Fortunately we meet in a district rich in incentives to appeals of this kind. Every crag and dell around seems to beckon us to its side that it may set problems before us for solution. Part of the work of the winter will lie in availing ourselves of these opportunities. We shall make visits to the hills and quarries of the neighbourhood, and test the lessons of the lecture-room by actual seeing and handling of the rocks.

Thus, while we gain larger conceptions of the structure and history of the planet on which we dwell, we shall at the same time perform no unimportant part in that long education which, though it stands out more prominently in our earlier years, is not less surely the business of our lives.

THE RECENT STAR SHOWER

A CONSIDERABLE number of exact determinations of the place of the radiant-point of the shooting stars recorded during the recent meteoric shower have during the last few days continued to reach me, of which the accompanying general list and a rough outline map (Fig. 2) will, perhaps, best convey the general result at present arrived at regarding this important point in connection with the astronomical character of its appearance. That the stream of meteors, originating in the materials of Biela's comet, pursue, in a current of great length and thickness, nearly the same orbit as that of the comet round the sun, may be clearly concluded from the many observations of the meteor shower which have now been brought together. Among the most interesting of the descriptions relating to this subject is a report by Dr. Heis, of Münster, in Westphalia, of the observations made at that observatory between 8h. and 9h. P.M., and of others which he received from distant places, of the frequency of the meteors at that and at later periods of the night. The number seen by two observers at Munster, in fifty-three minutes, between 8h. and 9h. P.M., was 2,200 meteors, 400 of which appeared in the last interval but one of six minutes before 9 o'clock, or about forty-two per minute during the whole time. At the Göttingen Observatory 7,710 meteors were counted in three hours, giving nearly the same average of frequency during the greater portion of the shower. At Svanholmsminde, in the north of Jutland, Mr. S. Tromholdt recorded, with the assistance of two observers, 600 shooting stars in the first quarter of an hour after 9 o'clock, or about forty per minute, as observed at Munster. Allowing at the latter place thirty minutes, and in Jutland forty minutes, as their longitudes in time, east from Greenwich, the great abundance of the meteors here noted nearly coincides with the second principal maximum of the shower seen by Mr. Lowe and by Prof. Grant, at Glasgow, to have occurred at about, or shortly after, 8 o'clock. From the same time until 11h. 30m. P.M. (10h. 50m. Greenwich time), Mr. Tromholdt counted 1,660 meteors in two hours and a half, indicating a greatly decreased intensity of the shower; and, although clouds then prevented further observations, a perfectly clear sky enabled him to resume them at half-past 4 o'clock A.M. (3h. 50m. Greenwich time) on the morning of the 28th, when he found the display to have entirely ceased, only four shooting stars making their appearance during the hour between half-past 4 and half-past 5 o'clock, or about 4 o'clock, Greenwich time.

