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REPORT ON THE

OBSERVATIONS OF TERRESTRIAL MAGNETISM

MADE IN THE BRITISH ISLES ON THE OCCASION OF

THE TOTAL SOLAR ECLIPSE OF JUNE 29, 1927,

BY

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REPORT ON THE OBSERVATIONS OF TERRESTRIAL MAGNETISM MADE IN THE BRITISH ISLES ON THE OCCASION OF THE TOTAL SOLAR ECLIPSE OF JUNE 29, 1927

By H. W. L. ABSALOM, B.Sc.

In consequence of a recommendation of a sub-committee of the Gassiot Committee of the Royal Society of London quick-run magnetograph records were taken during the period 4h. to 8h. G.M.T. on the days June 28, 29, 30, 1927, at the Abinger (51° 11′ N., 0° 23′ W.), Stonyhurst (53° 51′ N., 2° 28′ W.), Eskdalemuir (55° 19′ N., 3° 12′ W.), and Lerwick (60° 8′ N., 1° 11′ W.) observatories.

It may be recalled that the centre line of the narrow totality belt, at the earth's surface, of the eclipse of June 29 (Fig. 1)

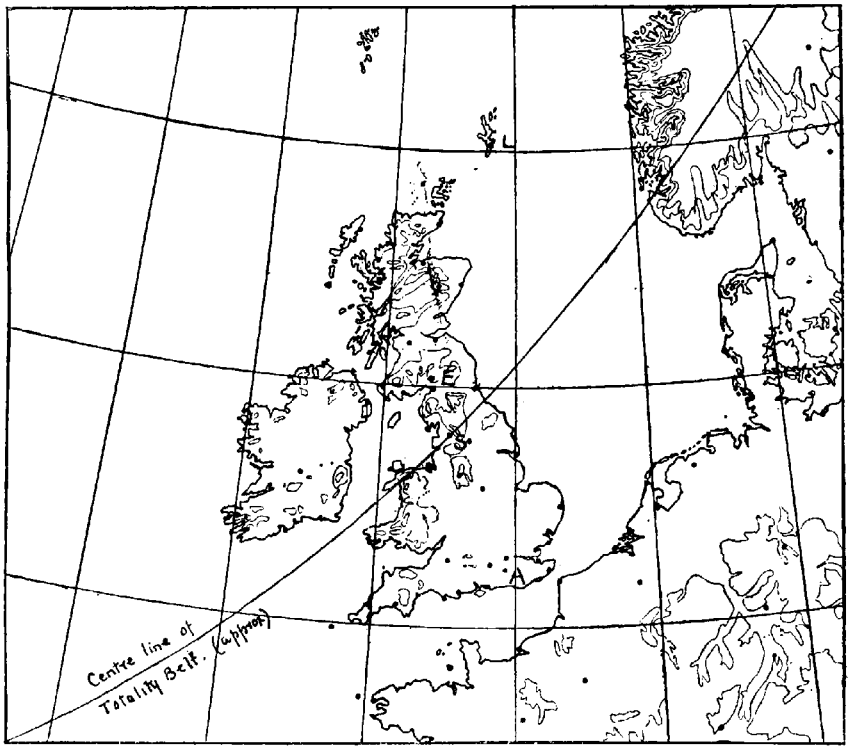


FIG. 1.

extended from (approximately) 46° 29′ N., 16° 14′ W. across the Atlantic to near Criccieth in Wales, across northern England to Hartlepool, across the North Sea to near Stavanger in Norway, thence in a north-easterly direction through Scandinavia, and, after skirting Novaya Zemblya, the northern Siberian coast, and passing across north-eastern Siberia, terminated near the Aleutian Islands. Stonyhurst was within the belt of totality; Lerwick and Eskdalemuir were about 250 and 80 miles, respectively, to

(39092) Wt. 15557, 700/1238 625 2/30 Harrow G.1/27.

the north-west, while Abinger was 200 miles to the south-east, of the nearest point of the belt. According to the *Nautical Almanac*, 1927, the times of beginning and ending of the general eclipse were, to the nearest minute, 4h. 0m. and 8h. 46m., G.M.T. At points in the British Isles the eclipse began and ended within a few minutes (±) of 4h. 30m. and 6h. 20m., respectively ; the greatest phase occurred within a few minutes of 5h. 25m., and the maximum duration of the total phase varied from about 22 to 24 seconds. Assuming that any eclipse magnetic effect is due to modification of the ionization and the electric current systems of the upper strata of the earth's atmosphere, owing to the screening off of solar radiation, it is of interest to note that Dr. E. H. Rayner pointed out*, in connexion with the radio-transmission problem, that the plan position of the intersection of the centre of the moon's shadow with the atmospheric level at about 60 miles (100 km.) above the earth followed approximately the 0·98 totality line across England, i.e., about 100 miles to the south-east of the central track.

The magnetic records obtained on June 28–30 at the four British observatories were of horizontal force (H), declination (D), and vertical force (V) at Lerwick, Stonyhurst, and Abinger, and of north (N) and west (W) components and V at Eskdalemuir. The H and D data for Eskdalemuir were derived from the N and W records. The Abinger and Stonyhurst records were placed at the disposal of the writer, who made the necessary measurements of these records and of those obtained at Eskdalemuir and Lerwick, the basis of procedure being the tabulation of mean values for the successive ten-minute intervals centred at 1h. 55m., 2h. 5m. . . . . 10h. 5m. on each of the three days. No use was made of the Stonyhurst V traces, the authorities of that Observatory having stated that the vertical force balance does not give sufficiently consistent readings to allow of numerical values being safely quoted. Faintness of the quick-run trace prevented tabulation of H for Abinger on all three days, and failure of the base line prevented tabulation of V for Abinger during the second part of the quick run on June 30. Matters affecting the facility, and degree of accuracy, of measurement were the width and clearness of definition of the traces (in both of which respects there was variety), and the ordinate scale value. The scale values are given below :—

	Abinger.	Stony-hurst.	Lerwick.		Eskdale-muir.
H γ/mm. ..	2·65	4·96	6·39	N γ/mm. ..	4·91
D '/mm. ..	0·61	1·13	1·93	W γ/mm. ..	6·62
V γ/mm. ..	2·40	—	9·03	.. .. ..	4·30

* *Nature, London*, **119.** Supplement, June 18, 1927, pp. 87, 97, 98.

For each observatory the normal time scale was between 15 and 15·5 mm. to the hour, and the quick-run scale was approximately 12 times the normal except at Stonyhurst, where it was six times the normal. Some uncertainty was introduced into tabulation of the Abinger traces by the presence of small embroidery due to artificial causes. This effect commenced shortly after 4h., G.M.T., on each of the three days.

