at Paris ; the Astronomical, Geographical, and Zoological Societies at London ; the Essex and Franklin Institutes ; Mr. S. F. Haven ; Dr. Roehrig ; Prof. J. D. Whitney ; the New York Lyceum ; the Librarian of Congress ; and the Public Museum at Buenos Ayres.

The death of Sir William J. Hooker, at Kew Gardens, England, on the 12th of August, aged 80, was announced by the Secretary.

A communication entitled "The Nebular Theory," by Prof. Ennis, of Philadelphia, was read by the Secretary.

Pending nominations 540, 541, were read.

And the Society was adjourned.

Stated Meeting, October 6, 1865.

Present, nine members.

Prof. CRESSON, Vice-President, in the Chair.

Letters with photographs were received from Sir Henry Holland, London, Sept. 6th, and Prof. E. N. Horsford, Cambridge, Mass., June 24th. The photograph of Mr. William P. Foulke was added to the album.

Mr. A. H. Smith accepted the appointment to prepare an obituary notice of Mr. Foulke.

Donations for the library were reported from Prof. Zantedeschi, of Padua ; Dr. Schinz, of Strasbourg ; the Bureau des Mines ; the Essex and Franklin Institutes ; Harvard Observatory ; the American Journal of Science ; Prof. Silliman ; Dr. G. B. Wood ; Mr. Lamborn ; the Ressel Committee, and various booksellers.

The death of Dr. Wayland, President of Brown University, at Providence, R. I., September 30th, aged 69, was announced by Mr. Trego.

The committee on M. Julien's paper reported progress.

Mr. Lesley described some relics lately exhumed from Indian graves near Wilkesbarre. Dr. Coates referred to the wearing away, without decay, of the teeth in skulls found in tumuli and graves on the West Branch Susquehanna and elsewhere.

Mr. Chase presented a detailed account of his experiments upon the Mechanical Polarization of Magnetic Needles under the influence of Fluid Currents, or Faraday's "Lines of Force."

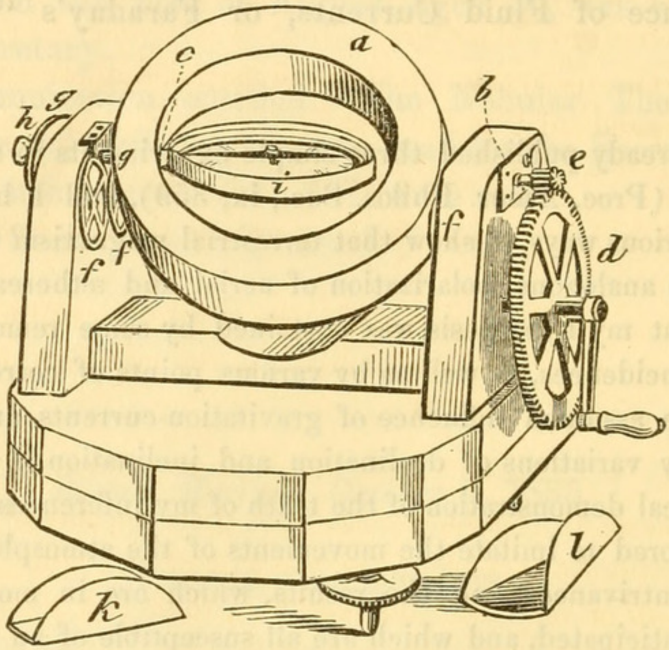
I have already published three simple experiments in mechanical polarization (Proc. Amer. Philos. Soc., ix, 359), and I have endeavored, in various ways, to show that terrestrial magnetism is probably owing to an analogous polarization of aerial and æthereal currents. Finding that my hypothesis was sustained by some remarkable numerical coincidences, as well as by various points of correspondence between the assumed influence of gravitation-currents and the observed daily variations of declination and inclination, I sought for some practical demonstration of the truth of my inferences. I therefore endeavored to imitate the movements of the atmosphere by mechanical contrivances, and the results, which are in most respects such as I anticipated, and which are all susceptible of an easy explanation, are embodied in the following additional experiments.

4. By the use of fans, bellows, and blowers of various kinds, either alone or in conjunction with directing discs, currents may be produced that will deflect the needle in any desired direction, in accordance with simple and evident mechanical laws.

5. I have tried iron, copper, wood, zinc, and pasteboard, and find, as I anticipated, that the material employed for producing or directing the artificial currents has no effect upon their mere *mechanical* action; but I have found the results most satisfactory when, in order to avoid the complication of induced magnetism or electricity, I employed non-conductors, such as wood and pasteboard. Upon subsequently repeating the experiments with different metals, the effects of the induced currents have been plainly shown.

