May 28, 1868.

Lieut.-General SABINE, President, in the Chair.

The following communications were read :—

I. "A Comparison of the Kew and Lisbon Magnetic Curves during the Magnetic Storm of February 20–25, 1866." By Senhor I. BRITO CAPELLO, of the Lisbon Observatory. Communicated by B. STEWART. Received April 18, 1868.

During the 20th, 21st, 23rd, 24th, and 25th of February 1866, large magnetic disturbances were recorded by the magnetographs at the Lisbon and Kew Observatories.

As these indicate several appreciable deviations from the normal types, I trust a description of them may be not without interest to the Royal Society. Dr. Stewart, Director of the Kew Observatory, has kindly sent me copies of the Kew magnetic curves during these disturbances.

In order thoroughly to ascertain the laws governing the forces which disturb the ordinary magnetic condition of the globe, we should reduce in a systematic manner, such as General Sabine has so ably pursued, the observations made at a number of stations, and then classify and discuss the valuable results so obtained.

Nevertheless the present communication relative to the disturbances observed at two stations offers some interest, on account of the apparent variability of the forces which are in action during the same disturbance, and also the apparently variable relations between these forces at Lisbon and the same forces at Kew.

In a former comparison made between the magnetic curves of Kew and Lisbon (Proceedings of the Royal Society, No. 60), it was established that at Lisbon, during disturbances, the vertical force and the declination curves were *invariably* opposed to each other, *i. e.* a *concave* wave of one of the curves always corresponded with a similar *convex* one in the other; or, in other words, an augmentation of the vertical force agreed with an horizontal movement of the north pole of the bar towards the east, and a diminution of the same component to a movement of the north pole to the west.

This general law applied both to the large and slow movements (waves), and the short and rapid ones (peaks and hollows).

However, there were some very rare instances in which this law did not altogether hold good. In these cases, although the peaks and waves were reproduced in the two curves in inverted order, yet the whole of the one curve for some period did not assume the inverted form of the other curve.

The periods of disturbance which are the objects of this discussion belong to these *abnormal* types.

In the paper quoted above, the authors have also shown,—

1st. That all the small peaks in the Kew curves are simultaneously reproduced in the Lisbon curves in the same sense in the declination and bifilar, but in a contrary direction in the vertical force.

2nd. That, generally, all the waves of the declination and bifilar at Kew were reproduced in the corresponding Lisbon curves, sometimes more or less disfigured.

3rd. That in the generality of cases, with the exception of peaks and hollows, in which they are opposed, the vertical-force curves of the two stations do not resemble each other.

Let us now see if these laws are confirmed in these disturbances.

First Disturbance.—This series of disturbances commenced at Lisbon, February 20th 16^h 12^m G. M. T., by a sudden increase of the declination, and an enormous diminution of the vertical force. The horizontal force likewise decreased rapidly, but 13^m later (16^h 25^m): this is noteworthy. However, the three elements, and especially the horizontal force, had been somewhat disturbed since 10^h 27^m G. M. T.

It is noticeable, in the large diminution of vertical force, that although the curve in descending ran off the edge of the paper, we can fix the point of minimum (approximately), which gives us a little more than 0·1 (English units) as the value of the disturbance. The increase in declination was nearly a degree ($59'{\cdot}3$), and the diminution of horizontal force 0·052 English units.

This last diminution commenced, as we have before stated, 13^m later than the other disturbances; and the time of minimum is also 6^m to 8^m after the corresponding points of declination and vertical force.

In other respects the remaining waves of the horizontal force do not agree with those of the declination and vertical force.

The Kew curves agree tolerably well with the Lisbon curves, up to the time of the large and rapid movements. Here it appears that the large movements of the three instruments were of the same nature as the Lisbon ones; and it is very possible that the large variations were more considerable and rapid, since they failed to record their traces on the paper.