The object of carrying out, on the days adjacent to the eclipse day, a programme similar to that on the latter was to obtain a standard or normal by which to detect and gauge events specially associated with the eclipse. In the cases in which some investigators have claimed to have been able to recognise an eclipse magnetic effect, the latter has been small. Therefore, the reasonably certain detection of such an effect requires particularly quiet general magnetic conditions. The magnetic character figures assigned, according to the international scheme, to the days June 28, 29, 30, were 0, 0, 1 by the Lerwick and Stonyhurst observatories, and 1, 1, 1 by Eskdalemuir and Abinger; while the international mean character figures were 0·3, 0·3, 0·7. Not one of the days is included among the five international quiet days selected at De Bilt. As regards conditions during the interval 2h. to 10h. G.M.T., the 30th was the quietest of the days. This interval was fairly quiet on the 28th, although there were numerous minor irregularities before 7h. For some hours before the commencement of the eclipse interval on the 29th conditions were by no means ideally quiet: the values of the absolute range in N at Eskdalemuir in the successive 60-minute intervals commencing at 28d. 18h. and ending at 29d. 4h. are 11, 10, 8, 22, 20, 9, 16, 18, 7, 13γ.

The ten-minute mean values of D, H and V on June 29 are given in Table I, together with the values of the difference $29 - \frac{1}{2}(28 + 30)$, i.e., the algebraical excess of the value of an element on the 29th over the mean of the corresponding values on the 28th and 30th. The data of Table I are represented graphically in Figs. 2 and 3. The values for the different observatories for the 29th are plotted in Fig. 2 to arbitrary ordinate axes; but the broken line, which is drawn through points representing the mean hourly values at Eskdalemuir on the five international quiet days of June, 1927, is drawn to the same reference base as the Eskdalemuir curve for the 29th. Some uncertainty is felt about the V values for Lerwick on the 29th. According to the assigned base-line values, it seems that during the interval June 28–30 the trace was drifting upwards from the base line at the rate of about 16γ per day. The values of V for Lerwick in Table I are based on the assumption of a constant base-line value from 1h. 55m. to 10h. 5m., but if allowance be made for the drift the values should be diminished by amounts increasing from 0 at the beginning to 5γ at the end of this interval. Assuming the drift to have occurred at a uniform rate the values of the difference $29 - \frac{1}{2}(28 + 30)$ are unaffected.

TABLE I—VALUES OF DECLINATION, HORIZONTAL FORCE AND VERTICAL FORCE FROM 1 H. 55 M. TO 10 H. 5 M., G.M.T., ON JUNE 29, 1927, AND VALUES OF THE DIFFERENCE 29–½ (28+30), AT LERWICK, ESKDALEMUIR, STONYHURST AND ABINGER.

G.M.T.	Declination (West).								Horizontal Force.						Vertical Force.					
	June 29.				29–½ (28+30).				June 29.			29–½ (28+30).			June 29.			29–½ (28+30).		
	Ler.	Esk.	Ston.	Abin.	Ler.	Esk.	Ston.	Abin.	Ler.	Esk.	Ston.	Ler.	Esk.	Ston.	Ler.	Esk.	Abin.	Ler.	Esk.	Abin.
h. m.	° ′ 14 40+	° ′ 15 15+	° ′ 14 20+	° ′ 12 50+	′	′	′	′	γ 14590+	γ 16610+	γ 17210+	γ	γ	γ	γ 46710+	γ 44880+	γ 42910+	γ	γ	γ
1 55	6·0	4·7	5·5	6·6	−0·4	−0·8	−1·0	−0·4	27	36	28	− 4	+ 4	+ 5	1	3	9	−23	− 9	− 4
2 5	4·9	4·2	5·0	6·1	−1·8	−1·7	−1·7	−1·0	21	29	23	− 9	− 3	− 1	2	3	8	−23	− 9	− 5
15	5·3	4·3	5·1	6·1	−1·6	−1·8	−1·7	−1·3	19	27	20	−10	− 5	− 4	3	3	9	−21	− 9	− 5
25	5·8	4·5	5·1	6·1	−1·3	−1·7	−1·7	−1·3	20	29	22	−10	− 3	− 3	3	3	9	−21	− 9	− 4
35	5·3	4·1	5·0	6·1	−1·5	−1·7	−1·7	−1·3	25	32	23	− 6	− 2	− 3	2	2	9	−23	− 9	− 4
45	3·9	3·4	4·6	5·8	−2·4	−2·1	−1·9	−1·4	25	30	22	− 8	− 5	− 4	0	2	9	−24	− 9	− 5
55	3·3	3·1	4·5	5·5	−2·9	−2·4	−1·9	−1·6	23	26	19	− 9	− 8	− 6	2	3	8	−23	− 9	− 5
3 5	4·1	3·8	4·7	5·9	−2·1	−1·7	−1·7	−1·3	23	32	22	− 7	− 2	− 3	3	3	10	−21	− 9	− 4
15	4·5	4·1	5·0	*5·9*	−1·7	−1·3	−1·5	*−1·1*	27	36	25	− 5	+ 2	0	3	2	—	−21	− 9	—
25	5·4	4·3	5·2	6·3	−0·3	−0·7	−1·1	—	31	42	30	+ 1	+ 7	+ 5	3	1	10	−21	−10	*− 4*
35	5·1	3·8	*5·0*	6·0	−0·6	−1·1	*−1·2*	−0·4	30	38	*31*	− 2	+ 3	*+ 5*	1	1	9	−23	−11	− 6
45	3·9	3·0	—	5·5	−1·8	−2·0	—	−1·1	28	33	—	− 3	− 2	—	1	1	8	−24	−10	− 6
55	*2·9*	2·3	*3·6*	5·1	*−2·9*	*−2·8*	—	−1·4	*27*	30	*22*	*− 4*	*− 5*	—	*2*	2	8	*−23*	*−10*	− 7
4 5	*2·5*	2·3	3·5	4·7	—	*−2·8*	−2·2	−1·7	*29*	30	21	*− 1*	*− 5*	− 5	*3*	3	10	—	—	− 5
15	2·5	*2·7*	3·6	4·8	*−4·1*	*−2·5*	−2·2	−1·6	31	*33*	23	*+ 4*	*+ 3*	+ 1	6	*3*	11	*−19*	*− 9*	− 4
25	3·1	2·8	3·7	4·8	*−3·7*	−2·7	−2·3	−1·7	33	37	26	*+11*	+10	+ 6	8	3	11	*−18*	− 9	− 4
35	2·9	2·5	3·5	4·6	*−3·9*	−2·8	−2·4	−1·7	34	36	25	*+12*	+ 7	+ 5	9	3	11	*−19*	− 8	− 4
45	2·7	2·2	3·3	4·4	−4·1	−3·2	−2·6	−1·8	36	37	26	+12	+ 7	+ 4	10	3	11	−18	− 8	− 5
55	2·7	1·9	3·1	4·3	−4·7	−4·1	−3·2	−2·3	36	36	26	+15	+ 7	+ 4	12	4	11	−17	− 7	− 4

