

Kodaikanal Observatory.

BULLETIN No. LXXXVI.

SUMMARY OF PROMINENCE OBSERVATIONS FOR THE SECOND HALF OF THE YEAR 1928.

In pursuance of the programme of work adopted since 1st January 1923 under the auspices of the International Astronomical Union, all observatories taking spectroheliograms of the Sun have been asked to co-operate with the Kodaikanal Observatory by supplying copies of their photographs on those days when the Kodaikanal records are imperfect or wanting. In response to our requirements for the second half of the year 1928, the Mount Wilson Observatory supplied prominence plates for 55 days and H α disc plates for 33 days; Meudon Observatory supplied K β disc plates for 18 days and H α disc plates for 30 days; and the Pitch Hill Observatory (Mr. Evershed's) at Ewhurst, Surrey, England, supplied nine prominence plates and eleven H α disc plates.

When only incomplete or imperfect photographs for any day are available from more than one observatory, the best photograph is chosen as representing the solar activity of that day after weighting it according to its quality, and the remaining photographs are ignored.

The mean daily areas and numbers of prominences during the half-year are given below. The means are corrected for incomplete or imperfect observations, the total of 176 days for which plates were available being reduced to 149 effective days.

	Mean daily areas (square minutes).	Mean daily numbers
North	3.52	9.03
South	3.32	8.22
Total ...	6.84	17.25

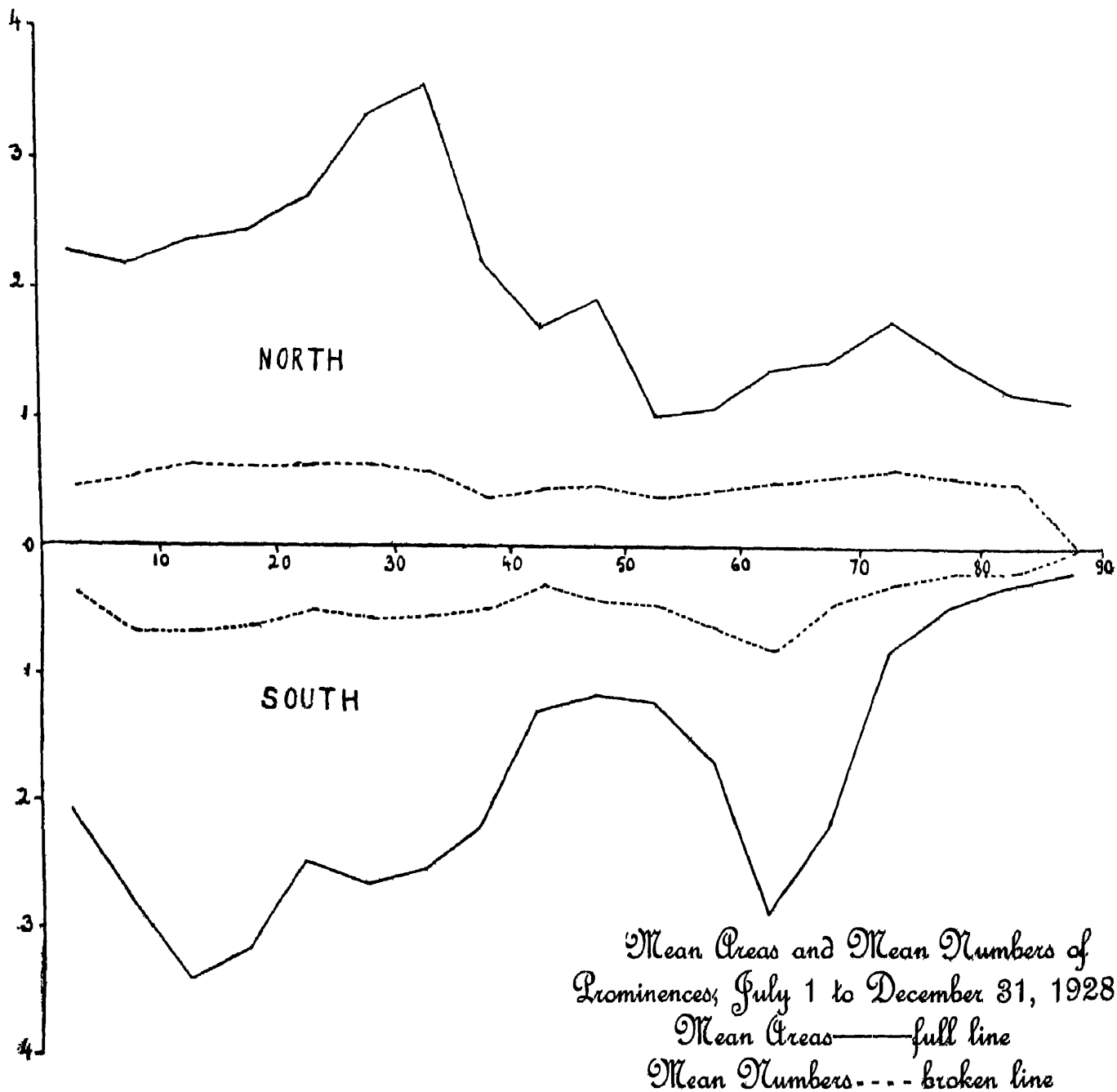
Compared with the previous half-year areas show a decrease of about 4.5 per cent and numbers a decrease of about 11.3 per cent, and the predominance of activity in the northern hemisphere is still maintained.

