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XXIII. Notice of a remarkable magnetic disturbance which occurred on the 2nd and 4th of July, 1842

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wrought iron in different stages of its crystallization, as there can be no doubt that very great differences exist in this respect, and it is probable that in most cases, when the crystallization has once commenced, the continuance of the same causes which first produced it goes on continually increasing it, and thereby further reduces the cohesive strength of the iron.

Earl Street, May 31, 1842.

[Several samples of broken railway axles accompanied this paper, and were exhibited at the Meeting. In some of them the same axle was broken in different places, and showed that where the greatest amount of percussion had been received, the crystallization of the iron was far more extensive than in those parts where the percussion had been less.]

XXIII. *Notice of a remarkable Magnetic Disturbance which occurred on the 2nd and 4th of July*, 1842. *By the Rev.* Humphrey Lloyd, *D.D., F.R.S., V.P.R.I.A., Professor of Natural Philosophy in the University of Dublin.*

To Richard Taylor, Esq.

Dear Sir,

A VERY remarkable magnetic disturbance (the *most remarkable* I ever witnessed) occurred in the beginning of the present month. A brief sketch of some of the principal features of the phænomenon, as they were observed at the Dublin Magnetical Observatory, may probably interest some of your readers.

On the 2nd of July, at 6 a.m. (Göttingen mean time), the attention of one of the assistant observers (Mr. O'Neill) was arrested by the extraordinary deviation of all the magnets from their mean positions, accompanied by a large vibration; and he immediately commenced a series of observations at short intervals. The *disturbance* of the declination (by which I mean the deviation of the freely suspended horizontal magnet *from the mean place corresponding to that hour*) then amounted to 149·2 divisions of the scale of the instrument, or $1^\circ\ 47'{\cdot}3$ of arc, —the north end of the magnet deviating *towards the west*, or the declination *increased*. The magnet of the bifilar magnetometer was driven beyond the limits of the scale of its collimator; and the diminution of the horizontal intensity *exceeded* the $\frac{1}{50}$th of the whole force. Both magnets were returning rapidly towards their mean positions at the moment of the first observation; so that the epoch of the greatest change was *before* 6 a.m., and its amount *exceeded* that observed. The

observations taken at the regular hours immediately preceding (2 and 4 a.m. Göttingen mean time) gave no warning of the approaching change.

From 6 a.m., for nearly an hour, both magnets returned rapidly, and almost uninterruptedly, towards their mean positions, the declination diminishing, and the horizontal intensity increasing. The latter element reached its maximum at 6^h 56^m; the declination continued to decrease until 7^h 12^m. After this, no very marked change occurred for some time, and the extra observations were discontinued at 8^h 36^m.

At 10 a.m. the declinometer indicated an increase of declination amounting to 18·6 minutes; and the extra observations were resumed, and continued for an hour. By this time (11 a.m.) both instruments had attained nearly their mean positions, from which the observations taken at the regular magnetic hours next following (noon, 2 p.m. 4 p.m.) showed no variation.

The extra observations were resumed at 5^h 36^m p.m., the bifilar magnetometer then indicating an *increase* of the horizontal intensity, amounting to ·0062 of the whole. The observations were continued for more than an hour, but without the occurrence of any very marked change.

The regular observation at 10 p.m. showed a considerable decrease of declination, accompanied by a decrease of horizontal intensity; and at 11 p.m. the extra observations were resumed, and continued, with both instruments simultaneously, until Sunday morning. In this interval another very remarkable change took place. The declination, after some irregular oscillations, began to increase rapidly, and reached its maximum at 11^h 48^m, the deviation from its mean value being then 28·1 minutes. It then returned with a very rapid movement, and in eight minutes the magnet traversed 83 divisions of the scale, or 1° of arc; after which it made some smaller oscillations of the same rapid kind. The change of the horizontal intensity which occurred at the same time was still more remarkable. This element increased from 11^h 8^m to 11^h 20^m; it then rapidly diminished for 12 minutes more; in another 6 minutes it reached a second maximum (at 11^h 38^m); and finally the magnet was driven impetuously beyond the limits of the scale in the opposite direction, the intensity reaching its minimum at 11^h 50^m, and the disturbance exceeding the $\frac{1}{30}$th of the whole intensity. The returning oscillation occupied 12 minutes more; and at 12^h 2^m the magnet returned to its extreme position on the opposite side, the fluctuation in this time exceeding 111 divisions of the scale. The disturbance during these two hours was characterized by the absence of all

vibratory movement, notwithstanding the magnitude of the changes.