5	5	2·7	1·9	3·0	4·1	−4·3	−3·7	−2·9	−2·1	37	38	27	+17	+10	+ 6	13	5	12	−15	− 5	− *3*
	15	3·3	2·3	3·3	*4·1*	−3·9	−3·1	−2·4	*−1·7*	37	37	26	+18	+10	+ 6	13	6	*12*	−13	− 4	—
	25	4·3	2·8	3·7	4·4	−2·8	−2·2	−1·6	*−1·1*	34	33	24	+14	+ 6	+ 4	15	6	12	−10	− 3	—
	35	4·3	2·7	3·5	4·1	−2·3	−1·9	−1·4	*−1·0*	32	35	26	+13	+ 9	+ 8	15	6	13	−10	− 4	—
	45	3·9	2·3	3·0	3·7	−2·5	−2·0	−1·5	−1·2	34	38	28	+15	+14	+11	14	6	13	−10	− 4	—
	55	3·5	1·7	2·6	3·1	−2·7	*−2·2*	−1·6	−1·4	34	38	27	+17	*+16*	+13	13	6	13	−12	− *3*	—
6	5	4·5	2·9	3·6	3·9	−1·1	*−0·3*	−0·1	−0·1	36	40	29	+20	*+20*	+16	14	7	13	−10	− *3*	—
	15	*4·7*	*2·7*	3·5	3·7	*−0·8*	*−0·4*	−0·2	−0·1	*34*	35	24	*+16*	*+12*	+11	*14*	*8*	12	*−10*	− *2*	—
	25	*4·1*	2·3	3·3	3·4	*−1·9*	−0·8	−0·4	−0·3	*31*	30	19	*+10*	+ 6	+ 5	*15*	9	13	− *9*	0	—
	35	3·7	2·1	3·0	3·2	−1·9	−0·6	−0·2	−0·1	31	28	18	+10	+ 7	+ 5	17	10	13	− 8	+ 1	—
	45	4·1	2·2	3·0	3·3	−1·6	−0·2	−0·0	+0·1	29	27	17	+ 9	+ 6	+ 5	19	11	13	− 6	+ 3	—
	55	3·9	2·0	2·8	3·0	−1·2	+0·2	+0·3	+0·4	26	23	13	+ 7	+ 2	+ 2	20	12	14	− 5	+ 4	—
7	5	3·9	1·8	2·5	2·9	−1·1	+0·2	+0·2	+0·4	23	21	12	+ 5	+ 1	0	21	12	13	− 4	+ 5	—
	15	3·4	1·3	2·0	*2·5*	−1·7	−0·1	−0·1	*+0·2*	22	21	11	+ 5	+ 1	+ 1	21	11	*12*	− 4	++ 4	—
	25	3·5	1·5	2·2	*2·7*	−1·1	+0·5	+0·6	*+0·9*	20	19	11	+ 4	+ 3	+ 4	22	10	—	− 2	++ 4	—
	35	3·5	1·3	1·9	2·7	−0·6	+0·9	+0·7	*+1·0*	19	20	12	+ 4	+ 5	+ 5	21	9	*11*	− 2	++ 2	—
	45	3·5	1·1	1·8	2·5	−0·2	+1·1	+1·0	*+1·2*	18	21	12	+ 5	+ 6	+ 6	20	8	10	− 3	++ 2	+ *4*
	55	3·9	1·0	1·9	2·6	+0·3	+1·1	+1·4	—	16	18	*10*	+ 4	+ 5	+ *5*	19	7	9	− 4	++ 2	—
8	5	*3·9*	1·0	—	2·7	*+0·3*	*+1·3*	—	+1·6	*16*	17	—	+ *5*	+ *5*	—	*18*	7	9	− *5*	+ *3*	+ 4
	15	*4·1*	*1·0*	—	2·6	*+0·6*	*+1·2*	—	+1·6	*16*	*15*	*7*	+ *7*	+ *5*	+ *5*	*17*	*6*	8	− *5*	++ *3*	++ 3
	25	3·9	*1·1*	—	2·6	*+0·7*	*+1·5*	—	+1·7	16	*15*	6	+ *9*	+ *8*	+ 6	16	*7*	6	− *6*	++ *3*	++ 2
	35	3·9	1·3	*2·1*	2·9	*+1·1*	+1·9	*+2·0*	+1·9	14	13	5	+ *9*	+ 8	+ 7	17	7	4	− *4*	++ 4	++ 1
	45	4·1	1·4	2·0	2·9	+1·2	+1·9	+1·7	+2·0	13	11	3	+10	+ 9	+ 7	17	6	4	− 4	++ 4	++ 1
	55	4·3	1·5	2·2	3·0	+1·5	+2·1	+2·0	+2·1	13	12	4	+11	+11	+ 9	16	5	3	− 6	++ 4	++ 1
9	5	4·3	1·5	2·6	3·6	+1·1	+1·8	+2·0	+1·9	12	11	4	+11	+12	+10	16	5	2	− 7	+ 3	+ 3
	15	5·3	2·3	3·4	4·0	+1·7	+2·3	+2·4	+1·9	8	9	3	+ 8	+10	+10	16	4	3	− 7	++ 3	++ 5
	25	6·0	2·7	3·9	4·5	+1·9	+2·2	+2·6	+1·9	7	9	2	+ 8	+12	+11	16	4	3	− 7	++ 3	+ 8
	35	6·4	3·5	4·4	5·1	+1·9	+2·5	+2·5	+2·2	7	10	3	+ 9	+13	+12	14	4	4	− 9	++ 3	+ 9
	45	6·8	4·0	4·8	5·9	+1·8	+2·5	+2·7	+2·5	4	9	2	+ 6	+12	+11	13	3	4	− 9	++ 3	+ 9
	55	6·6	4·4	5·2	6·5	+1·2	+2·1	+2·4	+2·4	7	11	5	+11	+13	+13	13	1	3	−10	+ 3	+ 9
10	5	6·6	5·0	5·7	7·3	+0·7	+2·4	+2·4	+2·7	6	10	5	+13	+17	+15	13	0	1	−10	+ 3	+ 8

Values derived from measurements of incomplete ten-minute intervals are printed in italics.

