IV. "On the Variations of the Diurnal Range of the Magnetic Declination as recorded at the Prague Observatory." By BALFOUR STEWART, LL.D., F.R.S., Professor of Natural Philosophy at Owens College, Manchester. Received May 2, 1878.

1. The Prague magnetic observations began in July, 1839, and have been continued until the present date. The observation hours, 18h., 22h., 2h., 10h., are common to the whole series, except for the year 1853, during which observations were made only at the hours 18h., 2h., 10h. As far, however, as the estimation of the diurnal range of magnetic declination is concerned, these last three hours are practically as good as the former four, inasmuch as the observations at 22h. are hardly ever made use of in determining the diurnal range.

In the determinations herein recorded, magnetic disturbances are included, and the range is a mean monthly one, obtained by comparing together the mean values of the magnetic declination, corresponding to the hours 18h., 22h., 2h., 10h., for any given month, and taking the difference between the highest and the lowest of these values as representing the mean range for that month. There is reason to believe that the ranges thus obtained are not greatly different from those which would have been obtained from an hourly series of observations.

A. *Annual Variation of Declination-Range.*

2. In order to obtain this variation, the mean monthly ranges obtained, as already described, and extending from the beginning of 1840 to the end of 1876, have been made use of. From these we obtain the following table:—

TABLE I. Containing mean values, for each month in the year, of the declination-range at Prague, in minutes of arc, taken from the whole series of thirty-seven years.

Jan.	Feb.	Mar.	April.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
5′·298	6′·808	8′·636	10′·366	10′·607	11′·513	11′·184	10′·695	8′·361	7′·365	5′·668	4′·699

B. *Variations of Long Period.*

3. In order to investigate the long-period variation of the Prague declination-range, I have treated these observations precisely in the way in which the Kew declination-ranges were treated (Proc. Roy. Soc., March 22, 1877). By this method, proportional values of the declination-range at Prague have been obtained for the middle points of each month for each year, and it is believed that these values are freed from any recognised inequality depending either on the month of the

year or on the relative position of the sun and moon. These are exhibited in Table II.

TABLE II. Exhibiting monthly means of the declination-range, the mean value of the range for the whole series for each month, as given in Table I, being reckoned = 1000.

	Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1839							1214	1396	1204	1355	1392	1047
1840	1299	1420	1168	1234	1088	1061	1057	1007	1190	1184	1147	1626
1841	1193	1181	1085	925	949	1015	845	873	954	970	958	1107
1842	834	817	830	861	921	822	736	832	773	863	783	702
1843	706	839	731	782	789	866	825	780	934	814	556	821
1844	557	473	835	716	753	794	840	803	764	986	864	772
1845	710	718	877	833	977	959	854	970	835	739	734	958
1846	676	671	950	923	1086	999	1066	1029	905	948	958	834
1847	725	880	996	1012	1096	972	1017	1214	1236	1157	1461	1477
1848	1384	1209	1225	1034	1254	1251	1361	1407	1294	1211	1138	1373
1849	1459	1329	1259	1290	1266	1200	1207	1080	1073	1107	1161	983
1850	1316	1113	1152	1127	1270	1281	1206	1087	1136	1155	1094	996
1851	1206	918	830	938	1015	1074	1043	929	1024	1054	981	1286
1852	1193	1486	1164	1023	1000	1048	932	949	1060	1063	1178	1032
1853	934	773	1023	839	767	878	949	829	850	841	930	1030
1854	925	1275	924	976	999	876	942	899	760	850	680	868
1855	897	969	917	872	841	835	870	819	782	953	835	632
1856	649	824	630	786	762	829	805	866	871	817	771	611
1857	734	762	691	767	839	900	927	899	861	950	1034	862
1858	938	1074	908	1027	470	463	621	1003	1265	1359	1037	870
1859	655	920	1220	1365	1263	1167	1177	1239	1629	1442	1256	1704
1860	1104	1193	1395	1116	1290	1355	1336	1429	1142	1111	863	911
1861	946	1241	1004	1169	1113	1122	1034	1086	1014	887	1097	1209
1862	1014	730	719	915	888	1168	1130	1165	895	1295	1111	1015
1863	1306	1135	1072	1044	1150	967	957	928	954	1019	1057	1177
1864	998	845	1085	876	979	1033	915	942	823	1001	1018	819
1865	1072	1044	1173	928	1005	900	846	894	999	834	949	498
1866	1172	1353	835	901	865	849	848	697	804	731	1124	677
1867	831	767	864	840	831	858	910	821	794	703	764	815
1868	874	836	991	1084	884	872	947	972	944	921	1002	1145
1869	1053	1041	1129	1041	1033	1270	1177	1033	1135	1096	932	930
1870	1142	989	1308	1386	1452	1318	1393	1369	1353	1287	1429	1400
1871	1183	1547	1315	1425	1289	1346	1354	1453	1257	1188	1581	1296
1872	1368	1031	1147	1292	1258	1195	1254	1289	1276	1113	1380	1502
1873	1533	1052	1121	1166	1015	869	1017	1012	1018	1018	985	1026
1874	1229	1094	932	928	950	904	939	825	931	846	872	651
1875	464	830	778	848	867	858	783	824	780	695	621	666
1876	721	623	717	711	724	826	880	750	687	796	665	724

4. The numbers of Table II have next been dealt with precisely in the way in which the corresponding numbers were dealt with in the case of the Kew and Trevandrum observations, that is to say, a set of nine-monthly values of declination-range has been obtained, corresponding to similiar nine-monthly values of spotted solar area. These are exhibited in the following tables, up to the end of the year 1852, after which date a comparison between the spots and declination-

ranges has already been made in previous communications (Proc. Roy. Soc., March 22, 1877, and Feb. 7, 1878).

