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WITH EIGHTEEN PLATES.

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OBSERVATIONS MADE DURING TOTAL SOLAR ECLIPSES,

COLLATED BY

A. C. RANYARD, M.A., SEC. R. A. S.

Prof. Grant.

42° 38' N. }	SIERRA DE TOLONO,
2° 40' W. }	18th July, 1860.

## MS. Reports of the Himalaya Expedition.

The breadth of the corona appeared to be equal to about a fourth of the moon's diameter. From its exterior margin there issued forth diverging beams of light of unequal length. These beams were not of uniform brightness throughout their whole extent. At their junction with the corona they appeared to be of equal brightness with the latter, but from thence they gradually faded off until they were finally lost in the dark ground of the heavens; their average length was about 30'.

Long curved ray  
to the right of  
the vertex.

One very long beam, a little to the right of the vertex, exhibited a decided curvature. The exterior margin of the corona was very imperfectly defined. A similar remark applied to the terminating sides of the diverging beams of light.

The light, both of the corona and of the beams issuing from it, appeared to me to be perfectly motionless. The above-mentioned features of the corona were observed with my naked eye, and not in the inverting telescope.

Mr. Francis Galton.

42° 34' N. }	HILL OF LA GUARDIA, SPAIN,
2° 35' W. }	18th July, 1860.

## MS. Reports of the Himalaya Expedition.

"Totality" came on in great beauty. The corona rapidly formed itself in full distinctness. It did not appear to me to *grow*, but rather to start ready formed into light as the brilliancy of the sun became masked;

\* Assumed time of mid-totality 2<sup>h</sup> 44<sup>m</sup> 54<sup>s</sup> local true time. Sun's axis 42° 41' to the west of the vertex.

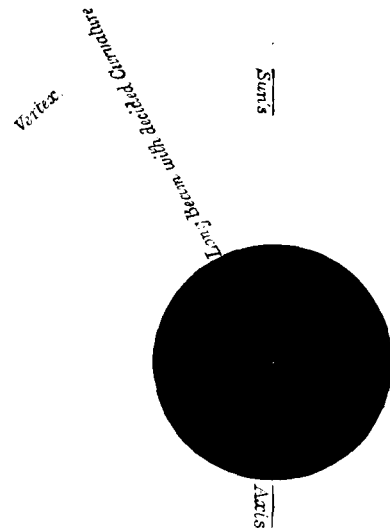


Diagram constructed to illustrate Grant's description of the corona of 1860, July 18th.\*

however, I speak with doubt upon the point. The drawing is developed from a rough sketch made about one minute after the commencement of totality, and it is to my mind a fair though very weak representation of the general appearance of the corona. I do not know to what I can justly compare that magnificent meteor. It differed from other objects in the remarkable whiteness and purity of its light, and also in the definition of