The screening of the solar radiation might be expected to exert some influence on the regular diurnal magnetic changes in progress during the eclipse hours and, therefore, to affect the time of occurrence of any prominent diurnal variation feature which normally falls within or shortly after the eclipse interval. During the hours in question on the average quiet June day in Britain, westerly declination decreases to a minimum which occurs about 7h. or 8h. G.M.T., i.e., after the termination of the local eclipse over Britain, but before the end of the general eclipse. H is normally fairly steady for three or four hours before 5h., but then decreases to the minimum at 10h. or 11h. Judging only from the usual course of events at Eskdalemuir and at Kew or Greenwich, V after attaining a slight secondary maximum at 5h. or 6h. decreases to a minimum at 11h. or 12h. Thus, of the elements considered, D is the only one in which a principal turning point of the regular diurnal variation falls within the hours of the general eclipse of June 29. The time of occurrence of the minimum, obtained from the readings of the ten-minute mean curve in D, H and V on each of the three days is given in Table II. The entry for V in round brackets indicates a secondary minimum which is barely distinguishable from the principal minimum. In Table III are given the ranges (also derived from the readings of the ten-minute mean curve) in the three elements during (*a*) the local eclipse interval, 4h. 25m. to 6h. 25m.; and (*b*) the general eclipse interval, 3h. 55m. to 8h. 45m.

At Abinger, Stonyhurst and Eskdalemuir the time of the minimum in D on the 29th was earlier by an hour, or rather more, than on the 28th, but was very little different from the time on the 30th. The D minimum on the 28th was rather later than on the average day. At Lerwick on the 29th the D minimum, about 1′ less than the lowest value near 7h. or 8h., occurred as early as 4h. 5m., i.e., almost immediately after the beginning of the general eclipse. It seems unlikely that this phenomenon had any connexion with the eclipse. Referring to Table I, or Fig. 3, it is seen that throughout the interval of the local eclipse, and also for at least two hours before, D on the 29th was more easterly than on the mean of the 28th and 30th. Shortly before 7h. (or 8h. in the case of Lerwick) the difference $29 - \frac{1}{2}(28 + 30)$ becomes positive and increases, declination on the 29th remaining more westerly as compared with the mean of the values on the 28th and 30th until at least 10h. Throughout the local eclipse interval the (relative) easterly tendency of D on the 29th increases with latitude; but this is the case, although less prominently, for some little time before and after the local eclipse interval. Relatively to the mean of the values on the two adjacent days D on the 29th was most easterly at 4h. 55m., i.e., about half-way between the beginning and the maximum phase of the eclipse over Britain. None of the particulars hitherto mentioned suggests a connexion between the solar eclipse and the course of events in D on the 29th as compared with those on the 28th and 30th.

FIG. 2. *To face p. 8.*

VARIATION IN D, H, AND V BETWEEN 2H. AND 10H. G.M.T. JUNE 29, 1927, AT LERWICK, ESKDALEMUIR, STONYHURST, AND ABINGER.

----- REPRESENTS MEAN HOURLY VALUES AT ESKDALEMUIR ON THE FIVE INTERNATIONAL QUIET DAYS OF JUNE, 1927.

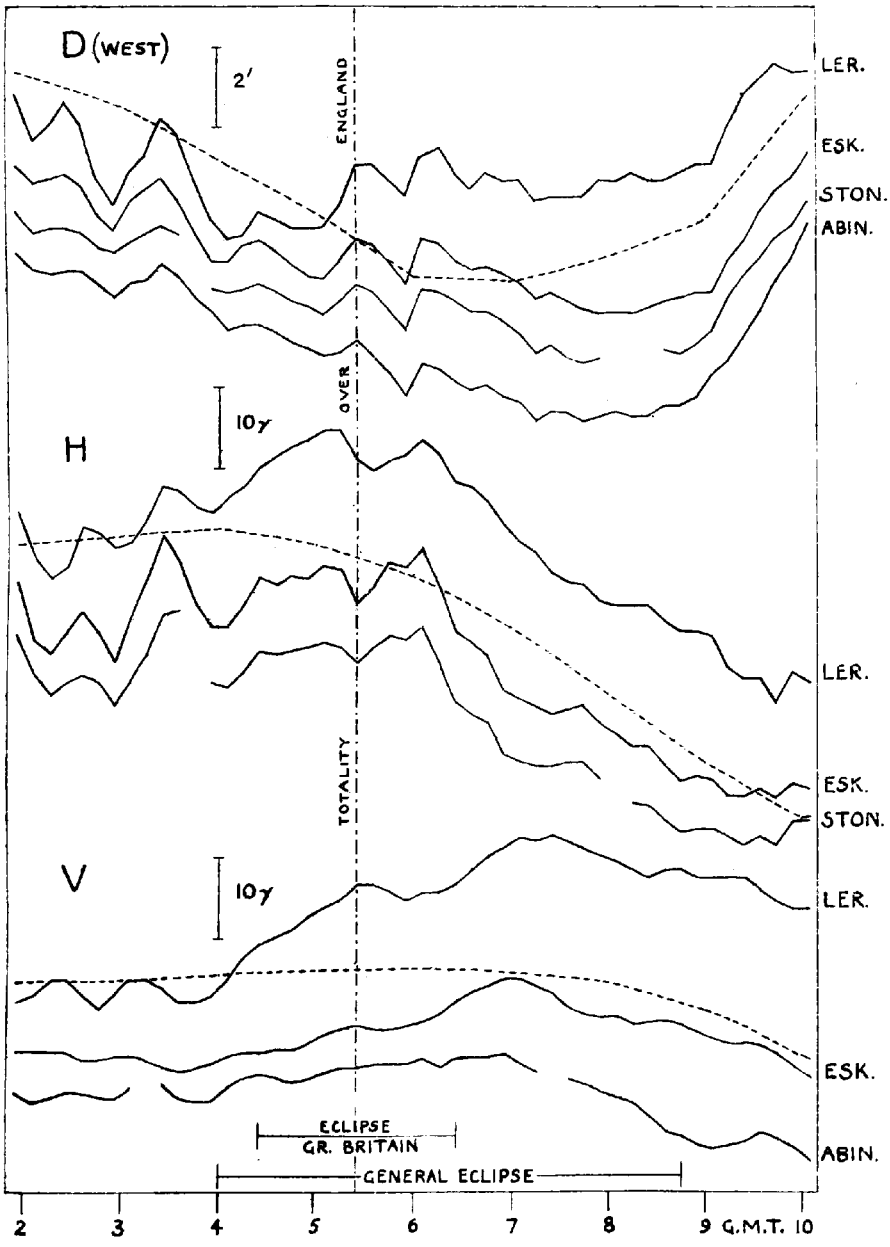


FIG 3. *To face p. 9.*

VALUES OF THE DIFFERENCE $29-\frac{1}{2}(28+30)$ IN D, H, AND V.