6. Increasing the number of directing discs (provided they are all parallel) often modifies the intensity of current-influence, but does not appear otherwise to affect the result.

The most striking developments that I have yet hit upon were obtained by the aid of a Gaussian modification of Faraday's apparatus for showing the electric currents developed in moving metallic bodies by terrestrial magnetism. It consists of a heavy copper ring (*a*), fixed to horizontal supports (*b*) (*c*), on which it can be rapidly rotated by a wheel (*d*) and pinion (*e*), the supports being relieved by friction-wheels (*f*). The outer diameter of the ring is 6 inches at each



edge, and $6\frac{3}{16}$ inches in the middle; the inner diameter, 5 inches; the thickness, $1\frac{1}{2}$ inches. The axle opposite to the gearing (*g*) is hollow, to allow the insertion of a brass rod (*h*), which supports a compass (*i*) horizontally in the interior of the ring. The compass is not shielded by a glass, and it is therefore easily affected by aerial currents. If the ring is made to revolve around the compass needle, the N. pole of the needle is deflected in a direction opposite to the motion of the top of the ring.*

For my special purpose, I replaced this copper ring by a wooden one of the same dimensions, and prepared a number of discs (*k*) (*l*), in the form of semicircles and circular segments, fitted so that they could be fixed, in different vertical positions, in the compass box, above the needle. Causing the wheel to rotate, with the axis variously placed, I tried the following experiments:

* For the use of the apparatus, I am indebted to the kindness of President Richard S. Smith, of Girard College.

A. SINGLE DISC, OR MULTIPLE AND PARALLEL DISCS.

a. *Axis in magnetic meridian.*

7. When the disc was in the meridian, the currents produced a slight tendency in the needle* to move in the same direction as the upper part of the ring.

8. When the disc was in the equator, the slight tendency was opposite to that in Exp. 7, and the same as if it had been produced by induced electricity in the ring.

9. When the disc was inclined to the meridian, there was a marked polarity, perpendicular to the disc.

b. *Axis in magnetic equator.*

10. The disc being placed in the meridian, there was no disturbing current.

11. Placing the disc equatorially, the needle was still undisturbed.

12. But when the disc was inclined to the meridian, the current-polarity was parallel to the disc.

c. *Axis* 45° *from magnetic meridian.*

13. In nearly all positions of the disc there appears to be a disposition in the needle to move *from* the axis of the ring. But when the disc is in or very near the meridian, there is a slight tendency towards the axis.

In order to imitate more closely the earth's principal thermal radiation-planes, which are all theoretically parallel with the thermal meridians and meet at the thermal pole, I constructed a compound disc (*l*) of two circular segments, inclined to each other at an angle of about 30°, with which I tried the following experiments:

B. SPHERICAL-ANGULAR DISC.

a. *Axis in magnetic meridian.*

14. If the disc is so placed, with its opening towards the south, that its angle is bisected by the meridian, the current-polarity carries the needle in the same direction as the motion of the top of the ring.

15. If the opening of the disc is turned to the north, the apparatus remaining in other respects as in the last experiment, the current-polarity is reversed (as in Exp. 8).

16. Placing the disc equatorially, I am unable to discover any current-polarity.

* In speaking of the needle's tendency, I always refer to the motion of the N. pole.

17. Inclining the disc towards N. W. and S. E., the needle moves towards the east, whether the opening of the disc is towards the north or towards the south.

18. If the inclination is towards N. E. and S. W., the motion of the needle is westerly.

Experiments 14 to 18 are perhaps the most interesting and important of the entire series. Exp. 14 represents the direction of the gravitation-currents that tend to restore the equilibrium which is continually disturbed by the thermal radiation of the northern hemisphere; while Exp. 15 represents the like direction in the southern hemisphere, and all the experiments demonstrate that *in the daily magnetic fluctuations, the motion of that end of the needle which is nearest to the equator should follow, precisely as observation shows that it does follow, the direction of the sun's meridional influence.*

b. *Axis in magnetic equator.*

19. When the disc is in the meridian, the current-polarity and the magnetic polarity coincide.

20. If the disc is in the equator, with the opening to the east, when the top of the ring moves towards the north the needle declines to the east.

21. But when the motion of the ring is towards the south, the current-polarity is reversed, and the needle declines to the west.

22. The reversal of the disc, placing the opening to the west, likewise reverses the polarity, the declination being east when the ring moves south, and west when the ring moves north.

23. The disc being inclined to N. W. and S. E., the needle declines towards the west (the action in Exp. 17 being reversed).