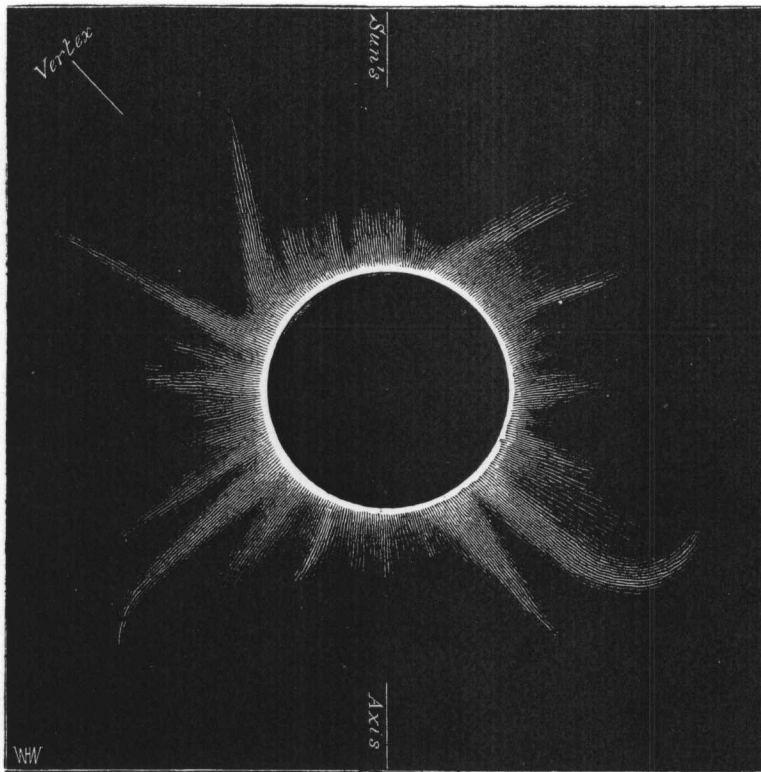


Fig. 1.—Galton's drawing of the corona of 1860, July 18th.\*

its shape, as combined with a peculiar tenderness of outline. The rays References to the diagram on next page. *a, b, c, d* were especially noted.

*a* and *b* are tangents to the moon's disc ; *c* and *d* are curved.

The facts I particularly observed in reference to the corona, are—  
1st. The long arms of light did not invariably extend as rays from

\* Made from a water-colour drawing accompanying Galton's MS. report. Oriented from the vertex. Assumed time of mid-totality  $2^{\text{h}} 45^{\text{m}} 24^{\text{s}}$  local true time. Sun's axis  $42^{\circ} 49'$  to the west of the vertex.

Francis Galton's report.

the centre of the sun. They generally did so, but some were more or

less *tangential* to its disc.

2nd. The arms were not always bounded by straight lines; some were curved, and the lowermost one was remarkably so.

3rd. The shape of the corona seemed pretty constant in its main features, though its smaller details varied continuously by a gradual diorama-like change. But I cannot be sure that there were any changes, other than those which might be ascribed to growing and waning brightness, and definition. There

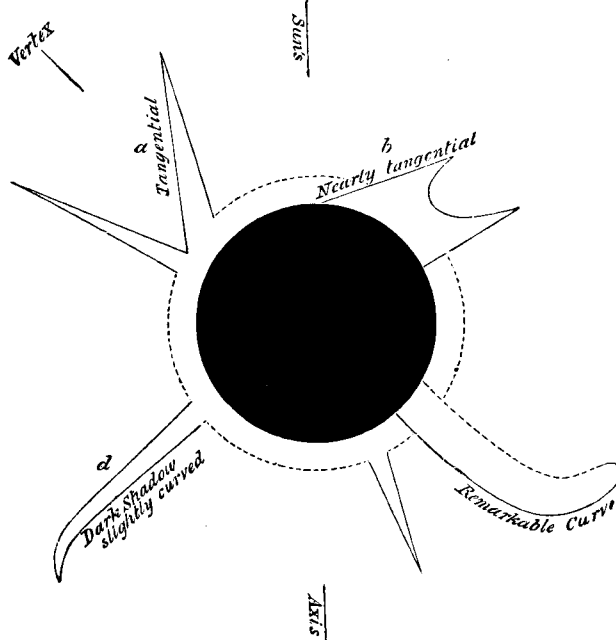


Fig. 2.—Made from a diagram given by Francis Galton.

was no pulsation or other peculiar movement visible to me in the light of the corona.

The Rev. R. A. Thompson.

42° 9' N. } TUDELA,  
1° 38' W. } 18th July, 1860.

“The English Churchman,” 26th July, 1860.

I now looked at the corona: it was not of uniform breadth, but generally about half the moon's diameter, while long beams of light issued forth in several directions. The longest, about 10 degrees below the east side of the sun, was considerably longer than the moon's diameter, if I can trust my-memory, after the totality was passed.

The beam next in length was not far from the lowest point of the sun's vertical diameter, a few degrees to the west; and this beam, as it approached the sun, appeared to curve upwards, and to join another beam, which was thrown off about 45 degrees below the western edge of the

**Eclipse of 1860, July 18th.**

According to the data collected by WOLF, it appears that this eclipse took place during a period of considerable solar activity, as evidenced by the formation of sun-spots. He gives as the relative monthly number for July 1860 (94.9) a number which nearly corresponds with that given for the period of the eclipse of 1871.

An examination of the photographs and drawings shows that the general outline of the corona was approximately circular, or but slightly elliptical,\* and that there were four principal groups of rays or structures within the area of the corona which arrested the attention of a large proportion of the observers. WEYER, FEILITZSCH and BULARD represent the corona with a circular outline, and four bright rays, forming a cross the arms of which are nearly symmetrically placed with respect to the sun's axis.