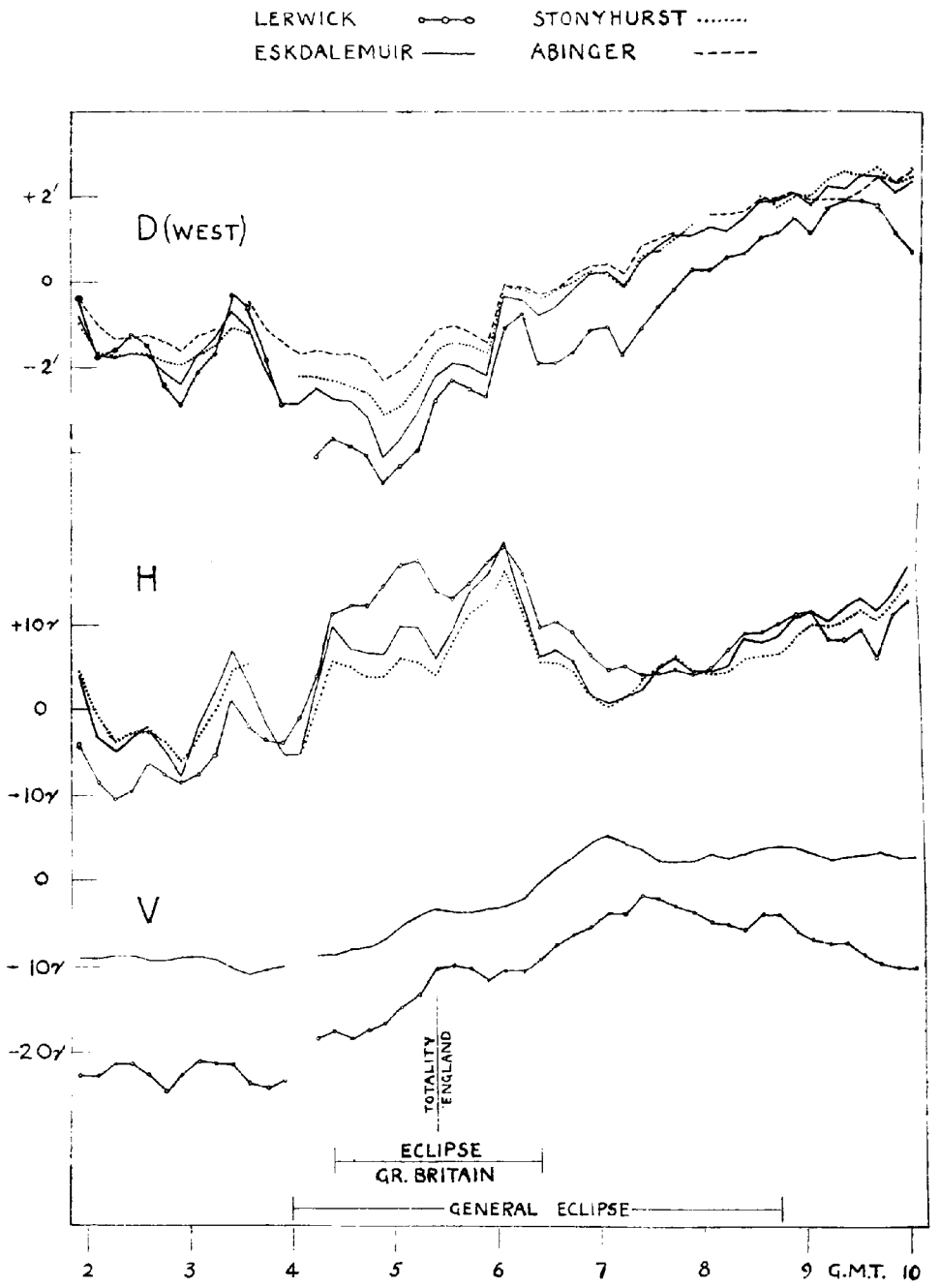


TABLE II—TIME OF THE MINIMUM IN DECLINATION (WESTERLEY), HORIZONTAL FORCE AND VERTICAL FORCE ON JUNE 28, 29 AND 30, 1927.

	D (West)			*H*			*V*		
	28th.	29th.	30th.	28th.	29th.	30th.	28th.	29th.	30th.
	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.	h. m.
Lerwick	8 55	4 5 4 15	8 25 8 35	10 35	10 35	10 15	13 5	2 45 (13 15)	13 5
Eskdalemuir..	8 55	7 55 to 8 15	7 45	9 15 9 25 10 15	10 25 10 35	10 55 11 5	10 55	12 45	11 45
Stonyhurst	8 55	7 45	7 45 7 55	9 25 9 35	10 35	11 5	—	—	—
Abinger	8 45 8 55	7 15 7 45	7 45	9 45	10 35	10 5	10 55	10 35	11 35

TABLE III—RANGES IN DECLINATION, HORIZONTAL FORCE AND VERTICAL FORCE ON JUNE 28, 29 AND 30, 1927.

	Declination.						Horizontal Force.						Vertical Force.					
	4h. 25m. to 6h. 25m.			3h. 55m. to 8h. 45m.			4h. 25m. to 6h. 25m.			3h. 55m. to 8h. 45m.			4h. 25m. to 6h. 25m.			3h. 55m. to 8h. 45m.		
	28th	29th	30th	28th	29th	30th	28th	29th	30th	28th	29th	30th	28th	29th	30th	28th	29th	30th
	′	′	′	′	′	′	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ	γ
Lerwick	3·1	1·9	1·5	6·0	2·2	3·7	7	6	10	29	25	28	9	7	7	9	20	10
Eskdalemuir	3·5	1·1	2·6	7·7	1·9	5·8	12	10	7	35	29	31	3	6	4	4	10	15
Stonyhurst	3·1	1·1	2·5	7·1	1·9	5·4	12	9	8	34	25	25	—	—	—	—	—	—
Abinger	3·1	1·7	2·9	6·8	2·6	5·4	—	—	—	—	—	—	4	3	—	13	10	—

As may be seen from Table III, the range in D during the interval of the general eclipse and (except at Lerwick) of the local eclipse was least on the 29th. Relatively to the mean of the ranges on the 28th and 30th the range on the eclipse day is smallest at Stonyhurst and Eskdalemuir, the two observatories nearest to the belt of totality.