TABLE III. Prague Declination-Range.—Nine-Monthly Values.*

	1839.	1841.	1843.	1845.	1847.	1849.	1851.	1853.
Jan. (0)		1167	776	824	924	1299	1036	974
Feb. (0)		1155	779	844	932	1286	1028	953
Mar. (0)		1126	782	847	940	1280	1019	936
April (0)		1092	780	846	957	1277	1003	911
May (0)		1040	793	855	994	1257	995	882
June (0)		990	812	861	1040	1220	989	866
July (0)		965	802	863	1096	1192	985	870
Aug. (0)		954	791	869	1155	1167	1013	879
Sept. (0)		950	783	864	1203	1153	1052	884
Oct. (0)		937	753	839	1230	1146	1093	917
Nov. (0)		920	734	821	1250	1135	1124	947
Dec. (0)	1278	911	727	824	1266	1128	1128	951

	1840.	1842.	1844.	1846.	1848.	1850.	1852.	1854.
Jan. (0)	1262	914	719	835	1269	1134	1131	962
Feb. (0)	1237	909	710	850	1271	1156	1136	973
Mar. (0)	1213	889	703	877	1283	1173	1130	980
April (0)	1175	869	718	912	1292	1175	1122	984
May (0)	1161	843	729	926	1279	1180	1107	968
June (0)	1163	826	750	938	1259	1178	1088	949
July (0)	1141	826	795	969	1245	1168	1063	912
Aug. (0)	1151	817	813	978	1250	1159	1039	875
Sept. (0)	1175	801	810	961	1281	1154	1027	868
Oct. (0)	1178	789	808	938	1310	1139	1009	862
Nov. (0)	1185	779	810	927	1315	1094	995	862
Dec. (0)	1178	776	814	924	1311	1055	989	861

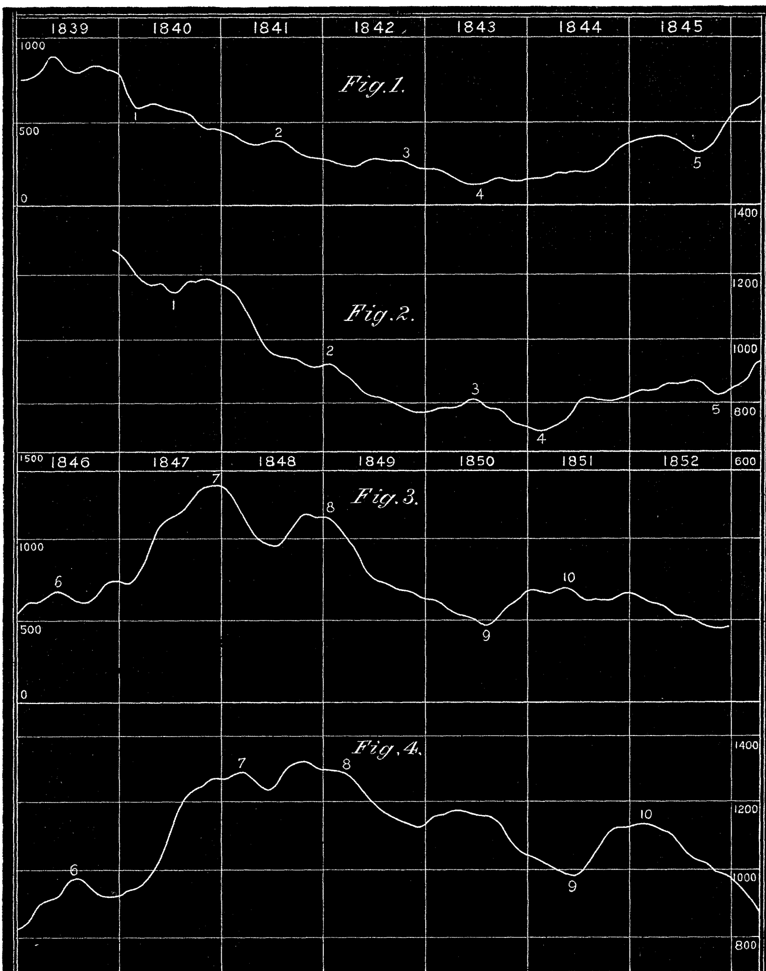
TABLE IV. Spotted Solar Areas.—Nine-Monthly Values.*

	1839.	1841.	1843.	1845.	1847.	1849.	1851.
Jan. (2)	730	456	181	384	722	1113	675
Feb. (2)	731	436	171	398	705	1073	668
Mar. (2)	745	400	144	407	728	1008	663
April (2)	795	362	115	419	805	964	677
May (2)	866	358	101	413	946	890	695
June (2)	853	363	95	403	1068	797	678
July (2)	792	369	102	382	1103	751	632
Aug. (2)	772	365	114	353	1148	726	618
Sept. (2)	787	335	111	348	1231	694	615
Oct. (2)	795	293	102	383	1288	678	613
Nov. (2)	786	264	103	444	1305	661	638
Dec. (2)	775	255	117	506	1309	632	656

* The numbers in Table III correspond to the beginning of each month, while those in Table IV correspond to the middle of each month.