These large movements seem to have begun in the three instruments at Kew at the same time (16^h 30^m), at which time the Lisbon declination and vertical force had deviated to half their full extent.

The small peaks are reproduced at the two stations at the same absolute time, the two vertical forces being always in opposite directions.

The first *period* of this disturbance seems, therefore, to be of the same nature in the two stations, *i. e.* the disturbing forces have acted on the three instruments in a similar manner.

Second Disturbance.—Let us now pass to the second period.

The large movements have ceased, but the horizontal force remains too low, and in continual vibration. Towards 2^h and 3^h of the 21st of February

we may take as the recommencement of a second period, which terminated about 7 P.M.

In the Lisbon declination we see at the beginning and end of this period two similar undulations, each about half an hour in duration, and almost regular. In the middle there are smaller waves, interrupted by peaks and hollows. The diminution of declination is not remarkable.

In the vertical force we have the same *waves* in a contrary direction to the declination; but the ascending branch is in one instance greater than the corresponding descent in the declination. A similar difference may be noticed in the last wave but one, by which it happens that the vertical-force curve shows an increase of force during two hours and a half, without a corresponding decrease of the declination.

The horizontal force retained its position below the mean until $3^h\ 20^m$, when it descended further till 4^h; then it ascended successively till 6^h, where it stopped very nearly in its normal position.

We will now discuss the Kew curves. The declination has been greatly disturbed by large deviations above and below its normal position, a general decrease of declination, however, taking place during more than three hours of great disturbance.

The needle has oscillated 40′ in arc, while the Lisbon oscillations have not exceeded 8′. Some movements seem to agree with Lisbon ones, others, on the contrary, disagree entirely; and even in those movements which correspond, some differences of time are appreciable, which cannot be due to error in the time-scale.

The vertical force at Kew increases rapidly from $2^h\ 35^m$ to $3^h\ 50^m$; a period of fluctuations then follows up to 5^h, after which the curve rapidly descends irregularly to the end.

The Kew vertical-force curve only agrees with the Lisbon curve in the general aspect of the disturbances, the period of greatest increase lasting but $1^h\ 15^m$, while at Lisbon it was $2^h\ 10^m$.

It should be also remarked that the vertical force does not agree in the slightest with the horizontal force at Kew.

The horizontal force at Kew seems to follow the inverse direction of that of Lisbon, and its general form resembles that of Lisbon inverted. After $5^h\ 30^m$ the waves appear to agree.

Thus we see, in the same disturbance, two periods at an interval of some hours, which show their relations at the two stations to be of an entirely different nature.

In the first period the three instruments agree; in the second, the horizontal components differ, and all similarity is wanting in the vertical force and declination during the greater part of the total duration.

A long calm period, 46^h in duration, followed these large disturbances; during which the series of small peaks and hollows were reproduced in the three curves, chiefly in the morning (17^h to 21^h) of the 21st and 22nd days.

Third Disturbance.—Another disturbance commenced about 6^h on the

23rd of February, which lasted up till $12^h\ 30^m$. The horizontal force was in motion from $3^h\ 50^m$.

The general appearance of this disturbance at Lisbon is a large decrease of declination and horizontal force, and an increase of vertical force for some hours.

It is noteworthy that the waves in the Lisbon curves are clean and rounded in the declination and vertical force. The Kew curves show also fewer peaks and hollows than during the former disturbances.

At Lisbon this general rule is found to exist: the declination disturbance is opposite in direction to the vertical force. The declination curve agrees very well with the Kew curve; the variations of the latter are larger, as is usual. There is one remarkable circumstance, the first *minimum* ($6^h\ 33^m$) happens 6^m or 7^m before Kew, the other *maxima* and *minima* agree, with the exception of very small differences, which may be attributed to the difficulty of determining precisely the extreme points of the Lisbon curve, on account of their roundness.