Considering, next, the H data : it is seen that from 2h. to 4h. the value of H at each observatory on the 29th was on the average less than the mean value for the 28th and 30th, and that this relative smallness of H on the 29th was more marked at Lerwick than at Eskdalemuir or Stonyhurst. Between 4h. and the time of commencement of the local eclipse the difference $29 - \frac{1}{2}(28 + 30)$ changes from negative to positive and remains positive until at least 10h. The graphs of the difference $29 - \frac{1}{2}(28 + 30)$ show a crest which is roughly coterminous with the local eclipse interval, but which is partly due to the occurrence of a depression in H between 4h. 5m. and 6h. 25m. on the 28th. This relative enhancement of H during the local eclipse interval, and likewise the depression in H on the 28th, increases with latitude. The nature of the variation with latitude of the main features of the difference $29 - \frac{1}{2}(28 + 30)$ for H and for D during the eclipse hours does not suggest that the causes which differentiated events on the 29th from those represented by the mean of the 28th and 30th were due to an influence arising from the eclipse. At all four observatories the minimum value of H on the 29th occurred at or near to 10h. 35m. : this is about one hour later than the time of the minimum on the 28th at Eskdalemuir, Stonyhurst, and Abinger, and not more than half an hour later (at Lerwick and Abinger) or earlier (at Eskdalemuir and Stonyhurst) than the time on the 30th. Thus, as in the case of D, there is no clear evidence of any particular effect on the time of occurrence of the minimum on the 29th relatively to the 28th and 30th. At Lerwick during both the local and general eclipse intervals and at Eskdalemuir during the general eclipse interval the range in H was least on the 29th ; at Eskdalemuir during the shorter interval the range on the 29th was intermediate between the ranges on the 28th and 30th, while during both intervals at Stonyhurst the range on the 29th was less than that on the 28th but practically identical with that on the 30th. The tendency for the range to be less on the 29th than on the two adjacent days is much less marked in H than in D.

For reasons which are given above, reasonably complete V data throughout the period 2h. to 10h. on all three days are available only for Eskdalemuir and Lerwick. From 2h. to 4h. the value of V on the 29th was less than the mean of the values on the 28th and 30th ; the average deficiency during this interval being about 5γ at Abinger, nearly 10γ at Eskdalemuir, and about 22γ at Lerwick. Some 40 minutes before the beginning of the local eclipse interval this relative deficiency in the value of V on

the 29th begins to decrease, and continues generally to decrease until between 7h. and 8h., i.e., after the end of the local eclipse. After 6h. 25m. on the eclipse day V at Eskdalemuir exceeded the mean of the values on the 28th and 30th. At Lerwick the difference $29 - \frac{1}{2}(28 + 30)$ is never positive. The range of variation in the difference $29 - \frac{1}{2}(28 + 30)$ is greater at Lerwick than at Eskdalemuir. The decrease in the numerical value of the difference $29 - \frac{1}{2}(28 + 30)$ for V is not uniform throughout the local eclipse interval: the rate of decrease is accelerated during the 40 minutes before 5h. 25m. (approximately the time of the maximum phase of the eclipse over Britain), and is then very small until the end of the local eclipse interval. This feature is more prominent in the Lerwick than in the Eskdalemuir values. The occurrence at Lerwick between 2h. and 3h. on the 29th of a minimum in V hardly distinguishable from the minimum value near midday can scarcely be attributed to causes connected with the eclipse. As compared with the 28th and 30th the minimum near midday was later on the 29th at Eskdalemuir and Lerwick, although the difference at the latter station is slight. At Abinger the minimum was earlier on the 29th than on the two adjacent days. It is not possible to reach any general conclusion as to the range in V during the eclipse hours. The range on the 29th was appreciably greater than on either of the other two days at Lerwick during the general eclipse interval and slightly greater at Eskdalemuir during the local eclipse interval.

The data designated $29 - \frac{1}{2}(28 + 30)$ may be of service for comparison with results obtained at places where special observations were made on these three days alone, but it has been thought desirable to refer the changes on June 29 to "normal" values representative of conditions more nearly ideally quiet than those which prevailed on June 28, 30. With this object the values of the difference "29–Q" have been tabulated: "29" denoting, as before, the mean value of H, D or V during a ten-minute interval on the 29th, and Q the corresponding mean value for the five international quiet days June 8, 19, 20, 21, 24, 1927. The Q values were read off from curves drawn through points representing the mean hourly values on the five quiet days. The adoption of the Q values as normals entails some slight uncertainty on account of secular change and of annual variation, and possibly on account of inaccuracies in the base-line value of the magnetogram; but such uncertainties appear to be less important than those attaching to the use, as normals, of the values on June 28, 30. The 29–Q data were obtained for D and V at Abinger, H, D and V at Eskdalemuir, H and D at Lerwick. Owing to the most unfortunate loss of the magnetograms whilst in transit by post Q data for Stonyhurst are not available. Also, owing to defective V record at Lerwick on at least two of the quiet days the values of 29–Q have not been tabulated. The values of the algebraic difference 29–Q are given in Table IV and represented graphically in Fig. 4.

TABLE IV—VALUES OF THE DIFFERENCE 29—Q IN DECLINATION, HORIZONTAL FORCE AND VERTICAL FORCE AT LERWICK, ESKDALEMUIR AND ABINGER.

