THURSDAY, OCTOBER 5, 1871

OBSERVATIONS UPON MAGNETIC STORMS IN HIGHER LATITUDES

THE extension of the telegraph into the more northern latitude of the Shetland Islands, between 59° 51′ and 60° 51′ 30″ N., has afforded a much better opportunity of observing the frequency and variation of the magnetic and auroral storms that have of late excited some attention and discussion in these pages.

Some of the earliest recorded observations upon the strength and direction of these atmospheric storms, date from the time when the extension of the telegraphic wires over England rendered the phenomenon visible by the disturbance of the magnetic needle placed in circuit with the wires, and to a certain extent rendered possible the mapping down of the position and direction of the magnetic storm over certain tracts of Great Britain.

On the 24th September, 1847, remarkable magnetic disturbances were observed in London, and the direction and deflection of the magnetic needle noted. The effects of this magnetic storm were carefully observed at Dawlish, Norwich, Derby, Birmingham, Rugby, Cambridge, Tonbridge, Wakefield, Edinburgh, and York. The magnetic disturbance appears to have commenced about $1^h\ 5^m$ P.M. on the 24th, and continued with variable intensity until $7^h\ 30^m$ A.M. on the 25th.

It may be interesting to give some of the galvanometer readings recorded as indicating the rapid oscillation and deflection of the galvanometer needle. In the period of time between $4^h\ 17^m$ P.M., and $5^h\ 48^m$ P.M. on the 24th, or in about one hour and a half, the direction of the current had changed no less than ten times, showing a maximum swing of the needle over an arc of 50°.

H. M.	deg.	H. M.	deg.
4.17	15 left	5.5	15 left
4.20	20 right	5.11	12 ,,
4.25	1 ,,	5.16	10 right
4.25.30^s	18 ,,	5.22	18 left
4.35	6 ,,	5.25	14 right
4.38	12 ,,	5.28	13 left
4.45	20 ,,	5.32	20 ,,
4.50	10 left	5.34	26 ,,
4.51	17 ,,	5.42	29 ,,
4.55	0 ,,	5.48	30 ,,
4.56	8 right		

During this magnetic storm, the variation of the dipping needle which was observed in London every 30^m, ranged between 69° 30′ and 67° 50′.

In some cases these magnetic storms were so severe as to impede the working of the railway signals. On the 18th of October, 1841, a very intense magnetic disturbance was recorded, and amongst other curious facts mentioned is that of the detention of the 10.5 P.M. express train at Exeter sixteen minutes, as from the magnetic disturbance affecting the needles so powerfully, it was impossible to ascertain if the line was clear at Starcross. The superintendent at Exeter reported the next morning that some one was playing tricks with the instruments, and would not let them work.

It will be fresh in the memory of many of our readers that during the month of October last year, very remarkable and brilliant "auroræ" were observed in London, chiefly of a deep blood-red colour, spreading from the zenith over a great portion of the heavens.

It is, however, in the more northern latitude of the Orkney and Shetland Islands that the grandeur of these wonderful electrical phenomena can be observed, and that reliable data can be obtained from which hereafter some practical result may be deduced.

As observed in Orkney and Shetland, the aurora, as a general rule, appears to concentrate and emerge from behind a dense mass of dark cloud lying low down in the horizon towards the north. The edge of this cloud-bank is serrated and jagged, as if the mass were electrically in a high state of tension. From behind this cloud-bank "dark" streamers will appear to start up high into the zenith, appearing as if attenuated portions of the edge of the cloud-bank had been dragged by some invisible power, these dark auroral rays being at the same time transparent as regards the power of transmitting the light of the stars, which shone through with undiminished splendour. At the same moment that these dark rays are emicant, brilliant green, violet, crimson, and white rays appear to stream upwards towards the zenith, but always with a less persistence of duration. These coloured scintillations change with greater rapidity than the black rays.

During the month of December of last year, some very vivid prismatic tints were observed from the Island of Eday. From careful observation it was then remarked that the red coloured rays appeared generally to be of a partially opaque nature, and it could be readily seen that the light of a star, when viewed through the red scintillation, was dimmed as compared with the brilliancy of the same star when observed through the scintillations of another colour.

In some of these displays, the most vivid and varied colouring was exhibited. These were noted down as visible to the eye at the same time, and as the colours were observed in contrast, the distinctiveness and brilliancy of the tint became the more decided. Black, pale yellow, strong yellow, white, violet, pale blue bright green, crimson shade fading into a reddish pink, pale orange, and a delicate sea-green tint. So far nothing approaching to the indigo hue has been noticed. With this exception, the entire prismatic colours and blending tints may be said to have been perfectly developed in the rapid electrical scintillations of the aurora. The colours fade away and change with astonishing rapidity, and this variation in tint will take place without apparently any great electrical disturbance in the special ray observed, beyond a slight flickering motion. In these regions, where the atmosphere is so perfectly still and at times calm, repeated observation has determined the existence of very appreciable sound to the ear, as an accompanying phenomenon [to the rapid rush of the auroral streams towards the zenith. The intensity of the sound emitted varies considerably. At times, it greatly resembles that of the rushing noise caused by the firing of a rocket into the air when reaching the ear from a distance. At other times it has a strong resemblance to the sound produced by the crackling of burning embers, but wanting in any very distinctive sharpness.