In NATURE, vol. vii. p. 86, the observations of Mr. W. Swan, at St. Andrews, show that the termination of the shower had actually arrived at an earlier hour on the morning of the 28th, since, the sky being quite clear at half-past 1 o'clock A.M., no shooting stars could then be seen. A writer on the appearance of the shower at Dublin informs me that his observations fully corroborated this result, for, on looking out at about 1 o'clock (Irish, or nearly half-past 1 o'clock Greenwich time), the number of meteors was found to have diminished to about one in two or three minutes, and during a quarter of an hour after about half-past 2 o'clock, Greenwich time, not a single shooting star appeared in sight, although there was then always sufficient clear sky to enable one observer to have an uninterrupted field of view of the constellations. Both the extent of the densest portion and the limits of the extreme boundary of the stream are excellently marked by these valuable observations. There appears without doubt to have been a period of nearly uniform maximum intensity, lasting from shortly after 6 to shortly before 8 o'clock P.M., in which one observer might, under the most favourable circumstances, count from fifty to a hundred meteors per minute, or on an average about one meteor per second. The duration of this period seems to have been about an hour and a half, its centre occurring at about, or very shortly after, 7 o'clock. For about two hours after it, the shower lessened so gradually as not to fall much below a quarter of its maximum intensity until nearly 10 o'clock, but from that time it continued to decline so rapidly that soon after midnight one observer scarcely counted so many as one meteor per minute, and by 2 o'clock A.M. it had entirely disappeared. Taking its gradual rise before 7 o'clock to have been similar to its rate of diminution afterwards, and the whole time of its visibility to have been divisible into periods of two hours each, of which the central one, of greatest intensity, occurred between 6 and 8 o'clock P.M., and three others, on either side of this, might be distinguished as copious, conspicuous, and hardly more than ordinary meteoric displays, it is easy to estimate, from the known inclination at which the earth's path crosses the axis of the stream, the thickness of the meteoric stratum which it traversed in each of these successive periods. The actual width or transverse thickness of each of these meteoric strata must have been about 50,000 miles, and that of their whole sum, consisting of seven such periods, was about 350,000 miles. The diameter of the visible nebulosity of Biela's comet, as it was observed in telescopes, was estimated at 40,000 miles, and the nearest approach of its orbit to that of the earth, in 1832, was computed to be about 17,000 miles, so that the thickness of the meteor stream which the earth passed through on Nov. 27 last, exceeds these calculated dimensions by very many times. That it was, however, not the tail, or envelope, of the comet through which the earth passed, but a stream of particles left behind the nucleus of the comet on its track, was pointed out by a Dutch observer, and writer on the astronomical features of the shower (Herr Van de Stadt), in the *Arnhemsche Courant*, referred to in NATURE, vol. vii. p. 86. He founds this on the consideration that if, as the most probable calculations by Mr. Hind of the comet's path at this return inform us, it passed its perihelion on or about Oct. 6 last, and therefore, through its node, and its nearest point of approach to the earth's orbit about Sept. 14 last, it must, at the time of the occurrence of the meteor shower, have advanced some 250,000,000 miles, or about a seventh part of the whole circumference of its orbit along its path, having already passed its perihelion, and proceeded nearly as far as the orbit of the planet Mars in its subsequent departure from the sun, and its distant approach towards the opposite part of its orbit from the earth.

Projecting all the meteor-tracks which were recorded from my point of view, at Newcastle-upon-Tyne, upon a plane perspective chart of the constellations, a very evident centre of divergence of the shower from a space round a spot in R.A. 20°, N. Decl. 40°, is very clearly shown by the backward prolongations of the tracks, about 60 per cent. of which pass within 4° or 5° of this place. Many of the tracks recorded were somewhat widely erratic, coming chiefly from a more northerly

area, between this place and Perseus or Cassiopeia. An extension of the radiant region in that direction or possibly its definite position there would perhaps have been recognised by more numerous observations continued to a later period of the shower ; but clouds completely covering the sky after 7 o'clock, made the determi-

Fig. 1.

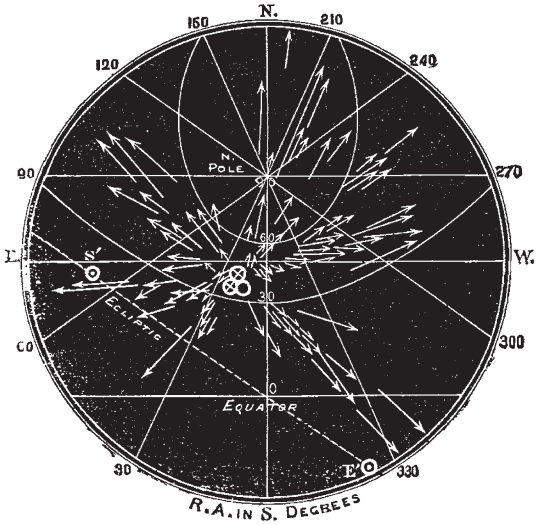

FIG. 1.—Tracks of 94 shooting stars observed at York, Birmingham, and Newcastle-on-Tyne, Nov. 27, 1872.

nation of its place by the 54 meteor-paths recorded during the preceding hour only apply to its position between 6 and 7 o'clock. The tracks of 23 meteors mapped at York by Messrs. E. Grubb, S. P. Thomson, and T. H.