GALTON, WILSON, DE LA RUE, and TEMPEL represent the corona as somewhat quadrilateral in outline, the diagonals of the quadrilateral corresponding in position with the arms of the cross. And it will be seen that the four principal groups of rays, referred to by many other observers, correspond in position with the rays forming the arms of the cross.

In one of the groups—viz., that in the south-western region—there was a decided synclinal arrangement of the rays, and it seems probable that the north-eastern, and possibly also the south-eastern and north-

\* There are not proportionally so many drawings with a quadrilateral outline amongst the 1860 corona drawings, as amongst the drawings of the sun-spot maximum coronas of 1870 and 1871. During the latter eclipses, probably owing to the controversy which was then taking place as to the possible atmospheric origin of the corona, the observers appear to have directed their attention rather to the extent and brightness of the corona on either side of the moon, than to the structures observable within the field of the corona. There were thus during the latter eclipses more contour drawings, representing areas of equal brightness. But the chief fact worthy of notice with regard to the outline of the corona of 1860, is that there does not seem to have been any such development of the corona in the equatorial regions as seems to have been observed during the sun-spot minimum eclipses of 1842, 1867 and 1878.

western groups, were composed of rays, inclined or curved in a synclinal manner. One or two observers who do not refer to any particular group of structure make use of language in describing the corona which appears to refer to synclinal structure. Thus LESPIAULT and BURAT speak of rays grouped together in narrow conical bundles, with their bases resting upon the moon; while WINTER describes "spiral lines of light radiating in pyramidal forms from the edge of the inner corona."

PLANTAMOUR, RUMKER and SECCHI appear to have been partially dazzled by the light from the lower layers of the corona or the chromosphere, and to have drawn the spurious rays which they observed.

*Group of Synclinal Structure in the South-Western Region of the Corona.*

On Plate 3, made from the Desierto de las Palmas photographs, the lower part of a group of structure in the south-western section of the corona is easily recognized. This appears, according to the observations of CHEVALLIER, WILSON, GOLDSCHMIDT, SCHULZ, WALLENBERG, and FEILITZSCH, to have consisted of curved rays with their concave sides turned towards one another; and the synclinal character of the group is still more clearly shown by the description of LESPIAULT and BURAT, who speak of the interior portion of the group as shaded by white lines which diverged from the summit to different parts of its broad base. The curved rays on the southern side of this group also attracted the attention of W. BECK, WEEDON, WINNECKE, LEWIS, OOM, MURRAY, STRONGLEIN, GALTON, and R. A. THOMPSON. RUMKER, though he only draws one curving ray, describes the group as "die leierförmigen Ausstrahlung"; and TEMPEL gives an elliptic structure somewhat resembling that given by WALLENBERG. WEYER speaks of very fine and distinct glossy white lines on the south-western limb, which as shown in his drawing indicate a bending together of the structure observed. WILSON apparently describes the same structure as reminding him of spun glass; and BUCKINGHAM probably refers to the same thing when he compares the structure of the rays to silk drawn out. WEILER and BULARD, though they did not notice the curvature of the rays, give great beams of light issuing from the

Synclinal groups  
of structure in  
the S.W. region  
of the corona.

south-western section of the corona. From a comparison of the photographs and the drawings and descriptions above referred to, it appears that there was a very distinctly marked group of synclinal structure in the south-western section of the corona, and that the axis of the group made an angle of about  $45^\circ$  with the sun's axis.

*Observations of Synclinal Structure and Curving Rays in the South-Western Section of the Corona.*

