Precipitation of Metallic Solutions.—Magnesium precipitates nearly all the metals from their neutral solutions. When these are taken in the form of protosalts, even manganese, iron, and zinc are precipitated as black powders. *Aluminium* and *uranium* (and perhaps chrome) are only precipitated as *oxides.*

Alloys of Magnesium.—I have examined only a few alloys of magnesium. Unlike zinc, magnesium *will not unite with mercury at the ordinary temperature* of the air. With tin 85 parts, and magnesium 15 parts, I formed a very curious alloy of a beautiful *lavender-colour,* very hard and brittle, easily pulverized, and decomposing water with considerable rapidity at ordinary temperatures. If the air has access during the formation of this alloy, the mixture takes fire; and if the crucible be then suddenly withdrawn from the lamp, the flame disappears, but a vivid *phosphorescence* ensues, and the unfused mass remains highly luminous for a considerable time. A white powdery mass, containing stannic acid and magnesia, is the result.

[With platinum, according to Mr. Sonstadt, magnesium forms a fusible alloy; so that platinum crucibles can be easily perforated by heating magnesium in them.]

Sodium and potassium unite with magnesium, and form very malleable alloys, which decompose water at the ordinary temperature.

It is probable that an alloy of copper and magnesium, which I have not yet obtained, would differ from *brass,* not only in lightness, but by decomposing water at the ordinary temperature with more or less rapidity.

Uses.—Magnesium will be found a useful metal whenever tenacity and *lightness* are required and tarnish is of no consequence. The light furnished by combustion of the wire has already been utilized in photography at night. In the laboratory it will be found useful to effect decompositions which sodium and potassium cannot effect on account of their greater volatility.

April 28, 1864.

Dr. W. A. MILLER, Treas. & V.P., in the Chair.

The following communications were read:—

I. "On the Magnetic Elements and their Secular Variations at Berlin," as observed by A. Erman. Communicated by General Sabine, P.R.S. Received March 1, 1864.

All observations and results to be mentioned here relate to

Latitude 52° 31′ 55″ North.
Longitude 13° 23′ 20″ E. from Greenwich.

1. *Horizontal Intensity.*

Denoting by $(1800+t)$ the date of observation in tropical years of the

Gregorian epoch, T the absolute value of *horizontal intensity* with millimetre, milligram, and the second of mean time as unities, ω the same in unities of the Gaussian constants; the two values of T for 1805·5 and 1828·31 have been deduced from observed ω, by $T=0{\cdot}00349216 \,.\, \omega$.

τ and τ' denote the observed *time of oscillation* of two magnets which, since 1853·523 were carefully guarded from the influence of other magnets; and therefore, marking by C, α, β, C′, α', β' unknown constants, e the basis of hyperbolic logarithms, and taking $t_1=t-53{\cdot}523$, each value of τ and τ' had to fulfil the equations

$$\tau^2=\frac{C}{(1+\alpha e^{-\beta t_1}) \,.\, T}, \qquad \tau'^2=\frac{C'}{(1+\alpha' e^{-\beta' t_1}) \,.\, T}.$$

In the following list of observed values, the first is due to Humboldt; the twenty-eight following were obtained by Erman:—

Date of observation.	Horizontal intensity, T.		Times of oscillation of Magnet I. τ.		Times of oscillation of Magnet II. τ'.	
1800+t	Observed.	Calculated.	Observed.	Calculated.	Observed.	Calculated.
1805·5	1·6452	1·6452	....	....	....	....
1828·31	1·7559	1·7437	....	....	....	....
1846·13	1·7751	1·7827	....	....	....	....
1849·59	1·7784	1·7867	....	....	....	....
1853·89	....	....	3·1090	3·1090	....	....
1854·59	1·7900	1·7904	3·1072	3·1141	8·0082	8·0056
1856·57	1·7900	1·7913	3·1168	3·1134	8·0954	8·1036
1857·54	1·7879	1·7916	3·1106	3·1131	8·1193	8·1104
1858·58	1·8035	1·7917	3·1158	3·1130	8·1364	8·1126
1859·60	1·7933	1·7912	3·1229	3·1129	8·1223	8·1132
1860·63	....	....	3·1043	3·1129	8·0870	8·1135
1861·52	1·7972	1·7917	....	....	8·1258	8·1138
1862·52	1·7900	1·7915	....	....	8·1100	8·1142
1863·80	1·7929	1·7911	3·1148	3·1135	8·0975	8·1151

