of polar prominences.

The mean daily areas and daily numbers (corrected for partial observations) are given in the table below, where the data for Kodaikanal observations alone are also given separately for the sake of uniformity with previous bulletins. It is seen that the inclusion of Srinagar observations has slightly reduced both the daily areas and daily numbers ; this is probably due to the fact that only visual observations at Srinagar were used.

		Mean daily areas (square minutes).	Mean daily numbers.
Kodaikanal and Srinagar Observations (157 effective days).	North	2·46	7·89
	South	2·49	7·40
	Total ...	4·95	15·29
Kodaikanal Observations (122 effective days).	North	2·62	8·15
	South	2·67	7·69
	Total ...	5·29	15·84

Compared with the previous six months there is a large diminution in the mean numbers but only a slight one in the mean daily areas. The average area of a prominence has consequently increased.

The monthly, quarterly and half-yearly frequencies and the mean height and extent of the prominences observed at Kodaikanal are given below in the following table. The frequencies are derived from the number of effective days.

Abstract for the second half of 1915 (Kodaikanal).

Month.	Number of days of observations.		Number of prominences	Mean daily frequency.	Mean height	Mean extent.
	Total.	Effective.				
1915.					"	°
July	18	15	218	14·5	37·5	2·77
August ...	23	21	268	12·8	50·8	4 92
September ...	24	20	250	12·5	46·7	3·84
October	27	26	466	17·9	42·5	3·56
November	22	19	325	17 1	40·1	3·30
December	21	21	406	19·3	39·2	2 95
Third quarter ...	65	56	736	13·1	45·0	3·92
Fourth quarter ...	70	66	1,197	18·1	40·7	3 24
Second half-year .	135	122	1,933	15·8	42·5	3·47

There is a large increase (40 per cent) over the previous half-year in the mean height which accounts for the increase in the average area of a prominence mentioned above.

Distribution east and west of the sun's axis.

In the observations at Kodaikanal and Srinagar combined, numbers show a slight preponderance at the western limb, and areas a slight preponderance at the eastern limb.

1915, July to December.	East.	West.	Percentage east.
Numbers observed	1,196	1,204	49·83
Total areas in square minutes	3,892	3,880	50·08

Metallic prominences.

The following metallic prominences were recorded in the half-year. Since the Srinagar observations were generally made at a later hour than those at Kodaikanal, the metallic prominences observed at the two stations, as well as the displacements in prominences, have generally little relation to each other and are therefore given in separate lists.

TABLE I-A.—LIST OF METALLIC PROMINENCES OBSERVED AT KODAIKANAL. JULY—DECEMBER, 1915.

Date.	Time I S T.	Base.	Latitude.		Limb.	Height.	Remarks.
			North.	South.			
1915.	H. M	°	°	°		"	
July 8	9 0	6	..	22	W	30	D_1, D_2, b_1, b_2, b_3, b_4.
10	8 58	8	..	26	E	40	D_1, D_2, b_1, b_2, b_3, b_4.
August 10	8 33	5	..	16	W	125	D_1, D_2, b_1, b_2, b_3, b_4, 6677, C symmetrically widened.
14	8 52	2	..	16	E	30	D_1, D_2, b_1, b_2, b_3, b_4, 7065, 6677.
29	8 50	4	...	21	E	45	D_1, D_2, b_1, b_2, b_3, b_4.
September 14	8 32	17	.	31	W	50	D_1, D_2, b_1, b_2, b_3, b_4.
23	9 18	2	19	.	W	45	D_1, D_2, b_1, b_2, b_3, b_4, 6677, 7065.
October 3	8 27	2	11	...	W	60	6677, D_1, D_2, b_1, b_2, b_3, b_4.
20	8 46	9	...	25 5	E	..	D_1, D_2 slightly reversed.
November 9	8 52		...	14	E	50	D_1, D_2, b_1, b_2, b_3, b_4.
25	8 56	2	.	21	W	25	D_1, D_2, b_1, b_2, b_3, b_4.
December 5	8 35	1	...	20 5	W	25	D_1, D_2, b_1, b_2, b_3, b_4 slightly reversed.
6	8 55	10	25		W	55	D_1, D_2, b_1, b_2, b_3, b_4, 5316·8.
7	8 40	6	...	28	E	50	D_1, D_2, b_1, b_2, b_3, b_4.
10	8 46	1	.	23·5	W	40	D_1, D_2, b_1, b_2, b_3, b_4 strongly reversed (whole prominence seen in them), 7065, 6677, 5016 slightly reversed. Other lines: 4924·1, 5197·8, 5234·7, 5276·2, 5284·2, 5316·8, 5363·0.