- |                        |                                  |   |
|------------------------|----------------------------------|---|
| (p. 537.) Briviesca.   | <b>Lespiault</b><br><b>Burat</b> | } do not give a drawing, but speak of "trois grands faisceaux lumineux juxtaposés. . . . intérieurement sillonné de traits blancs, qui, s'irradient à partir du sommet, allaient atteindre les divers points de sa large base." |
| (p. 537.) Pancerberbo. | <b>Chevallier</b>                |   |
| (p. 538.) Pancerberbo. | <b>Wilson</b>                    | gives a drawing in which the curving together of the rays on both sides of the S.W. group is shown.   |
| (p. 542.) Miranda.     | <b>W. Beck</b>                   | describes a remarkable beam which curved away upwards from the S.W. limb.   |
| (p. 543.) Miranda.     | <b>Weedon</b>                    | gives a drawing in which rays are shown upon the S.W. limb, curving towards the north.  |
| (p. 547.) Near Pobes.  | <b>Winnecke</b>                  | gives a drawing in which there is a large ray on the S.W. limb curving towards the south. In the text he says that he is not sure about the direction of the curvature.   |
| (p. 550.) Bilbao.      | <b>Lewis</b>                     | gives a drawing in which there is a conspicuous curved ray on the S.W. limb. In the text he describes it as resembling "a Turkish scimitar."  |
| (p. 551.) Near Pobes.  | <b>Oom</b>                       | gives a drawing in which there is a striking ray curving in the same direction as the ray in Lewis's drawing. It evidently corresponds to the southern edge of the S.W. synclinal group shown in other drawings.                |
| (p. 555.) Llodio.      | <b>Murray</b>                    | gives a ray curving in the same direction as the curved ray given by Lewis and Oom. He describes it as "about $70^\circ$ below the eclipse course," and "in shape like a half-crescent."  |
| (p. 556.) Near Llodio. | <b>Stronglein</b>                | speaks of a horn-shaped ray on the under side, which was curved from left to right.   |
| (p. 557.) Vitoria.     | <b>Goldschmidt</b>               | writes: "Une grande masse lumineuse occupait la partie sud (evidently referring to the vertex as the north),  |



s'étalant vers le sud-est et sud-ouest en faisceaux courbes concaves vers le sud et entremêlés de masses claires. . . . . Le faisceau principal au sud-est avait une grande ressemblance avec la branche australe de la Nébuleuse d'Orion."

- (p. 559.) Vitoria. **Schulz** writes: "Waren sie rechts unten krummlinig und darin eine Lücke."
- (p. 560.) Vitoria. **Weyer** gives a drawing with some converging lines on the S.W. limb, which he describes in the text as "very fine and distinct," and of a "glossy white." He also gives a ray which would about correspond to the centre of the S.W. synclinal group as seen by other observers.
- (p. 563.) La Guardia. **Galton** gives a drawing with a great curved ray on the S.W. limb.
- (p. 564.) Tudela. **R. A. Thompson** describes a beam a few degrees to the west of the lowest point of the sun's vertical diameter, which "appeared to curve upward" as it approached the sun, and "join another beam which was thrown off about 45° below the western edge of the sun."
- (p. 567.) Valencia. **Wallenberg** gives a diagram with two incurving rays on the S.W. limb, which he describes in the text as "Zwei mit den concaven Seiten gegen einander gekrümmte hakenförmige Lichtstreifen, deren einer mit seinem Ende über den anderen noch etwas hinweggriff, Sie standen am unteren Rande, ihre Ausgangspunkte wenig von einander entfernt, und gaben zusammen das ungefähre Bild einer Ellipse mit geringer Excentricität."
- (p. 569.) Castellon de la Plana. } **Feilitzsch** gives a diagram with a synclinal structure on the S.W. limb, which he describes in the text as "eine leierförmige Ausstrahlung welche in Südwesten stand."
- (p. 572.) Castellon de la Plana. } **Rumker** gives a drawing with a curved ray on the S.W. limb, which he refers to in the text as the "leierförmigen Ausstrahlung."
- (p. 574.) Desierto de las Palmas. } **Secchi** describes an observation of M. CEPEDA, who noticed curved rays divided into branches like stags' horns, "vers leur partie supérieure."
- (p. 575.) Torreblanca. **Tempel** gives a drawing with an elliptic structure on the S.W. limb.

*Group of Structure in the South-Eastern Region of the Corona.*

The Desierto de las Palmas photographs show very distinctly the southern edge of a mass of brighter structure in the south-eastern section of the corona, at position angle 140° to 130°. TEMPEL's drawing shows in the same region a remarkable double ray, not quite radial to the sun's limb, and slightly convex towards the sun's axis. On the eastern

Conspicuous group of structure in the S.E. region of the corona.

side of the double ray is a fan-shaped group of rather shorter and fainter rays, all slightly curved in the same direction. WILSON'S drawing shows a long fibrous radial ray in about the same region, with shorter rays on either side, somewhat inclined from the radial towards parallelism with the axis of the longer ray. GALTON'S drawing shows a group of rays, the longest slightly curving towards the south at its outer extremity; and both WALLENBERG and WINNECKE'S drawings show long rays in this region slightly curving towards the south at their outer extremities. Besides the above, the drawings and descriptions of WEEDON, WEILER, OOM, STRONGLEIN, GOLDSCHMIDT, WEYER, R. A. THOMPSON, ARNDT, FEILITZSCH and BULARD, all go to prove that there was a conspicuous group of structure in this region, and that the axis of the group was inclined at an angle of about  $45^\circ$ , or a little more, to the sun's axis.