The calculated values result from the following most probable expressions for T, and for those values of τ and τ' which agree best with the contemporaneous T.

$$\text{I.}\quad T=1{\cdot}61892+0{\cdot}0057689\,t-0{\cdot}000048119\,t^2.$$

$$\left.\begin{array}{l}\text{II.}\quad \tau^2=\dfrac{17{\cdot}3633}{\{1+0{\cdot}07392 \,.\, e^{-8{\cdot}2988 \,.\, t_1}\} \,.\, T}\\[2ex] \text{III.}\quad \tau'^2=\dfrac{117{\cdot}956}{\{1+0{\cdot}09733 \,.\, e^{-1{\cdot}16927 \,.\, t_1}\} \,.\, T}\end{array}\right\}\text{with } t_1=t-53{\cdot}523.$$

The expression I. appears liable to the *probable errors*,

$$\left.\begin{array}{ll}\text{in first term,} & \pm 0{\cdot}00126\\ \text{in coefficient of } t, & \pm 0{\cdot}000065\\ \text{in coefficient of } t^2, & \pm 0{\cdot}00000074\end{array}\right\}\text{of a magnetic unity;}$$

and when brought under the form

$$\text{(A)} \qquad T = 1{\cdot}79183 - 0{\cdot}000048119\{t - 59{\cdot}930\}^2,$$

identical with I., it shows that the horizontal intensity reached in 1859·930 the maximum of 1·79183.

It ought to be observed, that equal probability has been attributed to the error

$$\pm 1 \text{ in } T,$$
$$\pm \frac{\tau}{2T} \text{ in } \tau,$$
$$\pm \frac{\tau'}{2T} \text{ in } \tau';$$

that is to say, equal errors to an *intensity* determined by each of the three methods,—this supposition being at once the most simple and the most conformable to my experience, by nearly contemporaneous repetitions of each class of observation.

All my determinations of absolute intensity have been obtained either by one of two, or by two magnetometers; the first of which is a Gaussian of large size, by Meyerstein, the second my declination- and transit-instrument by Pistor, completed by the usual graduated holders for deflecting magnets, and perfectly adapted to observations in the open air.

2. *Inclination.*

The values of inclination here employed are taken for 1806·0, 1832·5, and 1836·87, from the observations of Humboldt, Rudberg, and Encke; for the ten other dates since 1825·0, they have been obtained by my own applications of the methods exposed in my 'Reise um die Erde,' Physikal. Beob., tome ii. pp. 8–42, to two different instruments—viz. till 1850 to a large and highly perfect one by Gambey, and since that time to a smaller dip-circle by Robinson. The methods of observation leave no room for any constant error in the resulting inclination, as long as no directive magnetic force is exerted upon the needle by the instrument itself. In order to free my results from any influence from this improbable (but not impossible) source, I compared, in 1860, three full determinations by the last-mentioned apparatus, with an equal number which I obtained under identical circumstances with a most perfect copy of Weber's inductive inclinometer. The result was an agreement of the two kinds of determinations within the limits of accidental error of the first—that is to say, far below *one minute* in the inclination; I venture, therefore, to say hat the following numbers must give the absolute value of the element in question with no less certainty than the rate of its secular variation:

Date of observation.	Inclination, i.	
1800+t.	Observed.	Calculated.
	° ′	° ′
1806·0	69 53	69 52·99
1825·00	68 49·19	68 44·62
1828·29	68 34·55	68 34·17
1832·50	68 18·08	68 21·40
1836·87	68 7·43	68 8·84
1838·75	68 2·04	68 3·66
1846·20	67 43·25	67 44·46
1849·65	67 35·48	67 36·29
1853·78	67 29·81	67 27·09
1856·56	67 20·50	67 24·26
1857·55	67 20·30	67 19·25
1860·60	67 15·75	67 13·31
1862·55	67 7·63	67 9·69

The system of the above calculated values, which best agrees with the observed ones, results from the expression

(B) $i=70^\circ\ 17'{\cdot}42-4'{\cdot}1854\,t+0'{\cdot}018931\,t^2$;

it leaves in each single equation a probable error of $\pm 1'{\cdot}42$; and accordingly in the expression itself the probable errors appear to be

in the absolute term $\pm 2'{\cdot}17$;
in the coefficient of t $\pm 0'{\cdot}1211$;
in the coefficient of t^2 $\pm 0'{\cdot}001591$.

