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LXVII. *On a brilliant Arch of an Aurora Borealis seen on the Evening of March 21, 1833. By R. POTTER, Jun. Esq.\**

ON this evening the sky was cloudy in the neighbourhood of Manchester: it was nevertheless noticed by Mr. John Blackwall, of Crumpsall Hall, by Mr. Hatfield, of Cornbrook, and by myself, that there was a considerable light in the N.N.W.; no one in the neighbourhood, however, was able to obtain a useful observation.

This display was, however, seen in many other places situated at considerable distances from each other, and the same general description is given of it. Professor James D. Forbes kindly sent me an account of his observation immediately after it occurred; and I am since also indebted to him for extracts from the "Proceedings" of the Royal Society, giving particulars of the observation of the Earl of Darnley, made at Athboy, in Ireland. Having made a calculation of the height from these observations, I drew up a short essay on the subject, which was the first read in the Physical Section at the late Meeting of the British Association at Cambridge†. Dr. Robinson of Armagh, after the reading, mentioned his having made an observation about the end of March, which, although he had not then the date, might prove to be the same display, and he politely offered me a copy of his notes.

The following are extracts from the observations above mentioned. Prof. Forbes, under the date of Edinburgh, 24th of March 1833, writes: "Going out into the open air on the evening of the 21st, at exactly 45 minutes past 8 M. T., I observed a splendid luminous arch extending tolerably nearly east and west, and considerably to the south of the zenith. It perfectly resembled all the various displays of the phænomenon which I have before seen, in its general character. But in brilliancy it was probably exceeded by none; not even, I think, by that of the 19th of March 1825. As I was on my way to witness some light-house experiments, I was unable to make any precise observations; I obtained, however, such data as will make the observation available for the determination of height. At 8<sup>h</sup> 45<sup>m</sup> the highest point of the arch passed through the constellation of Leo, then about an hour from the meridian. It also passed through  $\alpha$  Orionis, and, I think, near Arcturus." "At its culminating point it occupied, as nearly as I recollect, the space between  $\gamma$  and  $\zeta$  Leonis; its breadth, therefore, was about 4°, but less towards the extremities, where, *as usual*, it was most luminous. Its greatest

\* Communicated by the Author.

† See present vol. p. 152.—EDIT.

altitude, therefore, at 45<sup>m</sup> past 8 o'clock, was from 52° to 56° (its upper and lower edges). It faded *with great rapidity* after I first observed it; but I readily detected its southward motion, as I have done on similar occasions." "At 8<sup>h</sup> 55<sup>m</sup> it passed through  $\alpha$  Leonis." "After this it was very imperfectly visible. There was a bright auroral light in the north, with occasional corruscations. I shall be very anxious to hear if you have observed this beautiful phenomenon."

Of the Earl of Darnley's observation Professor Forbes gives me the following particulars. "Seen at Athboy, Ireland, latitude 53° 47' N., longitude 6° 54' W." Observed about 9 P.M.: "reached from the eastern to the western horizon which it entered to the north of the constellation of Orion, passing about midway between the Great Bear and Arcturus, and *directly over the two principal stars of Gemini*:" most brilliant at the east, where 1° wide; but increased to 5° to 6° at west. "During the twenty minutes that Lord Darnley observed the phenomenon it *seemed to proceed through its whole extent from N. to S.*, its edges, when first observed, extending equally on either side of Castor and Pollux, having in that time entirely left the most northern of those stars." At 10 it had disappeared. An account of a similar phenomenon, it is stated, was *given in a Carlisle paper*. I hope you will be able to find this out." His Lordship, it appears, also notices the aurora having been seen at Castlereagh, about 60 miles distant from Athboy.