Compared with the previous half-year there is a decrease in the number of metallic prominences observed.

TABLE I-B.—LIST OF METALLIC PROMINENCES OBSERVED AT SRINAGAR. AUGUST 8 - DECEMBER, 1915.

Date.	Time I.S T.	Base.	Latitude.		Limb.	Height.	Remarks.
			North.	South.			
	H M	°	°	°		"	
August 9	10 20	20	15	...	W	60	D_1, D_2.
10	10 20	10	...	12	W	45	D_1, D_2, b_1, b_2, b_3, b_4, 6677; C displaced.
11	10 20	20	..	24	W	30	D_1, D_2, b_1, b_2, 6677.
19	9 55		..	17	W	15	D_1, D_2, C displaced.
23	..	..	14—25	...	W	15—40	D_1, D_2, b_1, b_2, b_3, b_4, 6677.
29	8 45	4 5	..	22	E	45	D_1, D_2, b_1, b_2, b_3, b_4.
September 8	9 27	...	.	26·5—29·5	W	20	D_1, D_2, b_1, b_2, b_3, b_4, 6677.
20	9 14	3	10	...	E	25	D_1, D_2, b_1, b_2, b_3, b_4, 6677; C displaced.
	9 1	8	...	18·5	W	70	D_1, D_2, b_1, b_2, b_3, b_4, 6677; C displaced.
22	10 0	.	18·5—21	...	E	25	D_1, D_2, b_1, b_2, b_3, b_4, 6677.
October 6	9 30	7	14·5	...	E	45	D_1, D_2, b_1, b_2.
20	10 5	0·5	10	...	W	20	D_1, D_2, b_1, b_2, b_3, b_4, 6677, C displaced.
29	10 0	2	.	16·5	W	45	6677 faint, D_1, D_2, b_1, b_2, b_3, b_4 very faint.
30	11 15	6	...	11	W	50	D_1, D_2, b_1, b_2, b_3, b_4, 5316, in two places; C displaced.
November 9	16 15	13	..	8	E	...	D_1, D_2, b_1, b_2, b_3, b_4, 6677, eruptive; C displaced.
13	9 0	20·5	..	19	E	45	D_1, D_2, b_1, b_2, b_3, b_4, 6677; in southern half only; C displaced.
17	16 0	2	...	22 5	E	25	D_1, D_2, b_1, b_2, b_3, b_4, 6677, 5316, 5018, 4924 and other green lines; C displaced.
18	11 0	7	21	...	W	25	D_1, D_2, b_1, b_2, b_3, b_4, 6677; C displaced.
23	9 37	1	...	15 5	W	20	D_1, D_2, b_1, b_2, b_3, b_4, 6677; C displaced.
25	11 15	5	...	20	W	25	6677 faint; C displaced.
	14 25		...	20	W	...	D_1, D_2, b_1, b_2, b_3, b_4, 6677 faint.
26	9 50	10	..	20 5	W	180	6677 faint but bright at $11^h\ 12^m$; C displaced.
December 1	12 30	..	19 5	...	E	...	D_1, D_2, 6677; not visible in C.

Displacements of the hydrogen lines.

The displacements observed at Kodaikanal are given in Table II-A and those observed at Srinagar in Table II-B.

TABLE II-A.—DISPLACEMENT OF THE C LINE IN PROMINENCES OBSERVED AT KODAIKANAL. JULY TO DECEMBER, 1915.