24. Changing the inclination of the disc to N. E. and S. W., the declination changes to east (reverse of Exp. 18).

From Exp. 19 to 24 we may infer that, *in consequence of the action of the trade-winds, combined with the greater radiation of the northern hemisphere, there should be a constant eastward tendency of the magnetic declination, such as is indicated by the secular variation of the needle.*

c. *Axis 45° from magnetic meridian.*

25. When the disc is in or near the meridian, there is a slight tendency, in the extremity of the needle which is under the opening of the disc, to follow the direction of the top of the ring. In all other positions, the needle declines *from* the axis.

d. *Axis variously inclined.*

26. If the inclination of the axis to the meridian is less, or greater, than 45°, the results approximate respectively to those obtained when the axis is in the meridian, and when it is in the equator.

C. APPARATUS-POLARITY.

Friction and the jarring of the apparatus, modified by the degree of velocity imparted to the ring, produce a polarity of their own which should be carefully estimated, and due allowance made for its influence in all delicate and doubtful experiments. In order to determine the directivity of the normal vibrations, independent of any mere current influence, the needle was shielded by a glass, as in the ordinary surveyor's or mariner's compass.

27. When the axis is in the meridian, the polarity appears to be meridional.

28. With the axis in the equator, the polarity is also meridional.

29. If the northern extremity of the axis is inclined to the west, the needle declines to the east.

30. Giving the axis an easterly inclination, the needle declines to the west. The declination is, therefore, *from* the axis in all cases, and we may infer that the earth's rotation exerts a constant tendency to increase the normal declination of the needle.

31. In all positions of the axis there appears to be a slight disposition in the needle to decline to the east, independent of the motion produced by the mere vibration of the apparatus. If this disposition is owing to terrestrial currents, it is probable that the declination would be westward in the southern hemisphere, in accordance with Ferrel's law, that, "*in whatever direction a body moves on the surface of the earth, there is a force arising from the earth's rotation which deflects it to the right in the northern hemisphere, but to the left in the southern.*" (Math. Monthly, i, 307.)

32. If a candle-flame, or the smoke of an extinguished taper, be brought near to the revolving ring, it will be repelled from the equator, attracted to the poles, and neither attracted nor repelled at a distance of about 30° from the equator.

33. If a magnetic needle is substituted for the taper, it tends to parallelism with the axis at the equator, and dips towards the centre as it approaches the poles, in accordance with its general disposition to range itself in the line of strongest vibration. (Exp. 3, Proc. A. P. S., ix, 359.)

D. Revolving Discs attached to the Ring.

a. *Discs Axial.*

34. Whatever may be the position of the axis, there is a very slight axial polarity.

b. *Discs Perpendicular to Axis.*

35. There is no current-polarity.

c. *Discs with* 45° *East Declination.*

36. If the axis is in the meridian, the needle declines to the east.

37. If the axis is in the equator, when the top of the ring moves south the needle declines to the east, but when the ring moves north the declination is westerly.

38. If the axis is inclined to the meridian, and the disc passes over the needle in the magnetic equator, the declination is easterly; but if the disc is meridional, I am unable to discover any decided current-polarity.

d. *Discs with* 45° *West Declination.*

39. Placing the axis in the meridian, the needle declines to the west.

40. When the axis is equatorial, the declination is westerly.

41. When the axis is inclined to the meridian, and the disc is equatorial, the needle declines to the west; but if the disc is meridional, it produces no marked polarity.

42. All of the experiments with revolving discs, as well as many of those with fixed discs, appear to be affected by changes in the earth-currents, especially when the motion of the ring is northerly.

The foregoing results are in precise accordance with the theoretical deductions contained in my papers on the "Numerical Relations of Gravity and Magnetism," on the "Influence of Gravity on Magnetic Declination," and on "Gravity and Magnetic Inclination" (Amer. Phil. Soc., Dec. 16, 1864, April 21 and May 19, 1865, and Amer. Jour. of Science [2], xxxix, 312; xl, 83, 166), as well as with Dove's discovery that analogous atmospheric states are more frequently found under the same meridian than under the same parallel, and with Ferrel's demonstrations of the tendency in fluids gyrating normally to move towards the pole, the parabolic route of cyclones, the lateral pressure of moving bodies, and the disposition of the axis of rotating bodies to parallelism with the earth's axis.* (Math. Monthly, i, 307; ii, 95, 380, 382.) The rationale is generally so obvious that the necessity of the experiments may reasonably enough be doubted by some, while others may question the validity of any inferences as to magnetic motions that are drawn from the effect of impulses which are confessedly purely mechanical.