The following are extracts from Dr. Robinson's letter to me, dated Armagh Observatory, July 26, 1833. "The observation I made of the aurora on March 21st last, was this: At 8<sup>h</sup> 44<sup>m</sup> 10<sup>s</sup>, Armagh time (or 9<sup>h</sup> 10<sup>m</sup> 45<sup>s</sup> Greenwich), the luminous arch was bisected by Arcturus and by  $\gamma$  Leonis; at the same time its upper edge was on  $\alpha$  Orionis, and its lower on  $\delta$  Orionis. *As to sense*, its highest point seemed on the magnetic meridian (which I found, in January 1829, to deviate 29° 7' west)." At exactly 5 minutes later he made another observation of the arch's place, from which we learn that its upper edge was then on  $\delta$  Orionis, and its lower on  $\zeta$  Orionis, which indicates a considerable southward motion, the upper edge at the same time being on  $\gamma$  Leonis, and the lower on  $\eta$  Leonis. Dr. Robinson did not observe the aurora longer, being at the time very much indisposed.

The above observations must be allowed to demonstrate, if there were need of any further demonstration, a most important point in the theory of the aurora borealis; namely, that the symmetrical arches are rings, or portions of rings, in planes perpendicular to the magnetic axis. If we take in round num-

bers  $73^{\circ}$  N. latitude and  $100^{\circ}$  W. longitude as the position of the magnetic pole, which, from the observations made during Captain Parry's voyage, is probably not widely wrong, we find the magnetic polar distance, or magnetic co-latitude, of Edinburgh to be  $39^{\circ} 23'$ , that of Armagh  $39^{\circ} 55'$ , and that of Athboy  $40^{\circ} 21'$ . Now at all places situated on the same parallel of magnetic latitude, it is clear that an arch following the direction just mentioned would appear at the same altitude at its highest point, which enables us to reduce observations anywhere taken to a common magnetic meridian; and Armagh being only  $32'$  of a degree more magnetically southerly than Edinburgh, the arch ought to have been seen at the former place with a little greater altitude from the S.S.E. horizon than at the latter, which we find to have been the case, as the following shows:—

At Armagh, and  $9^{\text{h}} 10^{\text{m}} 45^{\text{s}}$  Greenwich time, the arch was bisected by  $\gamma$  Leonis, then not far from the magnetic meridian.

At Edinburgh, and  $9^{\text{h}} 7^{\text{m}} 41^{\text{s}}$  Greenwich time, the arch passed over  $\alpha$  Leonis, and allowing still for the southward motion of the arch during the remaining  $3^{\text{m}} 4^{\text{s}}$  difference of time, we see that the arch had a considerably less apparent altitude at Edinburgh than at Armagh.

Though under so many disadvantageous circumstances,—of a base line of only 32 geographical miles when the places were so far distant, the quick motion of the arch, and the want of simultaneousness in the times of observing,—yet the notes taken by these accurate observers enable us to make a computation for the height of the meteor which agrees remarkably closely with former determinations, and is quite within the limits furnished by observations taken under much more favourable circumstances.

The difference of magnetic polar distance of the two places of observation is 32 geographical, or  $36.84$  English miles nearly; and the apparent altitude at Edinburgh for the middle of the arch, about  $43^{\circ} 29'$ ; and at Armagh  $52^{\circ} 25'$  at  $9^{\text{h}} 10^{\text{m}} 45^{\text{s}}$  Greenwich time. These altitudes require still to be corrected for the inclination of the horizons of the two places, which requires  $16'$  to be added to the former, and subtracted from the latter of these angles. From these data we find the arch to have been  $178.43$  English miles from Armagh, and  $142.84$  miles above the surface of the earth.

The calculation which I first made by using Lord Darnley's observation, must not, I find, be insisted upon, on account that the time of it is not sufficiently indicated in the abstract in the "Proceedings" of the Royal Society to enable us to

judge how nearly it might be taken as contemporaneous with that of Professor Forbes. This, it will be seen, is necessary to be attended to, for the observations at Armagh and Edinburgh agree in giving the southward motion as very nearly at the rate of  $2^{\circ}$  in 5 minutes. The calculation referred to gave 195.77 English miles for the height at  $8^{\text{h}} 57^{\text{m}} 41^{\text{s}}$  Greenwich time. This difference of the height, in  $13^{\text{m}} 4^{\text{s}}$  difference of time, is not otherwise than I should have expected, as I believe I have good grounds for the opinion that it will eventually be found that the arches *generally* descend nearer to the earth as they move southward.