Date.	Time.	Latitude.		Limb	Displacement			Remarks.
		N	S		Red	Violet	Both ways.	
1915.	H M	°	°		A	A.	A.	
July 2	9 2		18 5	W	1·5			
3	8 32		20	W	1	3		
6	8 37		17	E		Slight		
	8 22		24	W	0 2			
8	9 0		21·5	W		1		Metallic
10	8 50	19		E	0·5			
11	8 32	20		E	Slight			
	8 32	17		E		Slight		
17			20	W		Do.		
29	9 20		19	E	Slight	0 5		
		22 5		W	0·5			
August 6	8 40	43·5		W	Slight			
8	10 10		35 5	W		2		
9	9 52		14	W		1·5		
10	8 44		30	E	1·5			
	8 22	37		W	1·5			
	9 5		26	W	3·5			
12		20 5		W	2			
15			22	E		2		
16	9 20		35	W	Slight			
19	8 45		27	E	1	Slight		
	8 45		32	E	4			At top
					2			At base.
	8 55		32	W	Slight			
20	9 5		29·5	W	Do.	1		To red at base ; to violet at top.
21	8 59	66		E		Slight		No prominence.
22	9 27	35·5		E		0 5		At top.
			18 5	W	1			
27	10 38		20 5	W	1·5			At top
28	8 35		52 5	E		Slight		
29	8 50	23		E		2		Metallic.
September 9	9 25		37	E	Slight	Slight		To violet at base ; to red at top
14	8 35		29	W		Slight		
			34	W			Slight	
15	8 45		21	E	1·5			
			27 5	E		1 0		
19	9 50		35	E		Slight		
21	9 58		12	W			Slight	
23	9 16	10		W	Slight			
	9 15	19		W	1	0·5		Metallic
26	9 10	72 5		E	0·5			
			21	E	0·5			
October 2	8 28		19	E		Slight		
3	8 27	11		W	Slight			At base.
4	9 0		25 5	W		Slight		At top
5	8 34	56 5		E		Do.		
	26	12 5		E	1			At top.
	21		37	E		0·3		
	42		24	W	2			No prominence.
	47	43		W	0·5	Slight		To red at top ; to violet at base.
6	8 45	18		E	Slight			
7	8 43	10		E			Slight	
8	8 16	8		E		Slight		At top
	34	18		W			Slight	
12	8 40	71 5		E		Slight		
	35		79	E	Slight			
13	8 35		21	E	Do.			At top.
14	8 45		15·5	E	Do			Do.

Date.	Time	Latitude		Limb	Displacement.			Remarks.
		N.	S		Red	Violet	Both ways	
1915.	H M.	°	°		A	A	A.	
October 22	8 51	44·5		E		Slight		No prominence.
	46	14		E		1		
	43		2	E		Slight		No prominence.
	40		84	E	Slight			Do.
	59		27	W	Do.			At base.
23	8 34		25	W		0·5		Do.
24	9 0		13·5	W	2	2		Displacement changing rapidly in amount.
26	8 25		18	E		Slight		No prominence.
29	11 20		16 5	W	1	2		To red at base; to violet at top.
31	9 30	20 5		E	1			
November 3	8 35	36 5		W	0 5	0 5		
9	8 49		8	E	2	3		Displacement changed rapidly.
	34	27·5		W	Slight			
17	8 32		18	E		0 5		At base.
20	8 54	20		E		0·5		
21	8 35	35 5		E	Slight	Slight		To red at top; to violet at base
24			17	W	2			
25	9 0		21	W	1	3		
26	9 38	12		W		1·5		At top.
28	9 34		58	E		0 5		Over whole prominence
30			29	W		0 5		At top.
December 1	9 4	12		W	Slight			At base.
2	9 4	27·5		W	1			Do.
5	8 26		56	E	Slight			No prominence.
	45	10		W	Do			Do.
6	9 5	37·5		E	0 5			At top.
	0		38	W			Slight	Widened symmetrically.
	8 56	15		W		Slight		At top.
	46	59		W		Do.		
7	8 40		28	E		Do		At top.
9	8 22		20 5	E	Slight			Do.
10	8 39	88		E		Slight		No prominence.
	9 20		52	E	Slight			
	8 46		23 5	W			Slight	
	45		15	W		Slight		
11	8 42	49		E				No prominence.
	37		26	E		Slight		At top.
	46		34	W	Slight			At base.
12	8 34	17		W	Do			
13	8 34	68		E	Do			C bulging out to red over 2".
		16·5		W	Slight			
14	8 40		12	W	Do.			No prominence.
15	8 33		67	E		Slight		Do.
	56	10		W		Do.		
	59	24		W	Slight	Do.		To red at base; to violet at top.
16	8 32	18		W	0 5			At top.
17	8 49		33	E	Slight			
	34	12		W	Do			At base.
	37	44		W		Slight		No prominence.
23	8 53	12 5		W		Do.		
30	55		25·5	E		Do		
31	47		56	E		Do		At base.