	1840.	1842.	1844.	1846.	1848.	1850.	1852.
Jan. (2)	714	246	129	569	1276	621	646
Feb. (2)	616	221	137	607	1189	617	614
Mar. (2)	568	205	160	618	1104	586	589
April (2)	583	200	175	646	1038	547	577
May (2)	598	196	179	680	996	528	543
June (2)	588	209	183	675	981	510	521
July (2)	577	226	180	647	976	487	517
Aug. (2)	563	224	195	614	1031	481	492
Sept. (2)	526	217	218	609	1115	519	468
Oct. (2)	479	206	260	656	1142	571	451
Nov. (2)	463	187	322	714	1137	604	456
Dec. (2)	468	180	360	737	1124	646	467

Diagram I.



5. The results of Tables III and IV are exhibited in Diagram I above, in which figs. 1 and 3 represent sun-spot values, and figs. 2 and 4 Prague declination-ranges. From these figures it will be seen that a number of points in the sun-spot curves may be fairly identified as corresponding to certain points in the declination-range curve, but that the latter invariably lag behind the former in time. It ought, however, to be borne in mind that here the materials for comparison are not quite of the same order of completeness as in the case of Kew and Trevandrum.

The lagging behind may be well seen by comparing together the epochs of maximum and minimum sun-spot frequency with the corresponding epochs of declination maximum and minimum range. We thus obtain the following result:—

TABLE V. In which the Epochs of Maximum and Minimum Sun-Spots are Compared with those of Declination-Range.

Solar min., June 15, 1843...Prague, dec.-range, min., Feb. 28, 1844.
Solar max., Dec. 15, 1847...Prague, dec.-range, point 7, max., March 31, 1848.
Solar min., Sept. 15, 1855 { Prague, dec.-range, min., Mar. 31, 1856. Trev., dec.-range, min., Feb. 15, 1856.
Solar max., Nov. 15, 1859 { Kew, dec.-range, max., April 15, 1860. Trev., dec.-range, max., May 15, 1860.
Solar min., Mar. 15, 1867...Kew, dec.-range, min., August 15, 1867.

I have thus examined the most trustworthy sun-spot values and declination-ranges, and it may, I think, be fairly concluded that there is an intimate relation between the two phenomena, but that the points of the sun-spot ranges precede those of the declination-ranges in respect of time.

Variations which seem to depend on Planetary Configurations.

6. The Prague proportional values herein given cannot be regarded as equally good for the purpose of investigating these periods with those derived from Kew or Trevandrum. In the Prague series we have only one value for each month, whereas in the Kew or Trevandrum series we have one value for each week. Inasmuch, however, as the Prague series is longer than either of the others we may, perhaps, regard it as of equal value for the purpose now in hand with the Kew series, while the Trevandrum series, on account of its comparatively short duration, can hardly be regarded as possessing more than half the weight of either of the others. If we treat the Prague observations in the manner in which the Kew observations were treated (Proc. Roy. Soc., March 22nd, 1877), we obtain the following result:—

TABLE VI.—Venus and Mercury together (0° denotes Conjunction, in all 94 sets).

Between	0°	and	30°	+700
,,	30	,,	60	−171
,,	60	,,	90	−553
,,	90	,,	120	−100
,,	120	,,	150	+314
,,	150	,,	180	+ 92
,,	180	,,	210	− 31
,,	210	,,	240	+107
,,	240	,,	270	−301
,,	270	,,	300	−814
,,	300	,,	330	−218
,,	330	,,	360	+796

a result which is similar to that derived from Kew, in which we have manifest indications of a single, with some traces of a double, period.

7. If we next take the period of Mercury about the sun, we obtain the following result:—

TABLE VII.—Period of Mercury about the Sun (in all 153 sets, 0° denotes Perihelion).

				First half.	Second half.	Whole series.
Between	0°	and	30°	+ 565	−209	+ 356
,,	30	,,	60	+ 99	−384	− 285
,,	60	,,	90	− 441	−483	− 924
,,	90	,,	120	− 897	−442	−1339
,,	120	,,	150	−1079	− 64	−1143
,,	150	,,	180	− 981	+272	− 709
,,	180	,,	210	− 646	+389	− 257
,,	210	,,	240	− 176	+442	+ 266
,,	240	,,	270	+ 369	+407	+ 776
,,	270	,,	300	+ 667	+258	+ 925
,,	300	,,	330	+ 784	+165	+ 949
,,	330	,,	360	+ 841	+ 59	+ 900

We thus perceive a very considerable likeness between the results derived from the two halves, while the whole is very similar to the corresponding periods derived from the Kew or from the Trevandrum series.

8. Let us finally take the period of conjunction of Mercury and Jupiter, and we obtain the following result:—

TABLE VIII.—Period of Conjunction of Mercury and Jupiter (in all 150 sets, 0° denotes Conjunction).