In all these cases of auroral displays the inductive effects upon the telegraph wires are very strongly marked; currents of varying intensity and direction flowing unceasingly through these metallic circuits.

The result of observations made in Shetland during the months of September, October, November, and December last year, tend to show that these auroral disturbances attained their maximum effect upon the wires between $8^h\ 30^m$ and $9^h\ 30^m$ A.M., and between $8^h\ 30^m$ and $10^h\ 30^m$ P.M.; and such is the unstableness of these induced auroral currents, that frequently in five minutes the electromotive force will vary from very much less than that of a Daniell cell to a current of such intensity that a brilliant stream of light will flash across the points of the lightning conductors with sharp detonating reports, the electromotive force of which would be scarcely equalled by 500 Daniell cells.

In January last very curious electrical phenomena were observed at Lerwick through the day-time, in connection with the N.E. gales so prevalent at that period of the year. In Shetland these gales are almost without exception accompanied with very severe hail-storms. The day begins bright and fine, a clear sky, the barometer rapidly rising; low on the horizon may be observed dense and angry-looking clouds. One by one these clouds travel fast towards the zenith, when all at once a fearful gust of wind, accompanied with the most violent hail-storm, will apparently break out of the cloud, and continue for about fifteen minutes. The wind then subsides, and the day appears as fine as before. In half an hour's time a second cloud will have appeared, and there will be a repetition of the temporary tornado and hail-storm. The remarkable circumstance attending these successive storm clouds is that they appear to be a purely electrical phenomenon. The moment that the icy discharge takes place from the cloud with its accompanying "crack" of wind, an induced electrical current appears upon the wire, so strong that it attracts firmly down the armatures of the telegraph Morse apparatus. The moment, however, that the hail ceases, the current passes off, but with this result, that each successive cloud storm appears to induce a current flowing in an opposite direction from the last, that is to say, the currents appear to be (using conventional language) positive and negative in their effects.

That these storms are "electrically excited" there is no disputing, and that they occur during the prevalence of the chief auroral displays is also a matter of observation, but so far their connection with aurora has not been sufficiently determined to permit any opinion to be expressed.

The recent successful completion of the telegraph circuit to Shetland, and the extensions immediately to be carried out one hundred miles farther north, will afford much greater facilities for auroral observation than has hitherto existed. It is also proposed to institute a careful spectroscopical examination of the coloured scintillations; and now that the Meteorological Society are about to establish an observation station in Shetland, there is every prospect of some valuable data being collected on this interesting subject, which may hereafter guide our meteorological students in arriving at some satisfactory conclusion regarding the laws of electrical storms and auroral induction. At present we are only able to record a few carefully observed facts.

THE LIGHT OF JUPITER'S SATELLITES

Ueber die Helligkeitsverhältnisse der Jupiterstrabanten, von Dr. R. Engelmann, Observator der Sternwarte zu Leipzig. (Leipzig; London: Williams and Norgate. 1871.)

OF all the satellite systems which so essentially enrich the retinue of the sun, none, when we have left our own moon behind us, promises such a reward for investigation as that of the planet Jupiter. The remoter ones may be, and probably are, intrinsically of a more remarkable character, but they are, and ever will remain to a great extent, beyond our reach; while the attendants of the largest among the planets are numerous enough to interest by individual peculiarities, which their comparative proximity enables us to study with advantage. Yet it is readily observable that though ordinary telescopes of good quality would have done much towards elucidating their phenomena, very little progress has been made in the inquiry, especially in this country; and the work now before us is the first attempt to collect and to make serviceable the scattered observations which exist, of which we are sorry to remark how few are due to the astronomers of England.

The especial object of the eminent observer at Leipzig has been not the theory of the motions of these satellites, but simply their physical aspect in regard to the variable light which they have long been known to reflect, and to this investigation the author, notwithstanding constant engagement in important zone observations, has contributed far more than all who have preceded him. The instrument which he employed was the astrophotometer of Zöllner. In this ingenious contrivance, the light of the object to be examined is referred to that of one or more known comparison stars, by means of an artificial star produced by a petroleum flame, adjustable for brightness and colour by a Nicol prism, and a "colorimeter," or revolving wheel of tinted rock-crystal. But in order to eliminate the effect of unequal areas, so as to ascertain, not merely the absolute amount of light reflected, but the "albedo," or reflecting power of each surface, it is, of course, necessary to obtain reliable measures of these minute specks of light; and in order to decide the interesting question whether or not their rotation and revolution are, as with our own satellite, synchronous, their anomalies, or orbital positions relative to their primary, have to be taken into account. All this has been done with most praiseworthy care; the whole is discussed and reduced with scrupulous and exemplary attention to every possible source of accidental error; and the result is given to the eye in several elaborate diagrams. We shall merely specify some of the conclusions, which will be found of considerable interest to astronomers. The absolute brightness was found by the author, as it has been by all previous observers, very variable; and from the irregularity and occasional rapidity of its changes, it becomes impossible to decide, in the case of the three interior satellites, whether the periods of rotation and revolution are identical. This, however, appears to be decidedly the fact with the outermost. Herschel I. had extended the inference to all of them; but such a result could not now be accepted; and it seems probable that the spots which must occasion these variations, and which have been repeatedly noticed when the