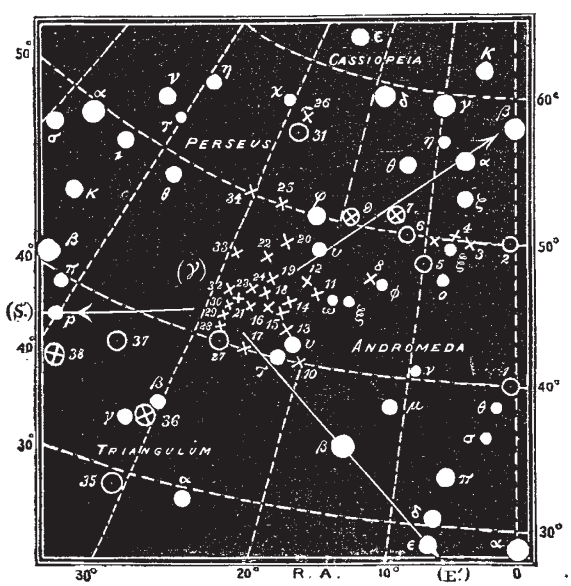

FIG. 2.—Map of the radiant points of the Meteor-shower, Nov. 27, 1872

Waller, between 6h. and 10h. 15m. P.M. were communicated to me by Mr. Waller, and those of 17 meteors noted during the same time at Birmingham, by Mr. W. H. Wood. The positions assigned to the radiant point by these observers are respectively at R.A. 25°, N. decl. 40°; and R.A. 20°, N. decl. 45° ; and a circular space having a line joining these two points for its diameter, includes between 60 and 70 per cent. of the backward prolongations of the 40 meteor-paths thus

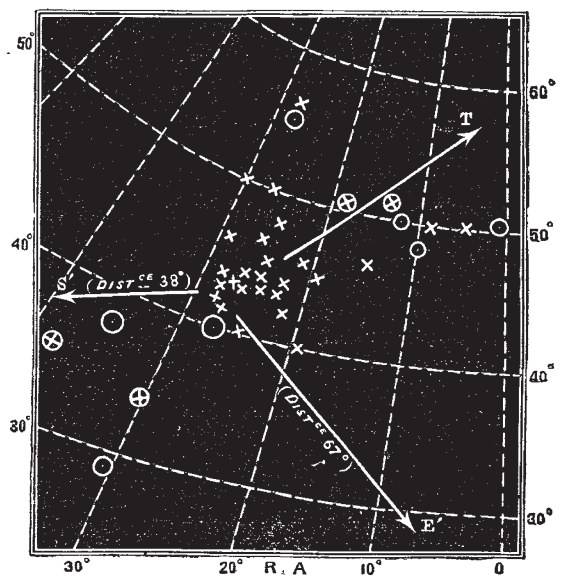

FIG. 3.—Map of radiant points, Nov. 27, 1872, and lines of direction to the points (S') opposite to the sun's place, (E') opposite to the earth's way, and (T) transverse to the last direction.

traced upon the maps. I have also received from Mr. Backhouse a list of 50 meteor-tracks observed at Sunder-

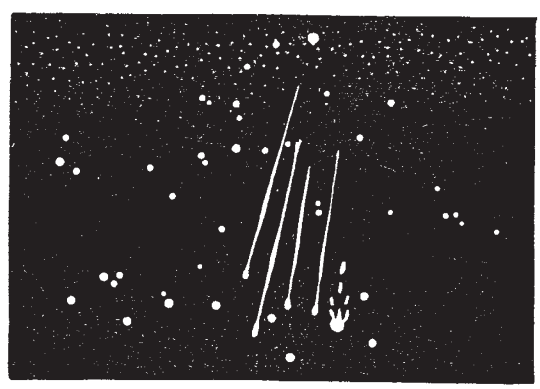

FIG. 4.—Large Meteor, at 5h 50m (the first observed), and paths of the next four meteors seen during the great meteor-shower of Nov. 27, 1872, 5h 50m 55s.—W. F. Denning (Bristol).

land before 7h. and after 9 o'clock ; and a sufficient number of recorded paths from the Rev. S. J. Perry, at

FIG. 5.—Flight of three collateral and contemporaneous meteors, with long parallel courses of 20° or 30°; and streak of a fourth meteor, showing its long endurance near the centre of the track. Seen during the great meteor-shower of Nov. 27, 1872.—S. H. Miller (Wisbeach).