				First half.	Second half.	Whole series.
Between	0°	and	30°	+ 47	+775	+ 822
,,	30	,,	60	−237	+217	− 20
,,	60	,,	90	−402	−358	− 760
,,	90	,,	120	−541	−738	−1279
,,	120	,,	150	−583	−740	−1323
,,	150	,,	180	−512	−402	− 914
,,	180	,,	210	−328	− 66	− 394
,,	210	,,	240	+ 21	+ 1	+ 22
,,	240	,,	270	+435	+ 90	+ 525
,,	270	,,	300	+636	+421	+1057
,,	300	,,	330	+496	+686	+1182
,,	330	,,	360	+300	+885	+1185

Here, as before, we have a very considerable likeness between the results derived from the two halves, while the whole is very similar to the corresponding period derived from the Kew series or from that of Trevandrum.

9. Let us now try to combine together the planetary periods derived from the three observatories—Kew, Trevandrum, and Prague—giving equal value to the results of Kew and Prague, and half value to those of Trevandrum.

We thus obtain the following values of a single period, the unit being as before, one thousandth of the whole mean range:—

TABLE IX.—Mean Magnetic Result from the various Observatories.

				Venus and Mercury.		
				Kew.	Prague.	Mean.
Between	0°	and	30°	+4·95	+7·45	+6·20
,,	30	,,	60	+0·59	−1·82	−0·61
,,	60	,,	90	−5·03	−5·88	−5·45
,,	90	,,	120	−5·31	−1·06	−3·18
,,	120	,,	150	−2·38	+3·34	+0·48
,,	150	,,	180	−1·51	+0·98	−0·26
,,	180	,,	210	−1·10	−0·33	−0·71
,,	210	,,	240	+0·33	+1·14	+0·73
,,	240	,,	270	+0·66	−3·20	−1·27
,,	270	,,	300	−1·33	−8·66	−4·99
,,	300	,,	330	−1·26	−2·32	−1·79
,,	330	,,	360	+3·05	+8·47	+5·76

				Period of Mercury.			
	°		°	Kew.	Trev.*	Prague.	Mean.
Between	0	and	30	+6 ·60	+ 3 ·02	+2 ·33	+4 ·18
,,	30	,,	60	+6 ·66	+ 3 ·91	−1 ·86	+2 ·70
,,	60	,,	90	+3 ·94	+ 6 ·16	−6 ·04	+0 ·39
,,	90	,,	120	+0 ·08	+ 8 ·77	−8 ·75	−1 ·71
,,	120	,,	150	−4 ·31	+ 6 ·21	−7 ·47	−3 ·47
,,	150	,,	180	−6 ·75	− 5 ·19	−4 ·64	−5 ·59
,,	180	,,	210	−6 ·35	−15 ·35	−1 ·67	−6 ·28
,,	210	,,	240	−4 ·29	−15 ·23	+1 ·74	−4 ·07
,,	240	,,	270	−2 ·15	− 8 ·14	+5 ·07	−0 ·46
,,	270	,,	300	+0 ·20	+ 2 ·39	+6 ·04	+2 ·97
,,	300	,,	330	+2 ·43	+ 9 ·02	+6 ·20	+5 ·26
,,	330	,,	360	+4 ·28	+ 6 ·26	+5 ·88	+5 ·32

				Mercury and Jupiter.			
	°		°	Kew.	Trev.	Prague.	Mean.
Between	0	and	30	+10 ·05	+10 ·53	+5 ·48	+8 ·32
,,	30	,,	60	+12 ·05	+ 6 ·28	−0 ·13	+6 ·02
,,	60	,,	90	+10 ·35	+ 3 ·00	−5 ·07	+2 ·71
,,	90	,,	120	+ 5 ·21	− 2 ·74	−8 ·53	−1 ·88
,,	120	,,	150	− 1 ·94	− 8 ·93	−8 ·82	−6 ·09
,,	150	,,	180	− 8 ·00	−10 ·86	−6 ·09	−7 ·81
,,	180	,,	210	−10 ·76	−11 ·33	−2 ·63	−7 ·62
,,	210	,,	240	−10 ·76	− 9 ·51	+0 ·15	−6 ·15
,,	240	,,	270	− 8 ·70	− 2 ·84	+3 ·50	−2 ·65
,,	270	,,	300	− 5 ·11	+ 5 ·16	+7 ·05	+1 ·81
,,	300	,,	330	− 0 ·16	+ 9 ·65	+7 ·88	+5 ·02
,,	330	,,	360	+ 5 ·44	+11 ·70	+7 ·90	+7 ·68

10. The mean sun-spot results corresponding to these three periods may be derived from the researches of Messrs. De La Rue, Stewart, and Loewy (Phil. Trans., 1870). For a single period they are as follows, the solar unit being one millionth of the sun's visible hemisphere :—

TABLE X.—Mean Solar Results.

	°		°	Venus and Mercury.	Period of Mercury.	Mercury and Jupiter.
Between	0	and	30	+18 ·61	−2 ·57	−1 ·56
,,	30	,,	60	− 1 ·54	−8 ·03	−2 ·17
,,	60	,,	90	−18 ·50	−8 ·69	−4 ·07
,,	90	,,	120	−26 ·17	−8 ·53	−4 ·89

* I take this opportunity of mentioning that a slight error has occurred in my determination of the inequality due to the period of Mercury, as shown by the Trevandrum observations (Proc. Roy. Soc., February 7, 1878), and that the above is the correct result.