For comparison with bulletins issued prior to the co-operation of other observatories, the means based on Kodaikanal photographs alone are also given, 144 days of observation being counted as 122 effective days.

	Mean daily areas (square minutes).	Mean daily numbers.
North (Kodaikanal photographs only)	3.66	9.66
South (do.)	3.47	8.73
Total ..	7.13	18.39

The distribution of prominences in latitude is represented in the following diagram, in which 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. Compared with the previous half-year the diagram shows a slight change in the distribution of activity in the various zones. The peaks of activity in the higher latitudes have moved about 5° towards the poles, whereas those in the low latitudes have moved 5° towards the equator.



The monthly, quarterly and half-yearly areas and numbers, and the mean height and mean extent of the prominences on photographs from all co-operating observatories are given in Table I. The unit of area is 1 square minute of arc. The mean height is derived by adding together the greatest heights reached by individual prominences and dividing by the total number of prominences observed; the mean extent is derived by adding together the lengths of the base on the chromosphere of individual prominences and dividing by the total number of prominences.

TABLE I.—ABSTRACT FOR THE SECOND HALF OF 1928.

Months.	Number of days (effective)	Areas.	Numbers	Daily Means		Mean height.	Mean extent
				Areas	Numbers.		
1928						"	°
July	25½	177.1	451	6.9	17.5	43.9	7.99
August	25½	177.8	485	7.0	17.2	42.4	6.47
September	28½	224.7	503	8.0	17.8	38.2	7.03
October	26½	171.8	416	6.5	15.9	40.8	7.17
November	18	129.3	308	7.2	17.1	46.3	6.45
December	25½	137.2	446	5.4	17.5	37.0	4.93
Third quarter	79½	579.6	1,389	7.3	17.5	41.4	7.17
Fourth quarter	69½	438.3	1,170	6.3	16.8	49.4	6.13
Second half-year	149	1,017.9	2,559	6.8	17.2	45.0	6.69

Distribution east and west of the Sun's axis.

Unlike that in the previous half-year, both areas and numbers showed an excess at the west limb compared with the east limb as will be seen from the following table :—

1928 July to December.	East.	West.	Percentage East
Total number observed	1,240	1,309	48.6
Total areas in square minutes	4,989	5,195	49.0

Metallic prominences.

Twenty-seven metallic prominences were observed during the half-year. Their details are given below .—

TABLE II.—LIST OF METALLIC PROMINENCES OBSERVED AT KODAIKANAL, JULY TO DECEMBER 1928.