There was a large decrease on the previous half-year in the number of displacements observed at Kodaikanal. There were 47 in the northern hemisphere and 62 in the southern; there were 54 in the eastern hemisphere and 55 in the western. Fifty-six displacements were to the violet, 61 to the red and 7 both ways simultaneously.

Between 0° and 30° of latitude there were displacements observed at Kodaikanal in 73 prominences, between 31° and 60° in 28, and between 61° and 90° in 8.

TABLE II-B.—DISPLACEMENT OF THE C LINE IN PROMINENCES OBSERVED AT SRINAGAR. AUGUST 8TH TO DECEMBER, 1915.

Date.		Time.	Latitude		Limb.	Displacement.			Remarks
			N	S		Red	Violet.	Both ways	
1915.		H. M.	°	°		A.	A.	A.	
August	10	10 20		12	W	Slight	Slight		Metallic.
	12	11 30	30		E		1		
	15	9 33		21 5	E	0·5			At bases of the two bright streaks.
		9 10	25·5		W		2		
	16	10 34		19	W		Slight		No prominence
				17	W			Slight	Do
	18	9 0	32 5		E	1			At northern end.
	19	9 55		17	W	1			D_3 also displaced; metallic.
	20	9 20		28·5	W	Slight	Slight		To red at northern end; to violet at southern end
	28	9 20	18 5		E		1		Near top.
		8 41	53 5		W		Slight		Except near base.
September	1	9 30		24	W		Do.		Over taller streaks at northern end.
	3	8 45	22		E			2	At northern end. Displacement gone at $8^h\ 52^m$.
	7	8 50		38 5	E	1			
	8	9 27		26 5	W		0·5		
	10	9 58	81		W			Slight	No prominence.
	12	9 10		17	E	Slight			Do.
		9 30		35	W		1		On northern side.
		9 30		23	W		Slight		At northern end
	15	10 28		29	W	2			
		28		31	W	2			
	16	9 30		15 5	W		1		On southern jet.
	19	8 30	21		E	1			At northern end.
		8 30	14 5		E	1		4	At base.
	20	9 14	10		E		2		Metallic.
		9 1		18 5	W				At base of tall streak; displacement to red gone at $9^h\ 3^m$.
	26	9 30		23·5	E	Slight			At base
		10 8		23 5	E		2		Over whole prominence.
	29	10 33		32 5	E	1			In places.
October	5	11 48	10 5		E	0·5			At base
	7	9 30	22		E	2			
		11 42	10 5		E	3	2		To red over lower part; to violet in upper streak.
		9 40	18		E	2			Over whole height (170″).
		9 45	18		E		1		At base of stem.
		9 50	18		E	5			At northern end of top.
		10 5	18		E	2-3	2-3		To red on northern bright branch; to violet on southern faint branch. Displacement to violet over whole prominence from $10^h\ 40^m$ to $11^h\ 42^m$.
	8	10 40	56 5		E		Slight		
	12	10 0		45·5	W	Slight			
	13	9 43	31 5		E	Do.			
		9 38		14·5	E			1	No prominence.
	16	9 55	27		E	2			At base.
	19	9 15	18		E			Slight	No prominence at $9^h\ 15^m$. Prominence (15″) at $10^h\ 7^m$
	20	10 5	10		W		1		Metallic; no displacement at $10^h\ 20^m$.
	26	..	21		W	0 5			At base.
	28	...	33 5		E	1	1		To red at northern end; to violet at southern end.
	30	9 40		11	W	1-1·5			At southern end; over a spot; metallic at $11^h\ 15^m$.
November	4	10 9		15	E	0·5	0·5		To red in upper half; to violet in lower half.
	7	16 10	57·5		W		0·5		At top and in base.