				Venus and Mercury.	Period of Mercury.	Mercury and Jupiter.
Between	120°	and	150°	−25·76	−8·16	−3·48
,,	150	,,	180	−17·82	−6·94	−3·36
,,	180	,,	210	− 5·34	−3·50	−2·85
,,	210	,,	240	+ 6·08	+2·91	−1·29
,,	240	,,	270	+ 4·79	+7·31	−0·17
,,	270	,,	300	+ 2·53	+9·70	+1·05
,,	300	,,	330	+14·64	+8·66	+1·12
,,	330	,,	360	+25·37	+3·96	−0·31

These three planetary periods, as shown by the mean magnetic results of the three Observatories recorded in Table IX, are exhibited in Diagram II, in which fig. 2 denotes the period of Mercury, fig. 4 that of Mercury and Jupiter, and fig. 6 that of Mercury and Venus, while, as shown by the sun-spot results of Table X, they are exhibited in figs. 1, 3, and 5, fig. 1 denoting the period of Mercury, fig. 3 that of Mercury and Jupiter, and fig. 5 that of Mercury and Venus.

11. If we compare together the three sun-spot periods with the three magnetic periods, as exhibited in these diagrams, we shall remark a great similarity between them, while, however, as we might expect, the declination results lag behind the solar results in point of time.

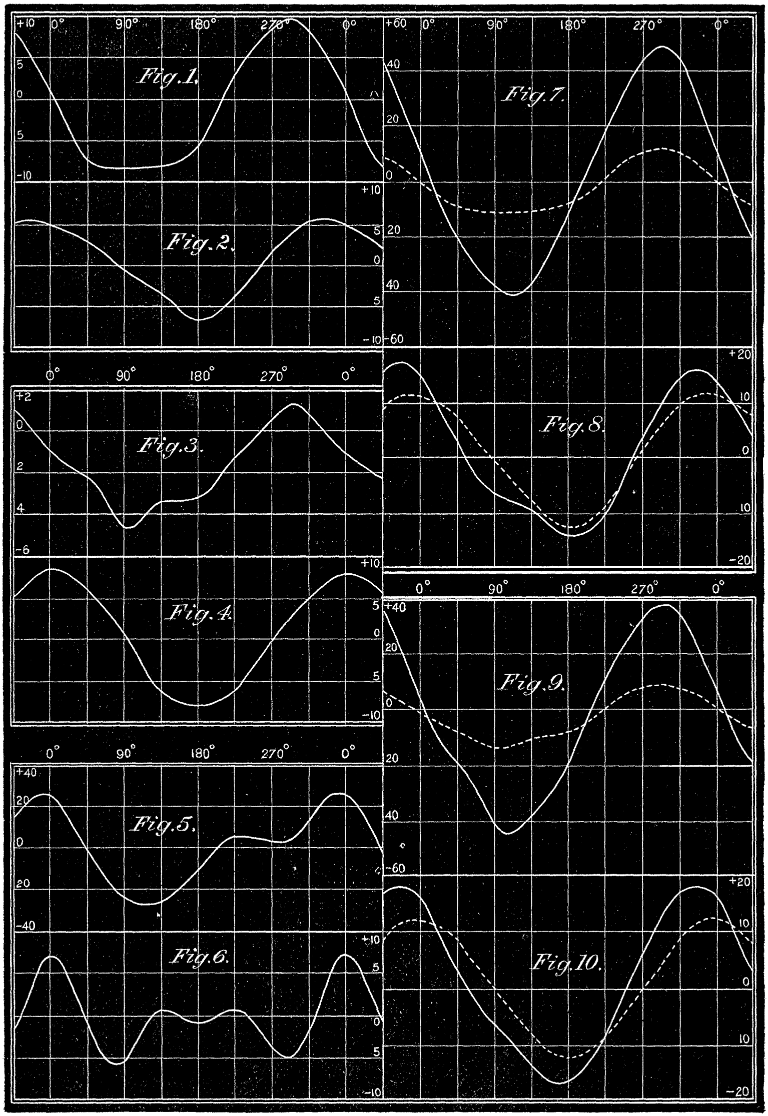
12. An inspection of the sun-spot records reveals the fact that at times of maximum spot frequency, not only are there most spots on the sun, but that the sun-spot inequalities or oscillations (however produced) are at such times much more prominent than during times of minimum sun-spot frequency. Now, if it be true that these spot periods are due in a great measure, if not entirely, to planetary configurations, we might expect that (possibly from an increase in the susceptibility of the sun) the planetary periods herein investigated should at times of maximum sun-spots be found to be greater than their average value.

13. I have endeavoured to test this in the following manner:—

The two most available periods are that of the orbit of Mercury round the sun, and that of the synodic revolution of Mercury and Jupiter. The average sun-spot inequalities for a single period of each of these have already been given in Table X. Now, it might be supposed that we have only for the present purpose to take these periods and find whether their values, during times of maximum sun-spots, are greater than their mean values. It is, however, a curious and interesting fact that (as far back as accurate observations extend) times of many sun-spots correspond well with times when Jupiter is at the perihelion of Mercury. Now, it is easy to see that on this account alone, and apart from any increased susceptibility of the sun, we should have sun-spot inequalities greater than the average at the times when the two planets are in this position with respect to each other. For

taking the average sun-spot inequality due to the period of Mercury (see Table X), we find a spot maximum somewhat before the time

Diagram II.



when Mercury comes to its perihelion, and again taking the sun-spot inequality due to the period of Mercury and Jupiter (see Table X), we have likewise a maximum somewhat before the time when Mercury

and Jupiter come together. If then Jupiter be at the same ecliptical longitude as that of the perihelion of Mercury, we should expect prominent oscillations from the effect of superposition of the two periods alone, apart from any increased susceptibility of the sun.