Date	Hour I S T.	Base	Latitude.		Limb.	Height	Lines
			North.	South			
1928.	H. M.	°	°	°		"	
July 11	10 49	6		20	E	15	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316.8, 5363.0, D ₂ , D ₁ , 6677, 7065.
August 24	8 32	2		17	W		5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5316.8, D ₂ , D ₁ , 6677
August 10	9 14	3	25.5		E	25	4924.1, 5016, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5276.2, 5316.8, 5363.0, D ₂ , D ₁ , 6677, 7065
August 27	12 12	4		23	W	20	4924.1, 5016, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316.8, 5363.0, D ₂ , D ₁

Date.	Hour I.S.T.		Base.	Latitude.		Limb.	Height	Lines.
				North.	South.			
1928	H	M.	°	°	°		"	
September	4	9 47			20	W	10	b ₄ , b ₃ , b ₂ , b ₁ , D ₂ , D ₁ , 6677, 7065.
	5	9 8	3		17 5	W	15	b ₄ , b ₃ , b ₂ , b ₁ , D ₂ , D ₁ .
	6	9 15		15		E		4924.1, 5018 6, b ₄ , b ₃ , b ₂ , b ₁ , 5234 8, 5276.2, 5316.8, 5363.0, D ₂ , D ₁ , 6677, 7065.
	18	8 50	4	17		E	20	4924.1, 5016, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316.8, 5363.0, D ₂ , D ₁ , 6677, 7065.
	18	8 44	5		19 5	E	10	4924.1, 5016, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316.8, 5363.0, D ₂ , D ₁ , 6677, 7065.
	19	9 10	2	20		W	15	b ₄ , b ₃ , b ₂ , b ₁ , D ₂ , D ₁ .
	24	8 45	4		15	W	20	4924.1, 5016, 5018 6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316.8, 5363.0, D ₂ , D ₁ , 6677.
	25	9 10	2		15	W	15	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5270.0, 5276.2, 5316.8, D ₂ , D ₁ , 6677.
	26	9 43	1		19 5	E	15	b ₄ , b ₃ , b ₂ , b ₁ , D ₂ , D ₁ .
	30	9 35	2		30	W	20	4924.1, 5018 6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316 8, 5363.0, D ₂ , D ₁ , 6677, 7065.
October	3	9 46	3		16 5	W	15	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5316 8, D ₂ , D ₁ , 6677.
	7	9 12	3	14 5		E	15	4924.1, 5018 6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5316.8, 5363 0, D ₂ , D ₁ .
	13	8 34	3		15.5	E	15	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5316.8, D ₂ , D ₁ .
	28	10 10	1	15 5		W	15	4924.1, 5018 6, b ₄ , b ₃ , b ₂ , b ₁ , 5276.2, 5363 0, 5371.8, D ₂ , D ₁ , 6677, 7065.
	29	10 30	6	14		W	5	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316.8, 5363.0, D ₂ , D ₁ , 6677, 7065.
	30	12 0	4	16		W		b ₄ , b ₃ , b ₂ , b ₁ , D ₂ , D ₁ , 7065.
November	3	10 2	2		15	E	10	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316.8, 5363 0, D ₂ , D ₁ , 6677, 7065.
December	6	10 6			11	E	15	4924.1, 5018 6, b ₄ , b ₃ , b ₂ , b ₁ , 5269.8, 5316.8, D ₂ , D ₁ , 6677, 7065.
	6	9 50	1	20.5		E	15	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , D ₂ , D ₁ .
	10	9 12	4	20		E	15	4924.1, 5016, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316.8, 5363.0, D ₂ , D ₁ , 6677, 7065.
	11	8 52	4	19		E	10	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5276.2, 5316.8, D ₂ , D ₁ , 6677.
	24	8 57	4	9		W	10	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5234.8, 5276.2, 5316.8, D ₂ , D ₁ , 7065.
	31	9 33	2	13		E	10	4924.1, 5018.6, b ₄ , b ₃ , b ₂ , b ₁ , 5233, 5316.8, D ₂ , D ₁ , 6677.

The distribution of metallic prominences was as follows :—

	1°—10°	11°—20°	21°—30°	Mean latitude.	Extreme latitudes.
North	1	11	1	16 8	9 and 25.5
South	1	11	2	17 1	5 and 30

Fourteen were on the east limb and 13 on the west limb.

Displacements of the hydrogen lines.

Particulars of the displacements observed in the chromosphere and prominences are given in the following table :—

TABLE III.—DISPLACEMENTS OF HYDROGEN LINES.