Date		Time	Latitude N	Latitude S	Limb.	Displacement. Red.	Displacement. Violet	Displacement. Both ways.	Remarks.
1915.		H M.	°	°		A.	A.	A.	
November	9	10 20		8	E	1·5			Metallic, at 16h 15m.
		11 32		8	E		1		At northern end.
		9 35		22·5	E		2		
	13	9 0	19		E	Slight	Slight		Metallic; to red near base, to violet near top at +14° E.
	16	8 50	87		E	0·5			
	17	9 32		22·5	E	1	Slight		To red at northern end; to violet at southern end.
		16 0		22·5	E	1 - 2			Metallic.
	18	9 52		23	E	1			No prominence.
		11 0	21		W	1	0·5		Metallic.
	22	9 54		54·5	W		Slight		
	23	..		63	E		Do.		
		9 37		15·5	W	Slight			At base; metallic
		10 20		15 5	W	1	1·5		To red at southern end; to violet at northern end.
		10 25		4·5	W	1·5			Over slanting streak at northern end.
		11 15	59·5		W	1			
		11 50	59·5		W		2–3		
	24	9 49		29	E	Slight			No prominence.
	25	10 40		29	W	1	1		To red in upper half; to violet in lower half.
		10 45		20	W	1	Slight		
		11 15		20	W		Do.		Over a short bright streak; metallic at 15h 30m.
		16 0		21	W			2	
		16 0		27	W		0·5		
	26	11 5	13·5		W			3	At base; smaller displacements observed from 9h 50m to 11h 10m in other parts of prominence; metallic.
	28	11 24	66·5		E		Slight		No prominence.
December	2	10 45	26		E	0·5			At base.
	5	9 20	38·5		E		Slight		In southern part.
	7	11 7		28	E		Do.		On northern edge.
	8	10 40		18	E			Slight	On lower bright part.
		10 58		26	W				In chromosphere
	9	14 30	11·5		E	Slight	Slight		Near base in southern half
	24	9 42	7 5		W		Do.		
			10		W	Slight			

Of the 71 prominences in which displacements were observed at Srinagar, 33 were in the northern hemisphere and 38 in the southern; there were 37 in the eastern hemisphere and 34 in the western. Forty displacements were to the violet, forty-three to the red and nine both ways simultaneously.

Between 0° and 30° of latitude there were displacements observed at Srinagar in 54 prominences, between 31° and 60° in 13, and between 61° and 90° in 4.

At both Kodaikanal and Srinagar the greatest number of displacements occurred between 0° and 30°; this is apparently characteristic of times of great spot activity.

Reversals and displacements of the C line on the disc.

One hundred and eighty reversals of the C line, 22 darkenings of the D_3 line and 66 displacements of the C line were observed at Kodaikanal near spots. There is a decrease on the previous half-year in all these. Their distribution east and west of the central meridian is given below :—

		East.	West.
Kodaikanal	Reversals of C near spots	80	100
	Darkenings of D_3	9	13
	Displacements of C	39	27

There was again a large preponderance of displacements towards the red, 46 being to the red and 6 to the violet.

At Srinagar there were observed 56 reversals of the C line, 5 darkenings of the D_3 line and 21 displacements of the C line near spots. Their distribution east and west of the central meridian was as follows :—

		East	West.
Srinagar ...	Reversals of C near spots	28	28
	Darkenings of D_3	3	2
	Displacements of C	10	11

Prominences projected on the disc as absorption markings.

The grating spectroheliograph for photographing the absorption markings in "H^{α}" light was in regular use during the six months. Photographs were obtained on 85 days which were counted as 63 effective days. The mean daily area in millionths of the sun's visible hemisphere, corrected for foreshortening and for imperfect observations, and the mean daily numbers are given below :—