This expression can be brought under the form

(B*) $i=66^\circ\ 26'{\cdot}09+(t^2-110{\cdot}543)^2 . 0'{\cdot}018931$,

which would prove that at the place in question the inclination will come, in 1910·543, to a minimum of 66° 26′·09. The aforesaid errors of terms give $\pm 2{\cdot}27$ years for the uncertainty of the epoch of this minimum, and $\pm 3'{\cdot}9$ for the uncertainty of its value; but as the expression (B) results from observations between 1806 and 1863, its consequences ought not to be extended as far as 1910.

3. *Declination.*

Four results of observations of this element, made by the late astronomers Kirch in 1731, Bode in 1784 and 1805, and Tralles in 1819, have been added to my own, which extend from 1825 to 1864. These latter were obtained with the declination- and transit-instrument employed in my voyage, which intermediately was frequently compared and found in perfect agreement with a large Gaussian magnetometer, whenever the indications of the latter were duly freed from the torsion of the suspending wires and from the want of parallelism between the normal of the employed speculum and the magnetic axis of the bar. My observations were all made in the open air, with the exception of the two in 1849 and 1850, which, having been executed in a room, were corrected for the influence of local attractions. As the determination of this latter seemed exposed to a somewhat larger

error than the other declinations, in combining the two reduced values with those obtained in the open air, I have given to the two first only a fourth of the weight of the others. A similar allowance for larger probable errors should perhaps have been made in employing the four statements of former observers; but, for want of particulars about the operations they are founded upon, it was more safe to neglect the difference between their weight and that of the others, than to fix it by an arbitrary assumption.

If, for the *moment of observation*, there were marked by $1800+t$, as before, the tropical years elapsed since the Gregorian epoch, m the positive excess of t over the next integer, x the horary angle of *mean Sun*, each observed west declination d' had to be brought under the form

$$d'=D+f(t)+\phi(m, x),$$

D denoting a constant, and f and ϕ two functions, the first of which was to be determined here.

In order to form $d'-\phi(m, x)=d$ out of each d', I put

$$\phi(m, x)=a+\alpha \cdot \cos x+\gamma \cdot \cos 2x+\epsilon \cdot \cos 3x, \\ +\beta \cdot \sin x+\delta \cdot \sin 2x+\zeta \cdot \sin 3x,$$

taking the values of a, α, β, ..., ζ by interpolation according to m, from the following Table, derived from observations in the Russian observatories at St. Petersburg, Catherinbourg, and Barnaoul in the year 1837 and 1838, and well agreeing with my own determinations of $\phi(m, x)$ for the years 1828 to 1830, and at eight places between latitude 50° and 62° North.

m.	a.	α.	β.	γ.	δ.	ϵ.	ζ.
0·042	+ 15″	+ 54″	+ 15″	−27″	+ 70″	+ 1″	+ 5″
0·123	− 62	+ 61	+ 46	−28	+104	+33	+12
0·204	− 43	+ 54	+135	+11	+173	+22	+62
0·288	−108	+ 64	+256	+14	+199	+21	+82
0·372	− 88	+104	+264	+65	+182	+42	+42
0·455	+ 14	+107	+290	+71	+184	+64	+45
0·538	+ 77	+ 82	+275	+76	+175	+72	+43
0·623	+ 60	+ 85	+221	+79	+187	+69	+60
0·707	+ 72	+ 91	+139	+51	+156	+57	+34
0·790	+ 63	+ 75	+ 69	+ 2	+137	+29	+ 9
0·884	− 4	+ 64	− 10	−12	+ 76	+36	− 1
0·959	+ 5	+ 82	− 18	−20	+ 68	+14	−11
1·042	+ 15	+ 54	+ 15	−27	+ 70	+ 1	+ 5