Such doubts may perhaps be removed by considering, 1st, the well-known danger of being led astray by the simplest undetected fallacy in *à priori* reasoning, which renders it desirable to obtain experimental verifications of every philosophical inference; 2d, that if all forms of force are, as is so generally supposed, mutually convertible, the convertibility can only be discovered through their mechanical momentum; and 3d, that *all the experiments illustrate the magnetic influence of a fluid controlled by the reaction of disturbed gravitation.* I have shown that forces proceeding in lines corresponding to those which represent solar and planetary† influence, produce magnetic deflections equivalent to the observed solar-diurnal, annual, decennial, and secular variations; and if it can be also shown that gravitation is an adequate force, we need seek no farther for a *vera causa*, or for conclusive evidence of the correlation of *all* the great cosmical forces.

Whatever theory we may favor respecting the nature of force, and the manner or medium of its transmission,—whether we consider with Fresnel and Grove, that the luminiferous and kinetic æther is material and ponderable; with Mossotti and Faraday, that it is imponderable; or with Dana, that the hypothesis of any medium is entirely supererogatory‡ (Amer. Jour. of Science [2], iv, 379, 382), it will be generally admitted that the quantity of motion is the proper measure of force. In an ordinary tempest, every flash of lightning is followed by a thunder-clap, which is occasioned by the

* Mr. Ferrel refers, for a beautiful illustration of some of his propositions, to Foucault's experiments with the gyroscope. (Amer. Jour. of Science [2], xv, 263; xix, 141.)

† The connection which has been pointed out by Sabine between Schwabe's theoretic course of the solar-spot phenomenon and the magnetic 10–11-year period (Phil. Trans., 1852, Art. VIII), acquires a new interest from Prof. Wolf's continued investigations into the influence of the several planets upon the sun-spot curve. (See Monthly Notices of the Royal Ast. Soc., May 12, 1865.)

‡ Is the "*pulsating molecular force*" of Prof. Dana's hypothesis material or immaterial? If the latter, is it intelligent or unintelligent? How can momentum be imparted by velocity without material mass, unless it be by the direct and voluntary act of a competent intelligence?

reacting gravitation of the air in the restoration of disturbed equilibrium; and, on the other hand, in water-spouts and tornadoes, the flashes seem to follow, instead of preceding, the equalizing action of aerial gravitation. We have never yet been able to measure the electrical and gravitating momenta in such instances of violent commotion; but we can hardly doubt their exact equivalence, in view of the well-established law, that "action and reaction are always equal and in opposite directions." And in consideration of such probable equivalence, it does not seem unreasonable to quote them as standing evidences of that long-desiderated link in the chain of kinetic unity, for the recognition of which the way has been partially prepared by Henry's discovery of the tendency to equality of electric momenta, and the correlation of intensity- and quantity-currents (Amer. Jour. of Science [1], xxxviii, 218), Challis's hydrodynamic researches (Phil. Mag., vol. i, sqq.), especially in their application to the explanation of gravity as a necessary resultant of universal æthereal vibrations (ibid. [4], xviii, 321, 443), Helmholtz's paper, "in which he has pointed out that the lines of fluid motion are arranged according to the same laws as the lines of magnetic force, the path of an electric current corresponding to a line of axes of those particles of the fluid which are in a state of rotation" (Crelle's Journal for 1859, referred to by Prof. Maxwell in Phil. Mag. [4], xxi, 348), Rankine's "Summary of the Properties of Certain Stream Lines" (Phil. Mag., Oct. 1864, pp. 282–8), Norton's recent articles on "Molecular Physics" (Amer. Jour. of Science [2], vol. 38, sqq.), and a variety of other physical discussions, some of which I have already cited.

The analogies which were pointed out by Gen. Sabine between the thermal and magnetic curves (Hobarton Obs., I, xli; Toronto Obs., I, xxxviii; St. Helena Obs., I, 38, &c. &c.), have been very fully, and, generally speaking, satisfactorily discussed by Profs. Norton (Amer. Jour. of Science [2], vols. 4, 8, 10, 19, 20) and Secchi (Phil. Mag. [4], vols. 8, 9), the former directing his attention exclusively to the correspondence between the magnetic and thermal variations, the latter to a hypothetical specific magnetism resident in the sun. *All of the reasoning of both these distinguished physicists can be applied, even more convincingly, in support of the hypothesis that simple gravitation-disturbances correspond to those of magnetism, and many of the difficulties in the way of other theories disappear before such an application.*

Having established the coincidence and equivalence (with opposite signs) of the magnetic and gravitating lines of force (Trans.