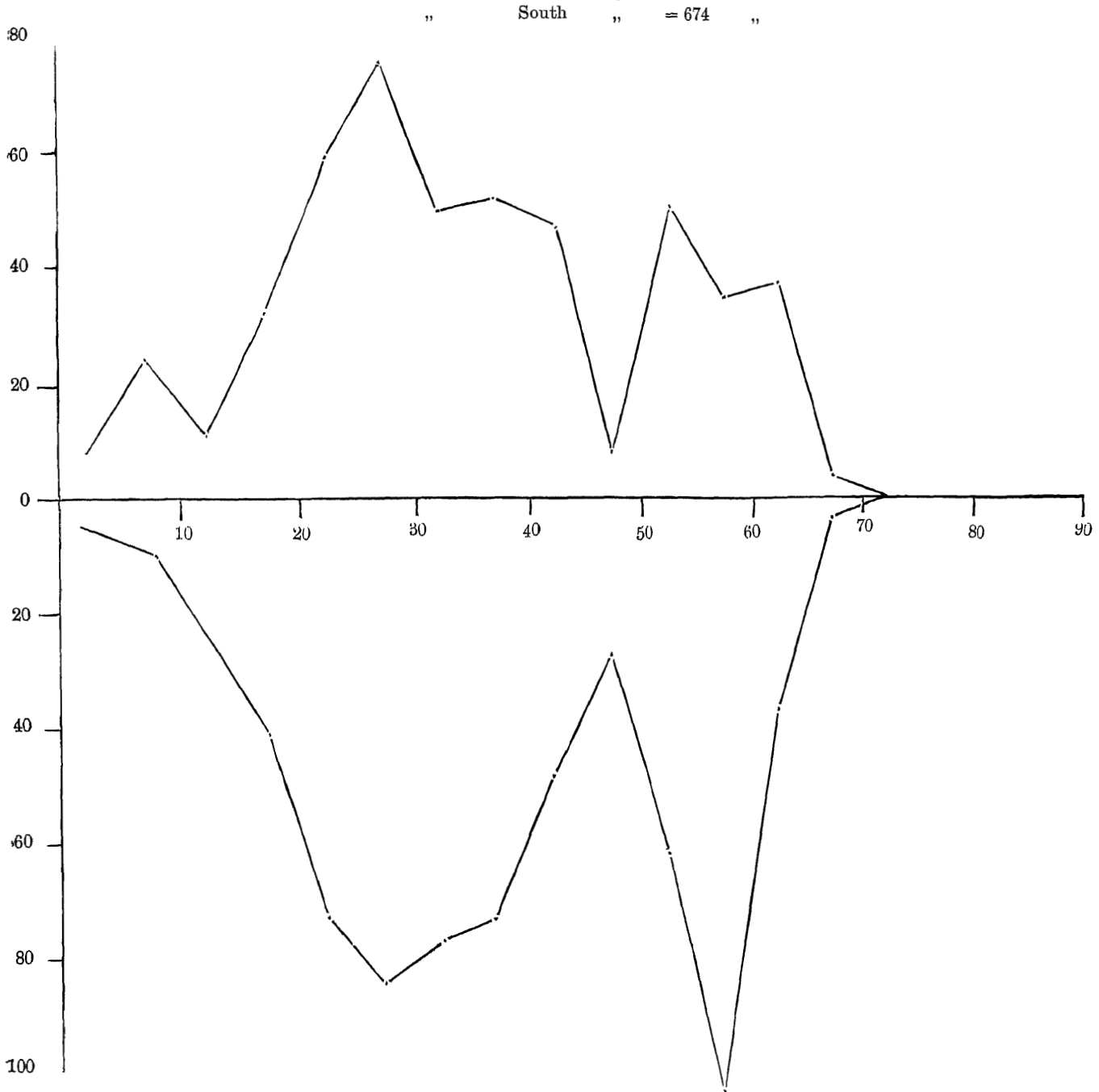
	1915, July—December.	
	Areas.	Numbers
North	492·0	4·7
South	673·9	6·0
Total ...	1,165·9	10·7

There has been an increase in the number observed but a decrease in the areas resulting from a smaller average area of each marking.

The distribution in latitude is given in the accompanying diagram, and is essentially similar to that in the previous six months of the year.

FIG. 2.—MEAN AREAS OF $H\alpha$ ABSORPTION MARKINGS—JULY 1 TO DECEMBER 31, 1915.

Total mean area for north hemisphere = 492 millionths.
" South " = 674 "



There was a preponderance of $H\alpha$ markings on the eastern side of the central meridian, the percentage east being 55·80 in areas and 53·63 in numbers.

THE OBSERVATORY, KODAIKANAL,
31st March 1916.

T. ROYDS,
Assistant Director.

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