Stonyhurst, to determine the radiant point exactly, on the night of the 27th as well as on that of December 4, when he observed some remarkable bright meteors proceeding

from the same direction. It was remarked by Mr. Backhouse, and it must have been apparent to most attentive observers of the shower, that the meteors far from the radiant point did not always appear to move in parallel paths when in the same part of the sky; thus at once giving the idea that the radiant area was really of considerable extent. Although the contrary phenomenon of two or three bright meteors apparently running a race with each other in parallel courses side by side, or pursuing each other upon the same path, was frequently observed, and occasionally, as noticed by Mr. S. H. Miller at Wisbeach, who, as well as Mr. Denning at Bristol, supplied the accompanying sketch of such meteors through closely adjacent courses of 20° or 30°, yet it was perhaps in the often occurring exceptions to this rule, and in the absence of the long-enduring light streaks, left parallel to each other on such occasions by the Leonids, that the recent meteor shower differed most

APPARENT PLACES OF THE RADIANT-POINT OF THE STAR-SHOWER OF NOVEMBER 27, 1872

No.	Observer.	Place of Observation.	Local Lines of Observation. From	To	Position of the Radiant Point by the Stars and Constellations. R. A.	N. Decl	
			h. m.	h. m.			
1	Ph. Breton.	Grenoble (France).	7 0	8 0	(0	40°)	Between Cassiopeia and the square of Pegasus.
2	J. W. Durrad.	Leicester.			(0	50)	South-west of Cassiopeia.
3	W. H. Wood.	Birmingham.	6 0	10 15	5	50	Near ξ Cassiopeiæ (outlying radiant).
4	E. V. Pigott.	Malpas.	7 0		9	50	About ξ Cassiopeiæ.
5	Communicated by Mr. Denning.	France.			(10	48)	South of Cassiopeia.
6	Watkins Old.	Hereford.			(10	50)	A little south of Cassiopeia.
7	G. H. H.	Birkenhead.	5 30	10 0	12	50	South of μ Cassiopeiæ
8	J. J. Plummer.	Durham.	7 0		15	46·5	Close to φ Andromedæ.
9	H. Weightman.	Oundle.	5 30	7 35	18	51	Between θ Cassiopeiæ and 51 Andromedæ (υ Persei).
10	A. S. Herschel.	Newcastle-on-Tyne.	6 0	7 0	20	40	Near υ Andromedæ
11	W. H. Wood.	Birmingham.	6 0	10 15	20	45	Near ω ,,
12	J. Birmingham.	Tuam (Ireland).			21·7	45·5	Near χ ,,
13	Dr. J. G. Galle.	Breslau (Germany).	6 20	7 50	22	42	Near υ ,,
14	F. B. Knobel.	Burton-on-Trent.	5 35	6 50	22·5	44	Near χ ,,
15	M. de Gasparis.	Naples (Italy).	7 0	9 0	23	43	Near υ ,,
16	A. Marth.	Gateshead.	5 45	6 30	24·5	43	Near χ ,,
17	T. H. Waller.	York.	6 0	10 15	25	40	Near γ ,,
18	T. W. Backhouse.	Sunderland.	5 30	11 5	25	44	Near χ ,,
19	R. Grant and G. Forbes.	Glasgow.	5 35	10 30	25	45	Near χ ,,
20	W. Swan.	St. Andrews (Scotland).	8 20	11 30	25	48	Near φ ,,
21	T. P. Barkas.	Newcastle-on-Tyne.	5 45	6 45	26·2	43	Near χ ,,
22	E. J. Lowe.	Beeston (Notts).	5 50	10 30	26·2	46·2	Near γ ,,*
23	S. J. Perry.	Stonyhurst.	9 29		26·6	43·8	Near γ ,,
24	Mr. Fearnley.	Christiania (Norway).	8 25	9 3	27	43	Near γ ,,
25	Dr. E. Heis.	Münster (Westphalia).	8 0	9 0	27	50	Near φ Persei (54 Andromedæ).
26	J. J. Plummer.	Durham.	9 45		27	56	Near χ Persei
27	W. B. Shorto.	Suez (Egypt).			(28	41)	General centre between Aries, Perseus, and Cassiopeia.
28	G. Lespiault.	Bordeaux (France).	5 0	9 30	28	44	Near γ Andromedæ.
29	F. Denza.	Moncalieri (Piedmont).	6 0	12 0	28	41·7	γ Andromedæ.
30	A. D. P.	Newcastle-on-Tyne.	6 0	6 30	28	41·7	Close to, if not coincident with, Mirach (γ Andromedæ).
31	H. W. Hollis.	Newcastle (Staffordshire).	7 40	8 17	(28	55)	Between Perseus and Cassiopeia.
32	M. Glotin.	Bordeaux (France).	5 0	9 30	29	43	Near γ Andromedæ.
33	W. F. Denning.	Bristol.	5 50	6 30	29	46	Near γ ,,
34	M. Lernosy.	Macon (France).	7 0	13 0	30	50	Near υ, φ Persei (51, 54 Andromedæ).
35	A. Secchi.	Rome (Italy).	8 0		(31	29)	Between Aries, Triangulum, and Musca.
36	,,	,,	9 0		31	34	Near β, γ Trianguli.
37	,,	,,	12 0		(35	38)	Between Triangulum and head of Medusa.
38	W. Garnet.	Clitheroe.	7 50	8 35	40	35	A point on the verge between Triangulum and Perseus.