14. Suppose we now take a group of fifteen periods, embracing nearly four years, around each of the epochs when Jupiter is in this position with regard to Mercury. These epochs will be as follows (as far as available sun-spot observations are concerned): March, 1835, January, 1847, November, 1858. Let us make use of these selected periods to determine the inequality due to the period of Mercury, and also that due to the synodic revolution of Mercury and Jupiter. Even if there be no increase on these occasions of the susceptibility of the sun, we shall have results greater than the mean for each of the inequalities so determined from the effect of superposition alone. In other words, the apparent Mercury inequality is mixed up with and exaggerated by the superposition of the Mercury and Jupiter inequality, while the apparent Mercury and Jupiter inequality is, in its turn, mixed up with and exaggerated by the Mercury inequality. Now, on the supposition that the susceptibility of the sun does not alter, we can calculate from knowing the mean inequalities what these apparent inequalities ought to be, because we can calculate the effect of mere superposition of the one upon the other. These we may call the calculated inequalities. Now, if there be an exaltation due, let us imagine to an increased susceptibility of the sun on these occasions (which are also those of numerous sun-spots) the observed planetary inequalities should be greater than the calculated. It will be seen from the following table that this is really the case.

TABLE XI. Comparing together the observed and calculated sun-spot inequalities for selected periods.

				Period of Mercury (one revolution).	
	°		°	Observed.	Calculated.
Between	0	and	30	− 2·31	− 3·95
,,	30	,,	60	−20·85	−10·63
,,	60	,,	90	−33·07	−12·10
,,	90	,,	120	−40·37	−12·33
,,	120	,,	150	−37·50	−11·96
,,	150	,,	180	−21·30	−10·13
,,	180	,,	210	− 2·04	− 5·83
,,	210	,,	240	+18·29	+ 1·54
,,	240	,,	270	+37·09	+ 6·99
,,	270	,,	300	+47·73	+10·00
,,	300	,,	330	+43·55	+ 8·91
,,	330	,,	360	+22·22	+ 3·63

Mercury and Jupiter together (one revolution).

				Observed.	Calculated.
Between	0°	and	30°	− 5·76	− 3·22
,,	30	,,	60	−18·95	− 7·56
,,	60	,,	90	−33·26	−11·72
,,	90	,,	120	−43·66	−13·11
,,	120	,,	150	−37·91	−10·91
,,	150	,,	180	−27·22	− 8·71
,,	180	,,	210	−11·24	− 4·84
,,	210	,,	240	+10·78	+ 0·73
,,	240	,,	270	+27·76	+ 5·45
,,	270	,,	300	+37·35	+ 8·33
,,	300	,,	330	+35·33	+ 7·29
,,	330	,,	360	+16·62	+ 2·41

The results of Table XI are exhibited in Diagram II, in which fig. 7 gives the observed and the calculated sun-spot inequalities for the period of Mercury, and fig. 9 the same for the period of Mercury and Jupiter.

15. If we now turn to declination-ranges we shall find that there are greater oscillations or sub-periods in the value of these ranges during times of maximum than during times of minimum sun-spots. But on the other hand the increased value of such oscillations is by no means so striking as in the case of sun-spots. Mr. Broun has already made the remark that while there is an increase in the whole declination-range during times of maximum sun-spots, yet this increase is not so marked as in the case of the spots themselves, inasmuch as we have a considerable declination-range when there are no spots on the sun. From what has now been said it would seem that a similar remark applies to the oscillations or sub-periods of declination-range, which, while increasing from times of minimum to times of maximum sun-spots, do not yet increase so strikingly as the oscillations or sub-periods of the spots themselves.

16. If we now treat the inequalities of magnetic declination that appear to depend on the two most available planetary configurations in the manner in which we have just treated sun-spot inequalities, we might expect the observed magnetic inequalities corresponding to times of maximum sun-spots to be greater than the calculated inequalities, but not to the same extent as in the case of sun-spots.

Let us make use for this purpose of the records of the three Observatories, Kew, Prague, and Trevandrum. We cannot, however, take absolutely the same epochs that we have taken for the sun, inasmuch as for the first of these, March, 1835, there are no magnetic observations. We may, however, take the other two epochs, January, 1847, November, 1858, and an additional one at October, 1870. Thus we shall

have three epochs in each case, while only two of these are common to both solar and magnetic observations. This comparison is made in the following table.

TABLE XII. In which observed and calculated declination-range inequalities are compared together for selected periods.