A. P. S., vol. xiii, Art. VI), the modifying magnetic influence of rotation (ibid., pp. 120, 129), barometric tides (ibid., pp. 123–7), winds (ibid., p. 121, and Proc. A. P. S., x, 104), thermal changes (Gen. Sabine, loc. cit.), and lunar attraction (Proc. A. P. S., ix, 434–8; Trans. A. P. S., xiii, 129; and Gen. Sabine's Diagrams, Toronto Obs., vol. iii, plate 2), and the probable, if not certain, dependence of the variations of long period upon trade-winds (supra, Exp., 19–24) and planetary positions (Sabine and Wolf, loc. cit.), the hypothesis of any peculiar magnetic æther, electric currents, or specific solar and lunar magnetism, to explain the normal perturbations of the needle, appears to be entirely superfluous and unphilosophical. Every particle of the earth's atmosphere is continually receiving and imparting the heat which is radiated from the earth and sun, its specific gravity constantly changing in such manner as to produce incessant rapid and short oscillations, both in the planes of the earth's thermal meridians* and in the great circles which pass through the centres of the earth and sun. The consequent disturbance of equilibrium, which is still farther increased by the condensation of vapor, the sun's direct attraction, and the earth's rotation, is counterbalanced by terrestrial attraction, acting most forcibly where the sun is in the horizon, and with the least relative efficiency when the sun is in the zenith (or at noon in the summer solstice, provided the station is extra-tropical).

The pressure thus exerted varies from 0 lb. to 15 lb. per square inch. Taking the mean (7½ lb. per square inch or 1080 lb. per square foot) as the average equilibrating tendency, we have a force nearly fifteen times as great as that which produces, and more than twenty-eight times as great as that which is produced by, a violent hurricane. (Enc. Britan., 8th edit., xiv, 647.) Only an insignificant portion of this mighty energy is exerted in the production of the various atmospheric currents, the remainder being quietly transmitted from molecule to molecule, and manifesting itself in barometric,† magnetic, and other meteorological perturbations. The adequacy of our supposed cause will therefore hardly be doubted; and, since its penetrating, pervading influence can be impeded by no material shield or screen, the demonstration of a correlation of heat and magnetism

* The earth's most powerful radiation is vertical, or in radial lines; next in intensity is the radiation towards the thermal poles, or along the thermal meridians; on the isothermal parallels, the radiation is comparatively insignificant.

† The morning and evening maxima and the noon minimum of effective pressure, combined with rotation, are the principal causes of the daily barometric tides.

with the force which keeps the planets in their orbits appears to be complete and conclusive.

It is possible that a careful study of the relation of the winds to the various magnetic variations would bring to light other evidences of parallelism as striking as the one I have already pointed out (Proc. A. P. S., x, 104) between the curves of vertical magnetic force and force of wind. Such a study might require special attention to the pressure and velocity of the wind, the times of maxima and minima, and other particulars, the need of which would be suggested by experience.

Whatever cause affects at the same instant the magnetic and aerial currents should first manifest itself through its influence upon the needle, on account of the amount of inertia in the air. Upon examining the second volume of the St. Helena Observations, which contains a record of the direction of the wind at intervals of six hours, so arranged as to facilitate a comparison with the magnetic declination, I find in each year, from 1844 to 1847 inclusive, that at one hour before the observation of the wind (and in each year except 1846, at the hour of observation) there was a greater average westerly declination when the wind was nearly east than when it was nearly S. by E. This is shown by the following table, which embraces all the tabulated instances when the wind was E. by N., E., E. by S., or S. S. E., S. by E., or S.

The variation of declination is ascertained, 1st, by subtracting from the observed declination the monthly mean at the same hour; 2d, subtracting the monthly average of the daily means from the mean variation of the day; and 3d, subtracting the latter result from the former. One scale division of the declinometer = 0′.711. Increasing numbers denote decreasing westerly declination.

Year.	E. by N., E., or E. by S.					S. S. E., S. by E., or S.		
	No. of observations.	Var. of decl'n. 1 h. before obs. Scale divisions	Average.	Var. of decl'n. at h. of obs. Scale divisions	Average.	No. of observations.	Var. of decl'n. 1 h. before obs. Scale divisions	Average.
1844	11	—5.11	—.46	—10.66	—.97	81	+4.77	+.06
1845	10	—3.09	—.31	—.52	—.05	283	—18.28	—.06
1846	20	—1.16	—.06	+4.37	+.22	191	+6.78	+.03
1847*	85	—4.96	—.06	—12.95	—.15	12	+1.52	+.12
Total	126	—14.32	—.11	—19.76	—.16	567	—5.21	—.01

* January to July inclusive.

The recent experiments of Marcus, showing the direct conversion of heat into electricity (see London Chemical News, No. 286; Journal of the Franklin Institute, No. 478), the well-known atmospheric daily cycles, with two maxima and two minima of electrical intensity,* and the tendency of the disturbance-variations of declination, inclination, and total force, to fluctuations which follow the solar-tidal and barometric-tidal hours,† are all noteworthy in this connection.