* The position at R.A. 2h. 45m., N. Decl. 46½°, given in Mr. Lowe's description of the shower, in the *Times* of November 29, is apparently a misprint for 1h. 45m. (26½°), which is here adopted as the R.A. of the Radiant-point near γ Andromedæ, close to which star Mr. Lowe describes the appearance of a stationary meteor at 8h. 52m., as bright as that star, among the many meteors which he observed, apparently without motion about the radiant-point.

remarkably from its great precursors of the 13-14th November, 1866-7. In his suggestions to observers and conjectures on the probable early identification of this meteor-shower, published in the Transactions of the Vienna Academy of Sciences in 1868, it was remarked by Prof. Weiss, from the near approximation of the meteors in the direction of their motion to that of the earth in its passage through their stream, that the radiant region of this star-shower, even when witnessed at its greatest intensity, would probably prove to have a considerable area rather than to be concentrated, like the radiant point of the 13th of November meteors, from Leo, about a point of very accurate divergence of their tracks. From the situation of the comet's paths, and from its small velocity relatively to the earth, small deviations from parallelism in the original courses of the meteors would appear as considerably exaggerated inclinations of the visible meteor-paths to each other, and as somewhat more exaggerated ones (the original velocities of all the meteors being supposed the same)—in the proportion of about 10 to 7—when the deviation is transverse to, than when it is in the same plane as the direction of

the earth's motion through the stream. In the former direction (which is 30° or 32° nearer to a meridian than the direction of the sun's apparent place) the exaggeration of the apparent meteor observations is about $2\frac{1}{2}$ times, and in the latter direction only about $1\frac{3}{4}$ times the original observations of the meteor-paths from perfect parallelism in their cometary orbits. Differences of velocity of the individual meteors from the average velocity of the stream, amounting to a tenth part of their mean speed, would on the other hand produce observations of 5° in the latter, without producing any sensible enlargement of the space included by the radiant region in the former direction. Owing to the powerful action of disturbing forces in changing both the direction and the velocities of motion of the meteors of this stream, a considerable extension of the radiant region in each direction from the mean radiant centre, might be certainly anticipated for this meteor shower. The combined causes affecting the form of the radiant area, its principal concentration along a straight or crooked line, or elongated space, and its motion with the time, are accordingly so considerable and various, that the problem of arriving at a true theory of their action must evidently be regarded as still continuing to invite further attention and research. Among the determinations of the position of the radiant point with which I have, however, become acquainted since the compilation of the present list, Prof. Newton's observations on the radiant region, which appeared in NATURE, vol. vii. p. 122, will perhaps appear, from the following considerations, to point to a somewhat more definite conclusion.