The vertical-force curves show a general similarity, but the connexion between the different phases is not seen. It is remarkable that the general form of the Kew vertical-force curve has a great likeness to the Lisbon horizontal force, but in an inverted order, although the extreme opposite points of maxima and minima do not occur at the same time.

The horizontal-force curves agree very well up to 8^h; after this time it is easily seen that the Kew curve agrees almost exactly with the Lisbon vertical force.

Fourth Disturbance.—Two less important periods follow this period, which terminate about 15^h on the 24th: after ten hours of comparative calm the magnets are again set in motion at Lisbon, by a deviation of the horizontal force and declination and a depression in the vertical force, about $1^h\ 45^m$ on the 25th. This disturbance is composed of three large *waves*, much agitated, and full of *peaks* and hollows, or serrated.

At the first glance we see immediately that the general trait of the disturbance is identical at Kew and Lisbon, *i. e.* the different phases of the three instruments agree with one another.

The Kew curve generally agrees with the Lisbon one, although several periods are more developed, particularly some waves between $5^h\ 30^m$ and 9^h more developed at Kew. The horizontal-force curves also agree; but it must be remarked that the *waves* (between $5^h\ 30^m$ and 9^h), which are most developed at Kew in the declination, are less developed in the horizontal force than at Lisbon.

The two vertical-force curves generally agree; but the phases at Kew are in advance of those at Lisbon. The small *peaks* (those which can be identified) are inverted and simultaneous. It is also noteworthy that the first vertical-force movement at Kew is opposite to that at Lisbon.

The vertical-force Lisbon curve is greater in its movements than the declination, and consequently deviates from the general law.

Thus we see that the same periods of certain disturbances are manifested very differently in two stations so near each other as Kew and Lisbon. The modification is the greatest, particularly in the periods which depart from the general rule at Lisbon, and are doubtless also abnormal at Kew.

From the examples here quoted, it is evident that a great value would be attached to the curves from another intermediate station; for the little vertical-force *peaks* and *hollows*, being opposed at Lisbon and Kew, it would be very interesting to see if these peaks would be wholly or nearly absent at some intermediate station.

With a certain number of these magnetographs very discreetly placed, we may one day analyze the different forces acting on the needle in the different places on the earth—a manifest desirability.

II. "On Supersaturated Saline Solutions." By Charles Tomlinson, F.R.S. Received April 21, 1868.

(Abstract.)

This memoir is divided into six parts. The *first* part contains a definition of the subject; the *second* an historical sketch; the *third* is on the action of *nuclei* in inducing crystallization, and the effect of low temperatures on a number of supersaturated solutions contained in chemically clean vessels; the *fourth* is on the formation of a modified salt, as in the case of zinco-sulphate and sodic sulphate; the *fifth* contains an inquiry as to whether anhydrous salts form supersaturated solutions; and the *sixth* and last part is a summary with a classified list of the salts examined.

1. *Definition.*—When water at a high temperature is saturated with a salt, and, on being left to cool in a closed vessel, retains in solution a larger quantity of the salt than it could take up at the reduced temperature, the solution is said to be supersaturated.

2. *History.*—During many years the phenomena of supersaturation were studied with reference to solutions of Glauber's salt. In 1809, Ziz of Mayence* showed that the sudden crystallization of these solutions is not due to agitation; that the vessels containing the solutions do not require to be hermetically sealed; but if put under a bell-glass, or loosely covered as with a capsule, they can be preserved during a long time; that solids brought into contact with the solutions act as *nuclei* and produce instant crystallization, but that such solids act best as nuclei when dry; if wet or boiled up with the solution they become *inactive*. The most efficient nucleus is a crystal of the salt itself. Air, if artificially dried, ceases to be a nucleus. Three varieties of the sodic sulphate are noticed, *i. e.* the *anhydrous* and the ordinary 10-*atom hydrate,* and also a peculiar salt formed when supersaturated solutions in closed vessels are left to cool down. This

* Schweigger, 'Journal,' 1815, vol. xv.