In the regions of variable winds, it can hardly be supposed that the correspondence between changes of wind and of declination should be so marked as in the torrid zone. I find, however, upon tabulating about two thousand of the Toronto Observations, that there are some indications of a similar character to those in the St. Helena Table; but they are, comparatively, so slight, that another form of comparison has given results which are more satisfactory to my own mind.‡

According to my several hypotheses, the magnetic impulses are transmitted with a velocity analogous to that of light, and the position of the needle at any moment is dependent upon the combined action of local and cosmical forces, the former producing continual agitations of short period, and the latter largely preponderating in the daily means. On the other hand, the barometric and other atmospheric changes, in consequence of greater inertia, are more obedient to cumulative influences that have a limited local origin, and less affected by sudden violent disturbances. It seems reasonable, therefore, to suppose that the oscillations about the mean magnetic values should differ, in duration and in other respects, from those about the thermal and barometric means. If their mutual relations are much obscured in consequence of this difference, any lingering evidences of inter-dependence that we may find may be entitled to great weight.

* For some recent interesting observations upon atmospheric electricity, see communications of Dr. A. Wislizenus in the Transactions of the Academy of Sciences, St. Louis.

† The long series of observations at Toronto show this correspondence in a very striking manner. See Gen. Sabine's Report, vol. iii, p. 63, table lvi.

‡ M. Kaemtz (Meteorology, Walker's translation, p. 451) states that "the dip depends, like the height of the barometer, on the direction of the wind and on temperature." This is the earliest intimation I have yet discovered, which can be possibly construed as either *implying* or tending to demonstrate a direct correlation between weight and magnetism. The resemblance between the curves of wind-force and magnetic vertical force, would naturally lead one to look to the dip rather than to the declination, for the most striking evidence of the magnetic effects of direction of the wind.

Taking Toronto as a typical station of average, and St. Helena as one of minimum accidental magnetic disturbance, I first deduced from three years' observations at each place (1843, '4, '5 at Toronto; 1843, '5, '6 at St. Helena; the observations of 1844 being comparatively incomplete), the average duration of the fluctuations of each element. I found the following mean lengths of an oscillation, measuring from the maximum of one wave to the maximum of the succeeding wave (B representing the barometer; T, thermometer; H, horizontal force; V, vertical force; D, declination).

	B.	T.	H.	V.	D.
Toronto, . .	3.98 days.	3.93 days.	4.54 days.	4.31 days.	3.10 days.
St. Helena,	4.38 "	3.67 "	3.82 "	4.46 "	3.35 "

The mean wave-periods, taking the duration of the alternate variations above and below the monthly means, were as follows:

	B.	T.	H.	V.	D.
Toronto, . .	2.91 days.	3.70 days.	4.55 days.	4.78 days.	2.32 days.
St. Helena,	3.76 "	3.86 "	4.34 "	5.51 "	3.27 "

By marking with the signs + and — the excess or deficiency of each daily mean, the monthly mean being assumed as the standard of comparison, I obtained the data for Tables I and II. The columns headed C contain the number of observations that present a correspondence (excess in one element accompanying excess in the other, and *vice versâ*), and those headed O give the number of instances in which there was an opposition of signs between the daily means indicated by the heading of each double column.

TABLE I.

Correlations of Temperature, Gravity, and Magnetism, in the Daily Means at Toronto.