When I supposed in this way that the parameters a, α, ..., ζ of the function $\phi(m, x)$, or ϕ as I will call it for abbreviation, are the same for all moments alike situated in different years, I was well aware that this assumption is but approximative, and that all sufficiently extended and direct investigations of ϕ, as chiefly those of General Sabine, have shown a periodicity of about 9·5 years in the total values of this function. But as the laws of such dependence between T and each of the seven para-

meters of ϕ have not yet been perfectly exposed, I preferred in the present to treat the latter as mere functions of m and x. In the following Table of employed mean declinations for the moments t, to each of them is subjoined the value of ϕ by whose subtraction it has resulted from the momentary value furnished by observation. This arrangement will allow us to appreciate (and, if wanted, to correct for) the influence exerted by any periodical variation of ϕ upon the final result of my observations. It may, too, be convenient to observe that for some of the following west declinations (D), as well as for the before-mentioned intensities (T) and inclinations (I), the observations were made in latitude $p-\Delta p$, and longitude $l-\Delta l$ (where p and l mark the corresponding and above alleged values for my ordinary place), and that then the directly obtained results, viz. $d-\Delta d$, $T-\Delta T$, or $i-\Delta i$, have been reduced by

$$\Delta d = -0{\cdot}0940 \,.\, \Delta p - 0{\cdot}6103 \,.\, \Delta l;$$
$$\Delta T = -0{\cdot}7480 \,.\, 10^{-3} \,.\, \Delta p + 0{\cdot}2152 \,.\, 10^{-3} \,.\, \Delta l;$$
$$\Delta i = +0{\cdot}7405 \,.\, \Delta p - 0{\cdot}1861 \,.\, \Delta l;$$

the minute of arc being the unity for Δp, Δd, Δi, and Δl.

These equations, which result from the Gaussian constants with the given p and l, are sufficiently approximated when, as with us, Δp and Δl do not exceed a few minutes. So then were obtained:

Date of observation. 1800+t.	Momentary declination. Mean declination, ϕ.	Mean declination, d.	
		By observation.	Calculated.
1731·60	0	12° 18′·05	12° 19′·85
1784·00	0	17 59·65	17 46·09
1805·40	0	18 1·35	18 7·86
1819·00	0	17 36·50	17 48·06
1825·79	−1·80	17 24·46	17 28·37
1828·33	−4·08	17 21·35	17 19·34
1834·05	−1·24	17 2·69	16 55·65
*1849·62	+2·74	15 21·55	15 24·39
*1850·63	+2·96	15 20·48	15 20·47
1853·81	+4·32	14 55·17	14 58·26
1854·36	−2·86	15 1·05	14 54·19
1856·58	+1·13	14 38·13	14 37·40
1857·49	−5·95	14 33·88	14 30·29
1858·54	−5·61	14 21·15	14 21·96
1859·58	−4·87	14 14·24	14 13·59
1861·50	+4·47	13 53·70	13 57·63
1862·55	+0·12	13 49·83	13 48·72
1863·79	+4·48	13 36·85	13 37·99

A fourth of the weight of each of the other observed values being given to each of the two marked *, the whole is best represented by

$$d = 18^\circ\ 8'{\cdot}46 + 0'{\cdot}26820\ t - 0'{\cdot}070665\ t^2, \quad . \ . \ . \ . \quad \text{(IV).}$$

which furnishes the above calculated numbers; and by their comparison with the observed ones, the *probable errors* are—

in *the absolute term of d* $\pm 1'\cdot 94$;
in the coefficient of t in d $\pm 0'\cdot 2932$;
in the coefficient of t^2 in $d \pm 0'\cdot 030669$.

If, now, instead of employing the variations ϕ (m, x), or ϕ according to observations in the years 1837 and 1838, we assume (1) that the periodical dependence between this function and the date t consists in always changing each parameter proportionally to its mean or primitive value, and then (2) that, as General Sabine has proved, the whole function has nearly reached a maximum in all moments marked by $t=48 \pm n\,.\,9\cdot 5$, n being an *integer*, and (3) that, according to the same philosopher, the least and the largest amount of corresponding variations are approximately as 1 : 1·4, then, Φ marking the function of t, m, x which in each case must be substituted for ϕ, and C a function of M and X, we shall have

$$\Phi = c\left\{1\cdot 20 + 0\cdot 20\,.\,\sin\left[\frac{720^\circ}{19}\,(t - 45\cdot 625)]\right]\right\}$$

and

$$\phi = c\left\{1\cdot 20 - 0\cdot 20\,.\,\sin\frac{720^\circ}{19}\,(8\cdot 125)\right\} = 1\cdot 35811\,.\,c.$$