G.M.T.	D (West)			H		V		G.M.T.	D (West)			H		V	
	Ler.	Esk.	Abin.	Ler.	Esk.	Esk.	Abin.		Ler.	Esk.	Abin.	Ler.	Esk.	Esk.	Abin.
h. m.	′	′	′	γ	γ	γ	γ	h. m.	′	′	′	γ	γ	γ	γ
1 55	−2·5	−2·2	−1·5	− 17	− 3	− 9	− 4	6 5	+1·1	+1·0	0·0	− 2	+ 5	− 7	− 3
								15	*+1·4*	*+0·8*	0·0	*− 3*	+ 1	*− 6*	− 3
2 5	−3·5	−2·6	−1·9	− 23	− 11	− 9	− 5	25	*+0·8*	+0·5	−0·2	*− 5*	− 3	− 4	− 2
15	−3·0	−2·4	−1·8	− 25	− 13	− 9	− 4	35	+0·4	+0·3	−0·4	− 4	− 4	− 3	− 2
25	−2·4	−2·1	−1·7	− 24	− 11	− 9	− 4	45	+0·7	+0·4	−0·3	− 5	− 4	− 2	− 2
35	−2·8	−2·3	−1·7	− 19	− 8	− 10	− 4	55	+0·4	+0·2	−0·6	− 7	− 7	− 1	− 1
45	−4·0	−2·9	−1·9	− 19	− 10	− 10	− 4								
55	−4·5	−3·1	−2·1	− 22	− 14	− 9	− 5	7 5	+0·3	0·0	−0·7	− 9	− 7	− 1	− 2
								15	−0·3	−0·6	*−1·2*	− 9	− 6	− 2	*− 2*
3 5	−3·5	−2·2	−1·6	− 22	− 9	− 9	− 3	25	−0·3	−0·5	*−1·0*	−10	− 7	− 2	—
15	−2·9	−1·7	*−1·5*	− 18	− 5	− 10	—	35	−0·4	−0·8	−1·1	− 9	− 4	− 4	*− 3*
25	−1·7	−1·3	−1·0	− 14	+ 1	− 11	− 3	45	−0·6	−1·1	−1·4	− 9	− 2	− 5	− 3
35	−1·7	−1·5	−1·2	− 15	− 3	− 12	− 5	55	−0·4	−1·3	−1·3	−10	− 3	− 5	− 3
45	−2·6	−2·1	−1·6	− 18	− 8	− 11	− 6								
55	*−3·3*	−2·6	−1·7	*− 19*	− 11	− 11	− 7	8 5	*−0·7*	−1·4	−1·3	*− 9*	− 3	− 4	− 3
								15	*−0·7*	*−1·6*	−1·5	*− 8*	*− 4*	*− 5*	− 3
4 5	*−3·4*	−2·5	−1·8	*− 16*	− 11	− 10	− 5	25	−1·2	*−1·7*	−1·7	− 7	*− 2*	*− 4*	− 3
15	−3·2	*−1·9*	−1·4	− 14	*− 8*	*− 10*	− 5	35	−1·5	−1·6	−1·5	− 7	− 3	− 3	− 4
25	−2·4	−1·5	−1·1	− 12	− 4	− 10	− 4	45	−1·6	−1·6	−1·7	− 7	− 4	− 3	− 4
35	−2·3	−1·6	−1·0	− 10	− 5	− 10	− 5	55	−1·7	−1·7	−1·8	− 6	− 1	− 3	− 4
45	−2·3	−1·7	−1·0	− 7	− 3	− 10	− 6								
55	−2·0	−1·8	−0·9	− 7	− 4	− 9	− 6	9 5	−2·1	−2·0	−1·5	− 6	− 0	− 3	− 3
								15	−1·5	−1·6	−1·4	− 8	− 1	− 3	− 2
5 5	−1·8	−1·5	−0·9	− 5	− 1	− 8	− 5	25	−1·2	−1·6	−1·3	− 8	− 1	− 2	0
15	−0·9	−0·8	*−0·8*	− 4	− 1	− 7	*− 5*	35	−1·2	−1·3	−1·1	− 7	+ 1	− 1	+ 2
25	+0·4	0·0	−0·3	− 7	− 5	− 7	− 5	45	−1·3	−1·3	−0·8	− 9	+ 1	− 1	+ 2
35	+0·7	+0·2	−0·4	− 8	− 3	− 7	− 4	55	−1·8	−1·5	−0·6	− 6	+ 5	− 2	+ 2
45	+0·4	+0·1	−0·6	− 5	+ 1	− 7	− 4								
55	+0·1	−0·3	−1·0	− 5	+ 2	− 7	− 4	10 5	−2·3	−1·5	−0·2	− 6	+ 4	− 2	0

Values derived from measurements of incomplete ten-minute intervals are printed in italics.

It will be seen that in the interval from 2h. to 10h. on the 29th the values of H and V were mainly less and the values of D on the whole more easterly than the corresponding (assumed) normal values ; and that there is a general tendency for the departure of H and V from the normal to decrease from the beginning to the end of the interval. As far as H and V are concerned these features bear general resemblance to the average type of effect, during the hours considered, due to moderate disturbance in summer months at Eskdalemuir. In the case of D, on the average non-quiet day in summer the value tends to be more easterly than normal (quiet day) for some hours before 6h. and then, for several hours, more westerly than normal.

The curves for H and D in Fig. 4 show a crest between 4h. and 8h. or 9h. From about 4h. the easterly tendency in D on the 29th, relatively to the quiet-day value, and the deficiency in H commence to diminish and continue to do so irregularly until between 6h. and 6h. 20m., when a change in the opposite sense sets in. The crest culminates a little earlier than the end of the local eclipse, and also than the time (6h. 27m.) of the central eclipse at local apparent noon. During most of the interval from about 5h. 25m., the time of totality over England, until shortly after 7h., D on the 29th was more westerly than the assumed normal value at both Lerwick and Eskdalemuir, this effect being greater at the former place. Relatively to the run of the values 29–Q prevailing for an hour or two before 4h. and after 8h., the crest between these times may be regarded as due mainly to the superposition of a disturbing force in a direction between north and west (magnetic) : at about 6h. the disturbing force, then at its maximum (say, about 15γ, but apparently rather greater at Lerwick than at Eskdalemuir), is directed at roughly 50°–55° west of the magnetic meridian at these places and therefore roughly perpendicular to the central line of the totality belt in the neighbourhood of the British Isles. If it be assumed that the crest in the D and H curves of values 29–Q represents an effect due to the eclipse, it must be concluded that such an effect was somewhat greater at Lerwick than at Eskdalemuir and that the disturbing force was opposite in sense to that which Bauer has deduced from observations made on the occasion of the eclipse of May 29, 1919.*