In the accompanying projection (Fig. 1) the apparent paths of the 94 meteors mapped at Newcastle-on-Tyne, York, and Birmingham are drawn on a plane-perspective chart of the heavens in their observed lengths and positions. Both their general divergence from a common centre and the irregularities of their divergence in many cases in distant parts of the sky are plainly seen, while the shortness of the paths near the radiant point clearly illustrates the effect of perspective in foreshortening the apparent courses of those meteors whose visible paths were represented, as they appeared to the observers, to be approaching them "end on." Some few of the foreshortened meteors appeared quite stationary, and two of these are represented in the drawing by a small star. Nearly round the places of these two stationary meteors are drawn small circles representing the positions of the radiant point observed at York and Birmingham; a third small circle shows the place of that observed at Newcastle-on-Tyne. They are numbered respectively 17, 11, and 10 in the list, and in the map of radiant points (Fig. 2). A small circle below the equator and another near the east point of the plain sphere upon the ecliptic (Fig. 1) represent respectively the anti-apex (or point *from which* the earth was moving), and the anti-solar point, or point *opposite to* the sun's place at the time of the star-shower. The latter point, it will be seen, is more nearly in the direction of a parallel of declination through the radiant-point than in the direction of a meridian, and it is in the direction of right ascension, or nearly in that of the sun's apparent place at the time of the shower, that a considerable elongation of the radiant region is described as having been most plainly perceived by Prof. Newton.

In the map of the radiant-places (Fig. 2), lines drawn from the star γ Andromedæ (which is replaced in the figure by the positions of several radiant-points described close to it), through β and ϵ Andromedæ, downwards, and through the small star ρ Persei towards the left, point towards the anti-apex, and to the anti-solar point; while a third line drawn from the same star nearly through υ Persei and α Cassiopeiæ is in a direction transverse to that from the anti-apex. Those radiant-points of which the star places or co-ordinates are exactly given are represented in the map by a cross; where only described by their neighbourhood to certain stars the cross is surrounded by a circle, and when simply described by the constellations their positions are represented by a circle only.

A large number of radiant-points is contained in the space included between the stars γ, τ, υ, ω, and 51 Andromedæ (υ Persei) clustering closely about a small star (not shown in the map) χ Andromedæ, near the centre of the space, of which the position is very nearly that deduced from calculation, as the probable radiant-point of the cometary shower. The direction of the outlying radiant-places is chiefly towards Cassiopeia, and shows with some distinctness a general confirmation of the conclusion obtained from direct observations of the shower by Prof. Newton, that the area of the radiant region was perceptibly elongated in right ascension, or approximately in the direction of the sun's apparent place. That the effect of the sun's attraction on a cometary cloud would be to produce an elongation of the radiant area in that direction appears on astronomical grounds to be capable of demonstration; and in their sensible agreement with this condition the results of the present observations lend satisfactory support to the astronomical theory of the meteor stream. A more complete analysis of the features presented by the radiant area would probably require a careful investigation of the disturbances which the meteor cloud may have undergone during many previous revolutions of the comet; but from the present comparison of the observations with the astronomical theory of comets and of meteor showers, there appears at least to be abundant evidence in their generally accordant results to show that beyond the regular action of universal gravitation, no powerful force of repulsion from the sun, like that supposed to be concerned in the enormous development of the tails of comets, affects the meteor orbits or changes their courses more than the regularly recurring revolutions of the planets. In the projection (Fig. 3) the radiant-points only and the directions of the three lines drawn from γ Andromedæ towards the antisolar point S′, the anti-apex of the earth's way E′, and towards a point T, at right angles to the latter direction, are represented for greater clearness without the fixed stars or constellations.

In my last letter in NATURE, vol. vii. p. 103, on the time of the maximum and the duration of the star-shower, and on meteors connected with it seen on adjacent nights, the remarkably bright meteors from the same radiant-point observed by Mr. Jackson on the evening of November 24, were noted by him near Hyde Park, and not near Regent's Park, as stated in my letter. A considerable shower of shooting stars from a radiant-point near γ Andromedæ was, it appears, distinctly observed on the same night in the United States, as described by Prof. Newton in NATURE, vol. vii. p. 122. The notes of the numbers of meteors seen after 10 o'clock, described in the last paragraph of my former letter were made by my assistants and myself at Newcastle-on-Tyne, and not at Rothbury, as would appear from their connection with the description immediately preceding them, by my correspondent on the very brilliant appearance of the shower near the latter place.

A. S. HERSCHEL

NOTES

WE believe that a reply has been received from the Government on the subject of the Arctic Expedition, which goes far to justify all that was said in our leader last week on the subject; for although the Government does not refuse absolutely to comply with the wishes of the deputation, all action will, unless strenuous efforts are made, be postponed for a year. We repeat that the deputation did not represent Science so broadly as it ought to have been represented; and we add, that if the Government thought so, it was, in our opinion, perfectly justified