Date.	Hour I S.T		Latitude		Limb	Displacement			Remarks.
			North	South		Red.	Violet	Both ways	
1928.	II	M.	°	°		A.	A.	A.	
July	3	9 29	7		W		0.5		At base
	4	8 38		14	E	1.5	1		To red at base, to violet at top.
	5	9 54	12		E		1.5		At base
	5	10 22	3		E	1			At top
	5	10 22		1	E		1		At base
	5	10 25		13	E	Slight			At top
	5	10 25		15	E		0.5		At base
	5	8 50		23	W		0.5		
	5	8 48		15	W	1			At top
	5	10 9	27		W	Slight			Do.
	6	11 40		8	E	0.5	0.5		To red at base, to violet at top
	8	9 8		7	W	1			At top
	10	9 7	17		E		0.5		Do
	10	8 50		78.5	W	0.5			Do
	10	8 45	20		W	1			Do
	11	10 46		18	E	1.5	2.5		To red at base to violet at top
	11	10 50		20	E	5.0			At base
	11	10 40		28	W		0.5		Do
	15	8 16	85		E		Slight		
	15	8 40	33		E		1		At top.
	15	8 40	30		E	1			At base.
	15	8 42	10		E	0.5			Do
	15	8 22		24	W		0.5		
	15	8 19	4		W		Slight		
	19	12 32		19	E		0.5		
	20	14 10	15		W	1			At base
	21	8 20	12		E		1		At top
	21	8 30	14		E	0.5			Do
	21	10 26		12	W	1			At base.
	21	10 24		7	W		0.5		At base
	21	8 15	11		W		0.5		Do
	22	8 50	17		E		0.5		Do
	22	9 5		61.5	W	1	1		At top
	22	8 55	1.2		W				Do.
	22	8 53	29		W	0.5			Do.
	23	12 47		16	W	1.5	1		To red at top, to violet at base.
	24	9 35		47	W	0.5			At top
	24	8 32		17	W	0.5			At top; extends over 2° from 16° to 18°
	24	8 32		13	W	1	1.5		To red at base; to violet at top.
	25	9 18	16		E	1			At top
	25	9 25		19	E		1.5		At top, extends over 4° from 17° to 21°
	25	9 25		24.5	E	1			At base; extends over 3° from 23° to 26°
	26	9 24		28	W		1		At top
	26	9 54	16		W	2			Do.
	26	9 20	19		W	1			Do
	26	9 6	21.5		W		1		Do
	29	8 33	71		E		0.5		At base
	29	8 36		8	E	1			Do
	29	8 29		18	W		0.5		Do
	29	8 27	13		W	Slight			At top
	30	8 28		14	E	1			At base
	30	8 30		34	E		1		At top
	30	8 33		81	E		Slight		
	30	8 23		79.5	W	0.5			At top
	30	8 20	22		W		0.5		
	31	9 2	13		E	1			At top
	31	10 45		23	W	2.5	1.5		

Date.	Hour I S T	Latitude		Lamb	Displacement			Remarks
		North.	South.		Red.	Violet	Both ways.	
1928.	II. M.	°	°		A	A.	A.	
September 18	8 44		17	E		0.5		At top
18	8 44		20	E	1.5			At base
18	9 1	17		W	1	0.5		To red at top; to violet at base.
18	8 38	23		W	1			At top.
19	9 13	11		W		Slight		At base.
20	9 25	13		E			Slight	
20	9 0	12		W	2			At top
21	9 37	18.5		E		Slight		At base.
21	9 40	1		E		Do		Do
21	9 45		15	E			Slight	
23	10 46	78.5		E	1			At top.
23	10 58		56.5	W	0.5			Do
24	9 5		12	E		0.5		At base.
24	8 45		15	W	1	0.5		To red at top, to violet at base.
25	9 10		15	W	0.5	1		Do.
25	9 28		12	W	1			At top.
26	9 45	0.5		E	Slight	1		To red at top, to violet at base
26	9 43		19	E	1			At base.
26	9 16		23.5	W	3			At top.
26	9 15		21.5	W	Slight			Do
27	9 31		15	W	2			At top, extends over 2° from 14° to 16°
27	9 30		12.5	W		1.5		At top.
29	9 20		24	W		1.5		At top; extends over 2° from 23° to 25°.
29	8 55	60		W		Slight		At top
30	9 14		30	W			2.5	At base, extends over 2° from 29° to 31°.
30	9 35		30	W	3	8		Extends over 2° from 29° to 31°
30	9 14		27	W	6			At base.
30	9 14		20.5	W	5.5			At top, extends over 3° from 19° to 22°
30	9 9		11	W	0.5			At base, extends over 2° from 10° to 12°.
30	9 8		9	W			Slight	At, base extends over 2° from 8° to 10°.
30	9 0	7.5		W	1.5			At base.
October 1	9 29	56.5		E		1		At top
1	9 3	18		E	1	2.5		To violet at top, to red at base.
1	9 8	15		E		1		At top.
1	9 25		24	W	0.5			Do
1	9 7		17	W	0.5			Do.
1	9 18		8.3	E	0.5			Do.
3	9 27	34.5		E	1.5			At base.
3	8 56		19	W		1.5		At top, extends over 2° from 18° to 20°.
3	9 46		19	W	3	3.5		Do.
3	8 55		16.5	W	5.5			At top, extends over 3° from 15° to 18°.
	8 50	1		W	1			At top, extends over 2° from 0° to 2°.
	9 14	11		E		1		At top
5	8 52	Equator		W	Slight			At base.
6	9 1	15		E	1.5			Do
6	9 2	9		E	1			At middle, extends over 5° from 0° to 5°
6	8 45		2.5	E	2			5°
6	9 5		9	E		1.5		At top.
7	8 49	70		E		0.5		At base.
7	9 12	18		E		2		At top
7	9 9	5		E	0.5			Do.
7	9 17		33	E	0.5			At base
8	9 2	26		W	Slight			At top.
12	10 24		8.5	W	Do.			At base
13	8 32	13		E	1			At top
13	8 34		15	E	1.5	1		To violet at top, to red at base.
24	10 14		40	W		Slight		At base.
24	9 55	18.5		W	1			At top