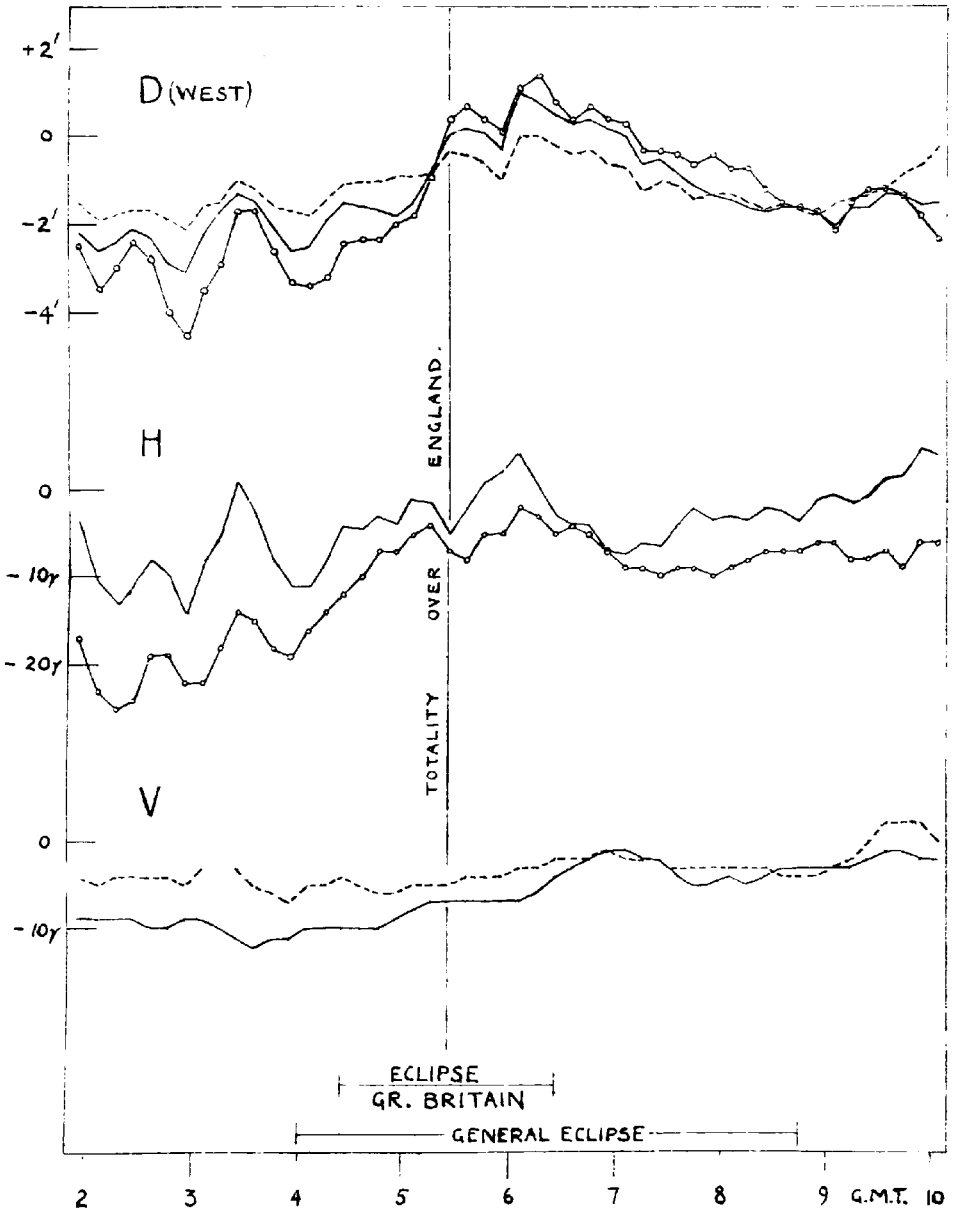
Turning to the values for the 29th shown in Table I or in Fig. 2, it is seen that, speaking generally, irregular movements are less in evidence after 7h. than during or before the eclipse. In a first examination of the Eskdalemuir records for the 29th the changes between 5h. and 6h. attracted attention. Superposed on the general trend are a crest in D, a depression in H, and a small crest in V, all culminating in the interval 5h. 20m. to 5h. 30m., i.e., near to the time of totality over England. Similar movements occurred at the other observatories. Using five-minute mean

* *Terr. Mag.* **25.** p. 97.

Fig. 4. *To face p. 14.*

VALUES OF THE DIFFERENCE 29-Q IN D, H, AND V.

LERWICK ——o——o—— ESKDALEMUIR ——
ABINGER - - - - -



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Ps 28498/985 wt 5557 D 700/1238 625 2/30.

values, not reproduced here, a more detailed inspection was made of the changes at all four observatories between 4h. 50m. and 6h. 10m. During this interval the general change in progress, at least in D, appears to undergo a fairly regular transition as we pass from Lerwick to Abinger. With regard to the special movement, the crest in D and V and the trough in H seem to occur five to ten minutes later at Lerwick than at the other places. At the part of the totality belt nearest to Lerwick the time of totality was about five minutes later than on the north-east coast of England. The changes in V between 5h. 10m. and 5h. 55m. appear to be most prominent at Lerwick; at the maximum of the crest V at Lerwick is about 3γ (which is equivalent to about 0·3 mm. on the magnetogram) in excess of the mean of the values at the limits of the interval mentioned. In the same interval the V changes at Eskdalemuir and Abinger are decidedly smaller, not exceeding 1γ, so that the suggestion of opposition in the V changes at these two places is probably of no significance. Apart from the slightly later time of culmination of the movement at Lerwick the data available appear to indicate no simple relationship between the changes between 5h. and 6h. and the solar eclipse.

In conclusion, it appears that the search for an eclipse magnetic effect, so far as the area of the British Isles is concerned, has had, if not an entirely negative, at least an inconclusive result. In view of the occurrence of even the comparatively slight magnetic unrest during several hours preceding the commencement of the eclipse on June 29 the failure to detect any definite indication of an eclipse magnetic effect is not surprising. Owing to the regular diurnal variation substantial changes occur in declination and horizontal force, at the observatories considered, during the interval in which the general eclipse was in progress. In this interval and, except at Lerwick, in the local eclipse interval the range in declination was appreciably less on the eclipse day than on either of the two adjacent days; and this effect was apparently most prominent at the two observatories nearest to the centre line of the eclipse. This circumstance may be held to favour the view that the occurrence of a solar eclipse may be expected to be associated with a diminution or retardation of the normal daytime magnetic changes. On the other hand, there is less conclusive evidence of a reduction in range of horizontal force during the eclipse hours; nor is there clear indication of any special displacement of the time of the minimum (the only prominent turning point in the diurnal variation which occurs within or a few hours after the eclipse interval) in any one of the elements. It is true that at Eskdalemuir and Abinger the time of the most easterly value of declination was later on the eclipse day than the time (about 6h. 30m. G.M.T.) of this feature as shown by the mean values of the element on the five international quiet days of June, 1927; but in this respect the average quiet

day of this month appears to be somewhat abnormal. Examination of the difference between the ten-minute mean values on the 29th and " normal " values derived from the five quiet days of the month reveals a " crest " effect in declination and horizontal force during the eclipse interval. So far as the nature of the data justifies a conclusion there appears to be no certain evidence that the effect referred to was due to the eclipse.

The observational programme at Eskdalemuir on June 28–30 was more extensive than is indicated above. In addition to the records from the standard N and W magnetographs, records with a time scale of 1 cm. to 1 minute were obtained from special N and W instruments, the approximate ordinate scale values being approximately $1\frac{1}{2}$ and 2γ per mm. respectively. Also, records of the rate of change of vertical force were obtained by registering the indications of a moving-coil galvanometer connected to a large loop of wire resting in an approximately horizontal plane.* The recording paper moved at about 1 cm. per minute, and the constants and arrangements of the apparatus were such that a uniform rate of change in vertical force of $0{\cdot}01\gamma$ per second produced a deflection of about 6 mm. on the paper. On none of these three records with especially open time scales are there any fine details or other features which have any apparent connexion with the eclipse.

* *Proc. Roy. Soc. Edin.*, **45.** Part III, p. 297. *Terr. Mag.*, **32,** p. 1.

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