To each of the preceding values of d must therefore be *added*

$$\phi - \Phi = \phi\left\{0\cdot 1163 - 0\cdot 1472\,.\,\sin\left[\frac{720^\circ}{19}\,(t - 45\cdot 625)\right]\right\}.$$

By executing this operation, I found that the reduced observations are best represented by

$$(\mathrm{C}^*) \qquad d = 18^\circ\,8\cdot 43 + 0\cdot 26831\,.\,t - 0\cdot 070652\,.\,t^2,$$

and that, though scarcely differing from (IV.), this expression is preferable, because the probable error of each of its terms is by nearly $\frac{1}{34}$ of its former value smaller than the corresponding one in (IV.)

As the expression (C*) is identical with

$$(\mathrm{C}) \qquad d = 18^\circ\,8'\cdot 68 - 0'\cdot 070652\{t - 1\cdot 899\}^2,$$

we see that, according to my observations, the west declination at the place in question arrived in 1801·899 at a maximum of 18° 8′·68.

Putting off for a further article some more general observations on the secular changes of terrestrial magnetism, I briefly resume, as results of my nearly forty years' observations, that for

latitude $=52^\circ\ 31'\ 55''$ North,
longitude $=13^\circ\ 23'\ 20''$ E. from Greenwich,

there have been—between 1805 and 1864,

$$Horizontal\ intensity = T = 1{\cdot}79183 - 0{\cdot}000048119\ \{t - 59{\cdot}930\}^2;$$

between 1806 and 1863,

$$Inclination = i = 66^\circ\ 26'{\cdot}09 + 0'{\cdot}018931\ \{t - 110{\cdot}543\}^2;$$

and between 1731 and 1864,

$$West\ declination = d = 18^\circ\ 8'{\cdot}68 - 0'{\cdot}070652\ \{t - 1{\cdot}899\}^2;$$

all results being meant to be just for the date $1800 + t$ in years of the Gregorian epoch.

N.B. It seems not unworthy of remark, that no evidence of the existence of a *third term* in the expression for any one of the three phenomena results from the above-mentioned observations; and this, though partly due to the inevitable imperfections of the observations, makes it highly probable that a man's lifetime, and even a century is but a very small part of the secular period of terrestrial magnetism.

II. "On the Action of Chlorine upon Methyl." By C. SCHORLEMMER, Assistant in the Laboratory of Owens College, Manchester. Communicated by Professor ROSCOE, F.R.S. Received April 5, 1864.

In a paper published in the Journal of the Chemical Society, New Ser. vol. i. p. 425, I pointed out the great interest which attached to the study of the lower terms of hydrocarbons, known by the name of the "alcohol radicals," inasmuch as the question of the chemical constitution of these bodies requires to be more definitely settled.

Having been aided in these researches by a grant from the Council, I beg to lay before the Royal Society the results of an investigation on the action of chlorine upon methyl, which are as unexpected as they are decisive.

Equal volumes of chlorine and of methyl were exposed in strong well-corked bottles, holding from two to three litres, to diffused daylight in the open air at a temperature of about 5° C. The methyl was prepared according to Kolbe's method, by electrolysis of a concentrated solution of acetate of potassium, and carefully purified by washing with a solution of caustic potash and concentrated sulphuric acid. The colour of the chlorine disappeared rather quickly; colourless oily drops condensed on the the sides of the bottles, and collected after some time on the bottom as a mobile liquid, the greater part of which volatilized again when the bottles were brought into a warm room. Hence it appears that by the action of one volume of chlorine upon one of methyl, substitution-products are formed, consisting chiefly of a volatile liquid, the boiling-point of which ies between 5° and 15° C. In order to collect these products, the bottles were heated till all the liquid had volatilized, and then opened, with the mouth downwards, under a hot concentrated solution of common salt, to which some caustic soda was added in order to quicken the absorption of