	B. & T. C.	O.	H. & V. C.	O.	B. & H. C.	O.	T. & H C.	O.	B. & V. C.	O.	T. & V. C.	O.	B. & D. C.	O.	T. & D. C.	O.
	9	17	20	1	16	8	2	22	14	8	2	20	9	15	11	13
Jan.	5	22	. .	. .	18	9	6	21	. .	. .	. .	. .	14	13	10	17
	11	16	18	9	15	12	8	19	14	13	8	19	9	18	15	12
	11	13	8	13	11	11	13	8	14	10	2	22	14	10	11	13
Feb.	9	16	16	2	20	5	10	15	15	3	6	12	16	9	14	11
	6	18	20	4	16	8	6	18	18	6	2	22	15	8	4	19
	10	17	13	14	6	21	17	10	16	11	9	18	13	12	9	16
March.	12	14	18	8	10	16	10	16	12	14	4	22	16	10	10	16
	16	10	20	5	9	16	6	19	8	17	5	20	13	11	12	12
	9	15	4	20	10	14	18	6	18	6	4	20	19	5	11	13
April.	8	17	16	9	13	12	12	13	13	12	5	20	14	11	11	14
	14	12	26	0	12	14	2	24	12	14	2	24	14	12	6	20
	8	19	5	22	10	17	15	12	18	9	5	22	11	16	12	15
May.	7	20	19	7	16	10	6	20	16	11	6	21	17	10	9	18
	7	20	23	4	15	12	7	20	18	9	6	21	13	14	14	13
	11	15	4	22	13	13	20	6	13	13	2	24	12	14	13	13
June.	8	17	17	8	20	5	7	18	16	9	1	24	14	11	15	10
	6	19	14	10	20	5	5	20	16	8	9	15	11	14	14	11
	8	19	8	18	10	17	15	12	21	6	6	21	13	14	12	15
July.	9	18	14	13	17	10	5	22	10	17	10	17	19	8	11	16
	10	17	22	5	13	14	6	21	14	13	5	22	19	8	12	15
	11	16	14	13	17	10	11	16	20	7	6	21	16	11	8	19
August.	15	12	21	6	14	13	8	19	10	17	10	17	10	17	10	17
	8	18	8	18	18	8	6	20	8	18	22	4	16	10	12	14
	9	17	22	4	13	13	4	22	15	11	2	24	16	10	11	15
Sept.	9	16	22	3	17	8	3	22	18	7	2	23	12	13	12	13
	8	18	22	4	16	10	6	20	18	8	4	22	12	14	12	14
	8	18	7	4	15	9	3	21	6	6	3	9	13	13	12	14
Oct.	7	20	18	9	13	14	9	18	18	9	4	23	15	12	11	16
	4	23	23	4	20	7	7	20	18	9	5	22	17	10	10	17
	7	19	. .	. .	15	11	8	18	. .	. .	. .	. .	16	10	11	15
Nov.	13	13	18	8	18	8	7	19	15	11	6	20	15	11	8	18
	6	19	22	3	19	6	2	23	18	7	3	22	12	13	9	16
	12	13	. .	. .	18	7	9	16	. .	. .	. .	. .	15	10	10	15
Dec.	10	15	20	5	14	11	3	22	11	14	4	21	13	11	7	18
	9	17	22	4	16	10	5	21	16	10	1	25	13	13	8	18
1843.	113	198	105	131	154	151	135	169	155	87	41	201	167	140	131	176
1844.	112	200	199	78	190	121	86	225	154	124	58	220	175	136	128	184
1845.	105	207	240	70	189	122	66	245	178	132	72	238	164	145	128	181
Total,	330	605	544	279	533	394	287	639	487	343	171	659	506	421	387	541

TABLE II.

Correlations of Temperature, Gravity, and Magnetism, in the Daily Means at St. Helena.

	B. & T. C.	B. & T. O.	H. & V. C.	H. & V. O.	B. & H. C.	B. & H. O.	T. & H. C.	T. & H. O.	B. & V. C.	B. & V. O.	T. & V. C.	T. & V. O.	B. & D. C.	B. & D. O.	T. & D. C.	T. & D. O.
	11	15	14	8	14	12	7	19	15	7	6	16	12	13	14	11
Jan.	17	10	14	12	11	16	10	17	13	14	11	16	13	14	11	16
	7	19	8	19	23	4	5	21	9	18	15	11	17	10	12	14
	13	11	15	8	12	12	9	15	8	15	5	18	12	12	13	11
Feb.	16	8	11	11	16	8	15	9	13	9	13	9	16	8	16	8
	10	14	12	12	12	12	4	20	8	16	8	16	9	15	11	13
	12	15	10	17	15	12	7	20	9	18	18	9	15	12	14	13
March.	11	14	15	10	8	17	16	9	14	11	16	9	13	12	15	10
	12	14	17	9	10	16	6	20	11	15	15	11	13	13	13	13
	21	4	4	20	10	15	10	15	19	5	19	5	13	12	15	10
April.	16	10	18	7	14	11	17	8	13	13	17	9	15	11	13	13
	9	16	3	16	12	13	12	13	8	11	15	4	10	15	10	15
	10	17	5	21	15	12	8	19	7	19	19	7	19	8	12	15
May.	10	17	6	20	20	7	5	22	7	19	19	7	12	15	17	10
	10	16	6	18	14	11	6	19	7	18	22	3	13	13	9	17
	10	16	5	20	21	5	11	15	10	15	19	6	15	11	15	11
June.	14	11	4	21	13	12	4	21	12	13	19	6	11	14	8	17
	12	14	8	15	18	8	8	18	10	13	10	13	15	11	19	7
	9	17	5	19	16	9	9	16	7	18	16	9	13	13	14	12
July.	12	15	14	13	14	13	9	18	13	14	18	9	14	13	17	10
	10	17	7	20	19	8	6	21	13	14	22	5	14	13	11	16
	5	22	3	23	20	7	6	21	7	19	20	6	16	11	10	17
August.	18	8	13	13	11	15	7	19	12	14	18	8	16	10	12	14
	8	18	14	11	17	9	11	15	7	18	17	8	12	13	15	10
	12	14	10	14	10	16	6	20	14	10	16	8	20	6	16	10
Sept.	15	11	11	15	9	17	8	18	14	12	19	7	12	14	7	19
	14	12	11	15	6	20	13	13	6	20	16	10	10	15	14	11
	16	10	18	6	10	16	6	20	11	13	4	20	18	8	14	12
Oct.	12	15	9	17	18	9	9	18	11	15	16	10	12	15	15	12
	11	16	9	18	16	11	12	15	16	11	20	7	16	10	12	14
	10	16	10	12	16	10	4	22	7	15	13	9	13	13	11	15
Nov.	12	13	7	18	14	11	9	16	10	15	15	10	15	10	12	13
	14	11	11	15	15	10	12	13	13	12	14	11	13	12	16	10
	9	16	17	8	18	7	8	17	12	13	8	17	16	8	11	13
Dec.	18	8	12	14	13	13	13	13	15	11	13	13	14	12	12	14
	14	11	15	10	7	18	6	19	7	18	12	13	7	17	8	16
1843.	138	173	116	176	177	133	91	219	126	167	163	130	182	127	159	150
1845.	171	140	134	171	161	149	122	188	147	160	194	113	163	148	155	156
1846.	131	178	121	178	169	140	101	207	115	184	186	112	149	157	150	156
Total,	440	491	371	525	507	422	314	614	388	511	543	355	494	432	464	462