Date	Hour I.S.T.		Latitude.		Lumb.	Displacement.			Remarks.
			North	South.		Red.	Violet.	Both ways	
1928.	H.	M.	°	°		A.	A	A.	
October	25	10 4		23	W		1		At base.
	25	9 54		0.5	W		2		Do
	28	10 0	15		W	2	1		To red at top; to violet at base; extends over 2° from 14° to 16°.
	28	9 31	25		W	1.5			At top.
	29	10 6	19		E		0.5		Do
	29	10 5	15.5		E		2		At top.
	29	10 30	15		W		1		At base.
	29	10 30	17		W			0.5	At top.
	29	10 30	19		W		1		Do.
	30	11 8	14		E		1		Do.
	30	11 17	13		E	1			At base.
	30	11 18	18		E		1		
	30	10 55		44	E		Slight		At top.
	30	11 45		25	W		1		Do
	30	12 0	15.5		W	1.5			At top; extends over 3° from 14° to 17°
	30	12 0	15		W		2		At base.
	30	12 0	18		W	1			At top.
	30	11 31	75.5		W	1			At base.
	31	9 42		35	W	1			At top.
	31	10 40		29	W	1			Do.
November	2	9 15		14	E	1.5	2		To violet at base.
	2	9 17		26	E	Slight			At base.
	3	10 27		4	E	1			At top.
	3	9 58		8	E		1		Do.
	3	9 58		9	E	1			At base.
	3	9 58		13	E	1.5			Do.
	3	9 58		20	E		1		At top.
	3	10 0		13	E	3	1		To violet at base
	3	9 47		46	E		1		At top.
	8	11 25		23.5	E			Slight	Do.
	8	11 38		8	W	Slight			Do.
	8	11 30	4		W	1.5			Do.
	17	10 50	5		E		1		Do.
	18	8 57		58	W		1		Do.
	19	8 58	25		E		0.5		Do
	25	9 22	50		E		Slight		Do
	25	9 14		29	E		1		Do.
	25	9 12		55	E		1		Do.
	28	10 8	25		W	1			Do.
December	2	9 24		49	W		Slight		At base.
	6	9 42	58		E		1		At top.
	6	9 50	20.5		E	2	0.5		To red at top; to violet at base.
	6	10 5		11	E			1	
	6	9 28	28		W		Slight		At base.
	10	8 52	35		E		Do.		Do.
	10	9 12	19		E	2.5			Do.
	10	9 17	15		E	1			Do.
	10	9 26	15		E	2			Do
	11	8 52	19		E	1.5	1		To red at base; to violet at top.
	12	14 52	4		W	1			At base.
	13	11 57	30		E	1			Do.
	13	11 58	27		E	1			At top.
	13	11 58	26		E	2			Do.
	14	10 53		14	W		1		At base.
	15	10 51	36		E	1			Do.
	15	11 10		52	E	1			Do
	15	10 38		14	W		1		At top.
	15	10 32		10	W	1			Do.
	15	10 26	.6		W		1		Do.
	16	9 19		32	W	0.5			At base