				Period of Mercury (one revolution).	
				Observed.	Calculated.
Between	0°	and	30°	+11·48	+10·42
,,	30	,,	60	+ 3·62	+ 7·25
,,	60	,,	90	− 3·50	+ 2·25
,,	90	,,	120	− 6·91	− 3·25
,,	120	,,	150	− 9·13	− 8·16
,,	150	,,	180	−12·37	−11·67
,,	180	,,	210	−13·72	−12·12
,,	210	,,	240	−10·44	− 8·68
,,	240	,,	270	− 2·45	− 2·62
,,	270	,,	300	+ 7·73	+ 4·10
,,	300	,,	330	+15·14	+ 9·26
,,	330	,,	360	+16·20	+11·27

				Mercury and Jupiter together (one revolution).	
				Observed.	Calculated.
Between	0°	and	30°	+11·87	+11·61
,,	30	,,	60	+ 2·56	+ 8·07
,,	60	,,	90	− 4·26	+ 2·75
,,	90	,,	120	− 8·72	− 2·45
,,	120	,,	150	−13·85	− 7·93
,,	150	,,	180	−16·24	−11·97
,,	180	,,	210	−13·44	−11·80
,,	210	,,	240	− 8·32	− 8·71
,,	240	,,	270	+ 0·51	− 3·11
,,	270	,,	300	+11·39	+ 3·44
,,	300	,,	330	+16·91	+ 8·74
,,	330	,,	360	+17·06	+11·89

The results of Table XII are exhibited in Diagram II, in which fig. 8 exhibits the observed and calculated magnetic inequalities for the period of Mercury, and fig. 10 the same for the period of Mercury and Jupiter.

17. It thus appears that in the case of the magnetic declination periods there is (as in those of sun-spots) an exaltation of the observed over the calculated values during times of maximum sun-spot frequency, but this exaltation is not so marked as in the case of sun-spots. Now, without pretending to know in what way the sun influences

the magnetism of the earth, we may imagine that the increased values not only of the average declination-range but also of the sub-periods of these during times of maximum sun-spots may be due to one of two causes, or to both of these together. Thus we may imagine that the sun has an increased magnetic influence during such periods, or we may imagine that there is an increase in the magnetic susceptibility of the earth; or, finally, we may imagine that both of these causes operate together. I cannot help thinking that we have some evidence of an increase of the magnetic susceptibility of the earth on such occasions derived from two facts discovered by Mr. Broun. The one is that the magnetic influence of the moon on the earth shows traces of following the solar period, this influence being greater during times of maximum than during times of minimum sun-spots. The other is that at Trevandrum the lunar magnetic influence, without changing its type, exhibits an increase of value when the sun is above the horizon at that place, as if on such occasions there were an increase of susceptibility to the lunar influence. These, however, are points which can only be determined by a further discussion of observations.

In conclusion, I beg to record my thanks to Mr. W. Dodgson and to Mr. Morisabro Hiraoka, who have kindly assisted me in the work of this paper.

Presents, April 4, 1878.

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Diagram I.

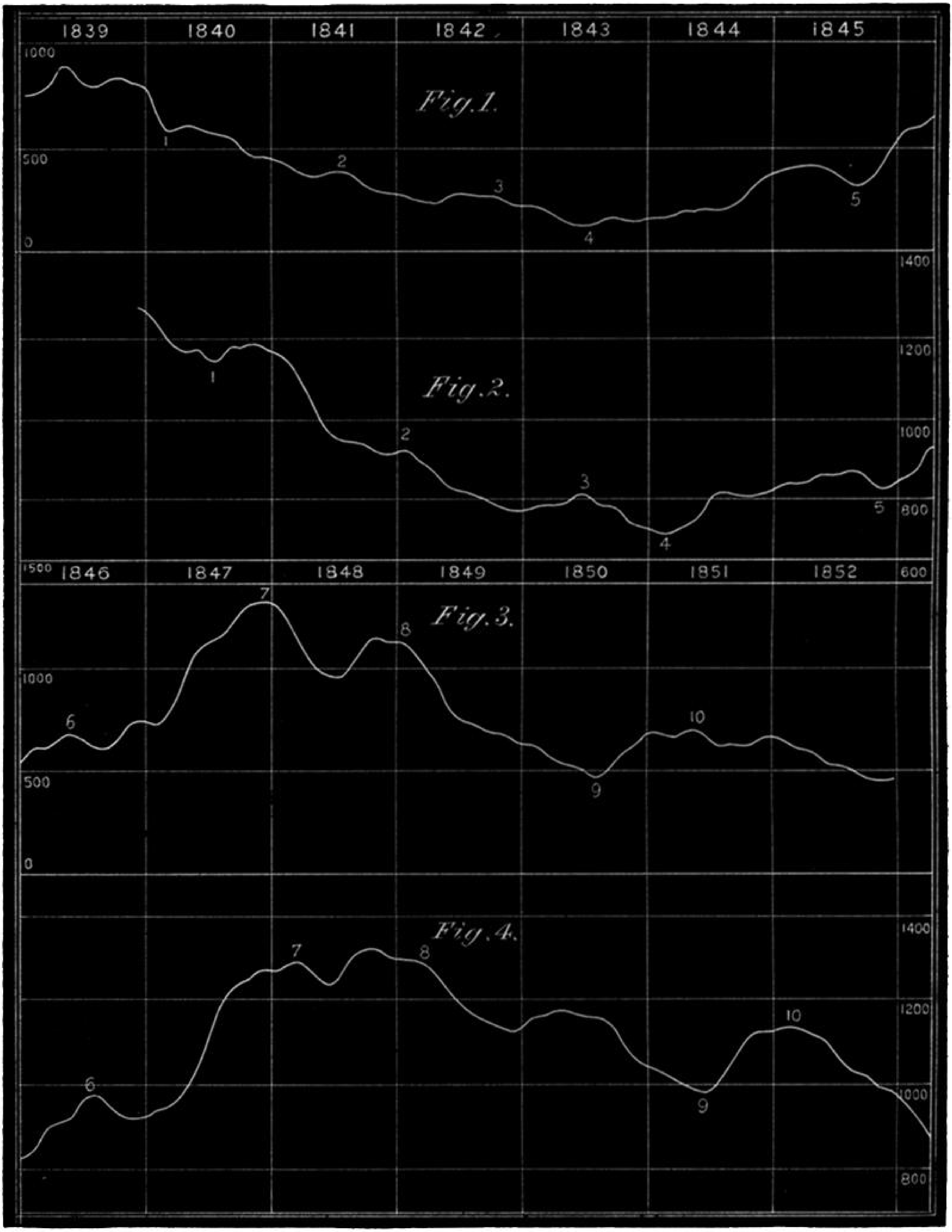
1839
1840
1841
1842
1843
1844
1845
1000
500
0
Fig. 1.
1
2
3
4
5
1400
1200
1000
800
600
Fig. 2.
1
2
3
4
5
1500
1846
1847
1848
1849
1850
1851
1852
Fig. 3.
6
7
8
9
10
1000
500
0
Fig. 4.
6
7
8
9
10
1400
1200
1000
800