Tabulating similarly the magnetic observations for one or two days prior and subsequent to the several thermometric and barometric fluctuations, I find indications of a continued action, which is paralleled by the ocean swell that remains after the subsidence of the winds by which the waves were originally excited.

In order to ascertain whether the correspondence, which is thus shown to exist between the daily means of the different elements, can also be traced in the hourly means, I noted the character of the undulations for several entire weeks, selecting observations at different seasons, in such a manner as I thought would give a pretty correct approximation to the average of each of three years. Considering the increasing waves as positive and the decreasing as negative, I obtained the data which are summarily detailed in Table III.

TABLE III.

Correlations of Temperature, Gravity, and Magnetism, in the Hourly Means at Toronto and St. Helena.

	B. & T.		H. & V.		B. & H.		T. & H.		B. & V.		T. & V.		B. & D.		T. & D.	
	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.	C.	O.
TORONTO.																
1st year.	197	242	208	188	212	232	227	232	201	176	162	229	225	211	195	260
2d "	202	234	170	202	246	217	197	234	188	173	165	192	225	217	189	238
3d "	191	232	171	128	218	211	192	259	155	125	120	172	230	202	200	248
Total,	590	708	549	518	676	660	616	725	544	474	447	593	680	630	584	746
ST. HELENA.																
1st year.	198	227	125	179	231	200	217	187	129	183	172	131	225	205	198	204
2d "	199	232	121	203	247	189	250	164	138	196	173	145	248	174	189	211
3d "	190	203	143	182	244	194	249	159	142	194	187	126	220	199	181	210
Total,	587	662	389	564	722	583	716	510	409	573	532	402	693	578	568	625

This triple comparison exhibits, in a very conclusive and satisfactory manner, a connection between temperature, gravity, and magnetic force, which, taken in conjunction with my previously adduced evidences of rotation-tides, appears sufficient to adequately explain all of the well-established normal meteorological fluctuations, and to give a clearer insight into the true meaning and value of the various partial relations which have been previously ascertained or surmised.

It is interesting, especially if we incline to adopt the common hypothesis that the barometric fluctuations are all owing, mainly, if not exclusively, to thermal disturbances, to observe that the magnetic force is more directly and powerfully affected by variations of temperature than the barometric pressure; and that at St. Helena the relation of the barometric to the thermometric movements is less marked than those of either the horizontal or vertical force to the fluctuations of gravity and of temperature. The relative preponderance of the rotation tide over the temperature tide at St. Helena (as shown by the barometer), is an additional evidence of the eligibility of that station for observing the correspondence between the fluctuations of magnetic force and the disturbances of gravitation.

In comparing the St. Helena and Toronto totals, five of the columns exhibit an opposition of relations, such as might have been anticipated, because the laws of equilibrium require that a disturbed "line of force" in one portion of the globe should be counterbalanced by an opposite line in another portion.

The analogies that have been pointed out by Sir David Brewster and Sir John Herschel, between the curves of terrestrial magnetism and those of the polarization of skylight, are a natural consequence of the mechanical laws which we have been considering. The special maximum which Herschel finds is so difficult to account for (Meteorology, p. 230), may be explained by the centripetal reaction against the centrifugal thermal and other solar disturbances, which is a maximum at 90° from the sun.

Pending nominations 540, 541, were read.

And the Society was adjourned.