Date.	Hour I.S.T.	Latitude.		Limb.	Displacement.			Remarks.
		North.	South		Red.	Violet.	Both ways	
1928.	π. M	°	°		A.	A.	A.	
December 16	9 16	43		W	1			At top.
18	9 3	18		E	0.5			Do
18	9 7	1		E	1			Do
18	9 9		10	E		1		Do
19	8 56		10	W	1			Do
19	8 50	67		W		Slight		
20	11 22		46	E		Do		At top
20	11 45		22	W	1			Do
21	9 14		13	E	1			At base
21	9 8		16	W		1		At top
21	9 4	21		W	Slight			
22	9 55	39		E		1		At top.
22	9 49		6	E	1			At base
22	9 49		9	E	1			At top.
23	9 7	6		E	Slight			At base
23	8 53	67		W		Slight		Do
24	9 11	35		E	0.5			Do
24	9 6		21	W	1.5			At top.
24	8 57	17		W	0.5			Do
31	9 32	13		E	0.5	1		At base
31	9 12	56		W	1			Do.
31	8 57	63		W	Slight			
31	8 52	78.5		W			Slight	

The total number of displacements was 281 as against 786 in the previous half-year and their distribution was as follows :—

Latitude	North.	South
Equator	1	...
1°—30°	119	113
31°—60°	17	17
61°—90°	9	5
Total	145	135
East limb ... ..	...	144
West limb ... ..	...	137
Total ... ..	...	281

Reversals and displacements on the Sun's disc.

Three hundred and twenty-nine bright reversals of the H α line, 300 dark reversals of D $_3$ line and 99 displacements of the H α line were observed during the half-year. Their distribution is given below :—

	North.	South.	East	West
Bright reversals of H α	184	145	170	159
Dark reversals of D $_3$	170	130	155	145
Displacements of H α	67	32	52	47

Sixty-eight displacements were towards the red, 29 towards the violet and 2 both ways simultaneously.

Eruptive prominences.

The highest prominence ever recorded at Kodaikanal was photographed during the period under review by the Director, Dr. T. Royds, on the 19th November 1928 and had reached a height of 20'9 or 910,000 kms. when clouds intervened. The successive photographs of this remarkable prominence showed the whole mass to be rising from the Sun's surface with an accelerating speed. The velocities in the lower parts of the prominence were 60—70 kms. and in the higher parts 100—170 kms. and increased with time.

Prominences projected on the disc as absorption markings.

Photographs of the Sun's disc in *H α* light were available from Kodaikanal and the co-operating observatories for a total of 176 days, which were counted as 169½ effective days. The mean daily areas of *H α* absorption markings (corrected for foreshortening) in millionths of the Sun's visible hemisphere and their mean daily numbers are given below :—

							Mean daily areas.	Mean daily numbers.
North	...	...	...	...	...	...	1,999	14.1
South	...	...	...	...	...	...	2,783	16.6
							—	—
Total	...						4,782	30.7
							—	—