There seemed to be a faint auroral light in the N.W. horizon, but without streamers.

When the regular observations were recommenced, on Monday the 4th instant, the disturbing forces were found to be still in activity. At 2 and 4 a.m. the instruments showed a very considerable *decrease* of declination, accompanied by a great decrease of horizontal intensity. At 6 a.m. the declination *exceeded* the mean of the hour by a still greater amount; and the horizontal intensity had also increased, though still below its mean value. All the magnets were then vibrating through very large arcs. The series of observations at short intervals was then begun, and continued (almost without interruption) for ten hours.

At $6^h\ 24^m$ the declination reached its maximum, the deviation then amounting to 43·2 minutes. The horizontal intensity also attained its maximum very nearly at the same moment. The two elements then began to diminish rapidly and simultaneously; and between 7 and 8 a.m. there was a double minimum of both, separated by an intervening maximum, that of the horizontal intensity taking place a few minutes earlier than the other element.

At 9 a.m. the disturbance was extremely rapid. The magnets were hurried to and fro with a violent movement; and these changes of mean position were accompanied by a large vibration, amounting in some instances (notwithstanding the copper rings) to 20 divisions of the scale.

This combination of movements rendered it difficult to seize the moment of greatest deviation, or to determine its precise amount. The declination attained a minimum at 9 a.m., which was followed by a marked maximum at $9^h\ 22^m$, the range of the oscillation being 29·4 minutes. There was a corresponding change of the intensity, but somewhat later in time,—the minimum occurring at $9^h\ 14^m$, and the maximum at $9^h\ 50^m$; and the range amounting to ·0147.

The changes of declination which occurred afterwards did not present any remarkable features; but the horizontal intensity, which was previously less than in its mean state, after reaching a minimum at $1^h\ 44^m$, suddenly increased to an amount exceeding its mean value, and reached a maximum at $2^h\ 5^m$ p.m. The period of this maximum was characterized by a sudden increase of the arc of vibration, as if by impulse. The intensity continued above its mean value (though with some considerable oscillations) during the remainder of the time of observation. The disturbance ceased about 5 p.m.

The induction inclinometer was observed, in conjunction

with the other two instruments; but the observations are unreduced, and I am therefore unprepared as yet to offer any remark respecting the changes of inclination or total intensity. It is manifest, however, even from this imperfect sketch, that this disturbance presents many features of prominent interest:

1. In the great magnitude, and marked and abrupt character of the principal changes. In both these respects the changes at 6 a.m. and 12 p.m. on the 2nd instant, afford perhaps the most interesting points of comparison of any that the system of simultaneous observation has yet furnished; and much light may be expected to be thrown on the phænomena by a comparison of the results which may certainly be expected to arrive from the colonial observatories, as well as of those which have been probably obtained at Port Louis, in the moveable observations of the Antarctic expedition.

2. In the striking confirmation which it affords to the conclusion of Prof. Kreil, viz. that all the greater changes are accompanied by a diminution in the horizontal component of the intensity. The whole of the day following the disturbance (July 5) was also characterized by a diminished intensity, which is also in accordance with the inductions of Prof. Kreil; but the increase of this element *towards the close* of the disturbance (in the afternoon of the 4th) is in opposition to one of his conclusions.

3. In the two classes of changes exhibited; in one of which (as on the evening of the 2nd) the disturbances from the mean position, although great and rapid, were accomplished without any sensible vibration of the magnets; while in the other (as on the morning of the 4th) the vibration exceeded any ever witnessed in this observatory, since the application of the copper rings.

4. In the occurrence of great magnetic changes without any marked auroral phænomena. The sky was clear on the night of the 2nd, during a very remarkable part of the disturbance, and a light was seen in the N.W.,—but of a very uncertain nature, and without any of the distinguishing characters of the aurora. I may observe, however, that throughout the whole of the 3rd, and the greater part of the 4th, the sky was covered during the day with a peculiar milky whiteness, apparently belonging to something distinct from and above the clouds; and that this disappeared suddenly, and the blue sky became visible, about 5 p.m. on the 4th, when the disturbance was at an end. I could not help regarding this appearance as connected with aurora.

Believe me, dear Sir, faithfully yours,

H. Lloyd.

Trinity College, Dublin,
July 19, 1842.