As the locality, within certain limits, in which the aurora takes place must now be considered, by impartial persons, *well* determined, as well as the direction both of the beams and the arches, I will now state some points to which observers should pay attention, in order to extend our knowledge still further, and enable us to deduce from the phænomena of the aurora, results which will assist us in the study of the important subject of the earth's magnetism. Amongst the most important points to which an observer can attend, is that of determining, with every accuracy the subject is capable of, the azimuth in which each end of an arch cuts the horizon, and as nearly as possible at the same time its altitude. When this shall have been determined, together with observations at other places sufficient to determine the height by common trigonometry, then we should have sufficient data for deducing the position of the magnetic axis of the earth, continued to the region in which auroral phænomena occur. We may naturally expect that those anomalies in the magnetic variation, &c., which occur at the earth's surface will disappear at those great altitudes, and especially if they arise from variation in the direction of thermo-electric currents.

When observations are made with respect to the *visible* horizon of any place, they should be corrected to the *real* horizon of that place by the observer, and also the effect of refraction should be allowed for. This latter, however, will, of course, be unnecessary when the azimuthal extent of arches, or their altitudes, are determined by a comparison with stars, both being then equally affected, and the places of such stars are easily found with accuracy.

The late splendid displays on September 17th and October 12th, have been observed over a great distance of country; but the aurora has frequently a more useful character for observations than these had, when even it has a much less imposing appearance.

I may here state, that in my former papers in the *Edinburgh Third Series*. Vol. 3. No. 18. Dec. 1833.

Journal of Science there was an error in the printing, which might cause a good deal of trouble to any persons who wished to prove upon their own observations the formulæ I have deduced for calculating the heights, &c., of arches from their azimuthal extents and altitudes. In the one paper, for  $p = 1 + cg$ , and in the other  $p = 1e + g$ , it should have been printed  $p = 1 + eg$ .

The reader will, I am sure, acquit me of being a party to tolerating any notion that the meteor seen in the N.N.W. part of the heavens, over a distance of country of 200 to 300 miles, can possibly be located in the region of the clouds, or that the epithet *borealis*, acknowledged to be appropriately applied to this aurora, can be with any propriety attached to any variety of aqueous clouds seen in our lower atmosphere.

LXVIII. *On the Cause of the Direction of Continents and Islands, Peninsulas, Mountain Chains, Strata, Currents, Winds, Migrations and Civilization.* By ALEXANDER WALKER, Esq.\*

I SHALL first endeavour to show that all of these have one general direction.

With regard to continents and islands, which, as indicating the course of lands generally, it is proper to consider in connexion, the general direction of America is, evidently and extensively, north and south, as regards both its continent and the groups of islands to the south of the Strait of Magalhaens. The Old World, if we take into view its continent alone, has its chief direction east and west; but when we add to the further peninsula of Asia, the Indian isles, Australia and New Zealand, and observe that that world is deeply indented by the Indian Ocean, the Persian Gulf, the Red Sea, &c.,—that, in fact, Asia is thus separated to half its depth from Europe and Africa,—it is impossible not to see, even in these two divisions of that world, a prevailing tendency to the same direction, north and south. The positions of the Black Sea and the Caspian, and of the White Sea and the Gulf of Obe, tend further to the same effect.

With regard to peninsulas, it is truly remarkable how universally they have this direction. Scandinavia, Spain, Italy, Greece, Africa itself, Arabia, India, Malaya, Corea, Kamtchatka, Alaska, California, South America itself, Florida, Nova Scotia, Greenland, run from north to south; and the pen-

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