Diagram II.

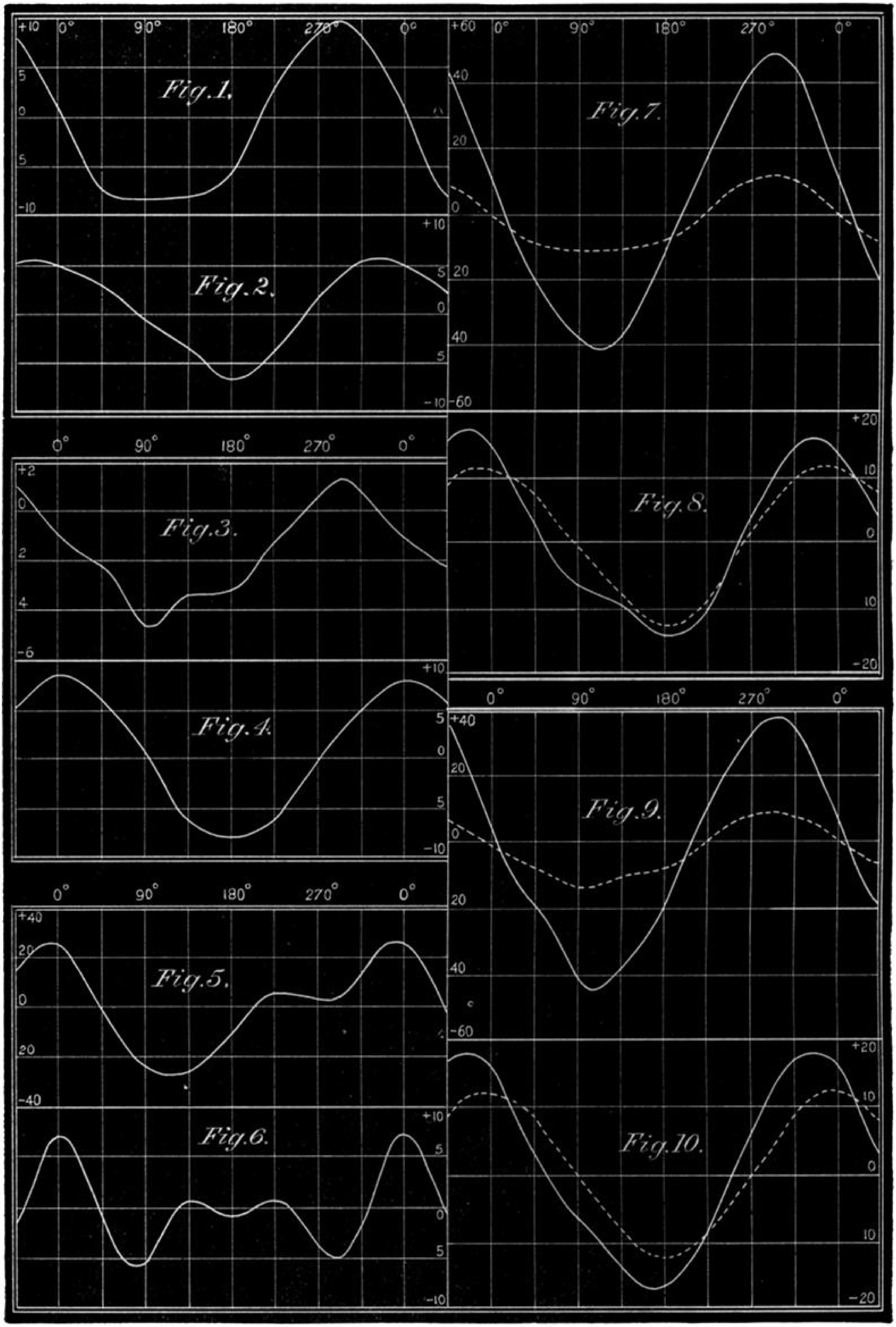
Fig.1.
Fig.2.
Fig.3.
Fig.4.
Fig.5.
Fig.6.
Fig.7.
Fig.8.
Fig.9.
Fig.10.
0° 90° 180° 270° 0°
+10
5
0
5
-10
+2
0
2
4
-6
+40
20
0
20
-40
+60
40
20
0
20
40
-60
+20
10
0
10
-20