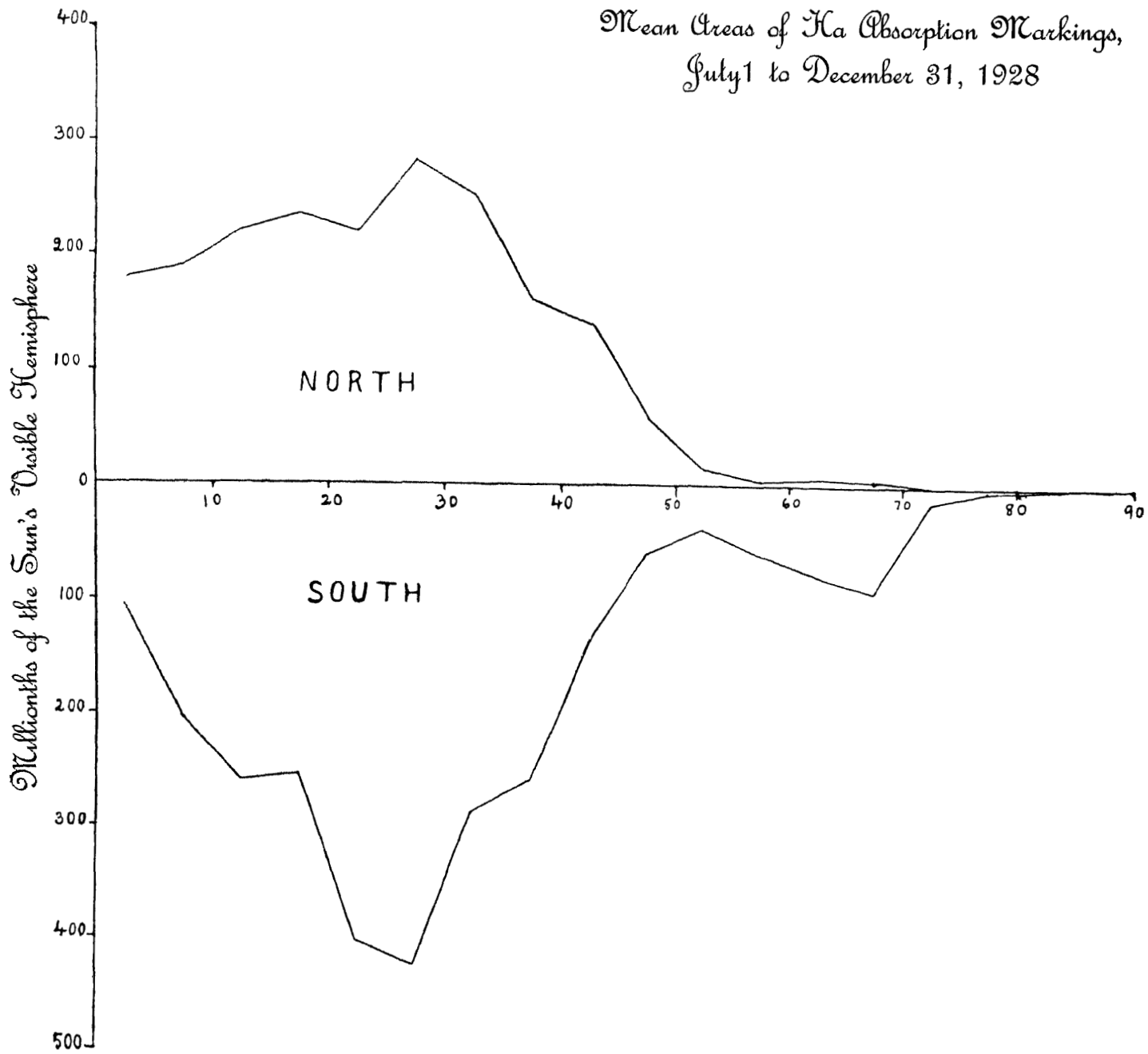
The above show an increase of about 28 per cent in areas and an increase of 4 per cent in numbers compared with the previous half-year. The preponderance of activity in the southern hemisphere still continues in contrast to the northern preponderance of prominences at the limb.

For comparison with bulletins issued prior to the co-operation of other observatories, the means based on Kodaikanal photographs alone are also given, 140 days of observation being reckoned as 126½ effective days.

				Mean daily areas.	Mean daily numbers.
North (Kodaikanal photographs only)	...	..	1,900	12.18
South (do. )	...	...	2,701	14.90
			—	—	
Total	...		4,601	26.08	
			—	—	

The distribution of the mean daily areas in latitude is shown in the following diagram. The maximum activity which persisted within the zone 10° to 20° in the previous half-year has now considerably shifted towards the poles, the zones of maximum activity now being 25° to 35° in the northern and 20° to 30° in the southern hemisphere as is seen from the diagram.

Mean Areas of H α Absorption Markings,
July 1 to December 31, 1928



The excess of activity with regard to areas and numbers still persists in the western hemisphere, the percentage east being 49.00 for areas and 49.86 for numbers.

Thanks are due to the co-operating observatories for the photographs supplied by them.

THE OBSERVATORY, KODAIKANAL,
8th August 1929.

A. L. NARAYAN,
Assistant Director.