*Observations of a Group of Structure in the South-Eastern Section of the Corona.*

- (p. 538.) Pancerbo. **Wilson** gives a drawing with a long "fibrous" radial ray towards the centre of the S.E. quadrant; the rays on either side of it are inclined from the radial towards parallelism with the axis of the group, and show some traces of synclinal curvature.
- (p. 543.) Miranda. **Weedon** gives a drawing with a long radial ray with a definite western edge situated decidedly below the centre of the S.E. quadrant.
- (p. 546.) Near Pobes. **Weiler** gives a drawing with a long radial ray from about the centre of the S.E. quadrant.
- (p. 547.) Near Pobes. **Winnecke** gives a drawing with a long radial ray curving slightly towards the south, and springing from about the centre of the S.E. quadrant. In the text he says that he had some doubts about the direction of the curvature. It would seem that the "dusky arc" observed by him upon the corona was in the neighbourhood of the base of this ray.
- (p. 551.) Near Pobes. **Oom** gives a drawing with a long radial ray from about the centre of the S.W. quadrant (position angle  $140^\circ$  measured from the N. point). Its western edge appears rather more definite than its eastern edge.
- (p. 555.) Near Llodio. **Stronglein** describes a ray more than one-third of the lunar diameter in length, in a position which would about correspond with the centre of the S.E. quadrant.

- (p. 557.) Vitoria. **Goldschmidt.** From the position of the great curved rays referred to by Goldschmidt, it seems certain that in speaking of the N. point he really refers to the vertex. On this supposition the ray ( $70^{\circ}$  von N.) would have been some  $20^{\circ}$  above the centre of the S.E. quadrant.
- (p. 560.) Vitoria. **Weyer** gives a drawing with a great ray from the centre of the S.E. quadrant.
- (p. 563.) La Guardia. **Galton** gives a drawing with a group of rays from the S.E. quadrant. The longest of the rays curves over at its extremity slightly towards the south, and another smaller ray curves over slightly towards the larger ray.
- (p. 564.) Tudela. **Thompson** describes a ray considerably longer than the moon's diameter, about  $10^{\circ}$  below the east side of the sun—that is, a little below the centre of the S.E. quadrant.
- (p. 567.) Valencia. **Wallenberg** gives a diagram with a long ray from about the centre of the S.E. quadrant; towards its outer end it curves over slightly towards the south: “Eine der Lichtstreifen, die über die Corona hinausragten, war von den übrigen durch seine beträchtliche Länge besonders ausgezeichnet. Er ging vom linken Rande aus, krümmte sich anfangs schwach, gegen sein Ende hin stärker und unregelmässiger nach unten (S).”
- (p. 568.) Castellon de la Plana. } **Arndt.** It is possible that the long ray observed by Arndt may have corresponded to the group of structure in the S.E. quadrant, referred to by so many other observers; but it seems more probable that he was speaking of the unoriented image.
- (p. 569.) Castellon de la Plana. } **Feilitzsch** gives a great ray in the S.E. quadrant, about  $90^{\circ}$  distant from the synclinal structure in the S.W. quadrant.
- (p. 575.) Torreblanca. **Tempel** gives a drawing with a conspicuous double ray from about the centre of the S.E. quadrant. It curves slightly away from the sun's axis, and on its eastern side are several other smaller rays all curving in the same direction.
- (p. 577.) Lambessa. **Bulard** gives a great ray in the S.E. quadrant, about  $90^{\circ}$  distant from the synclinal structure in the S.W. quadrant.

*Group of Structure in the North-Eastern Region of the Corona.*

GOLDSCHMIDT, after describing a parabolic form which evidently corresponded with the synclinal group in the south-western section of the corona, says that there was a similar though less distinct form on the opposite limb of the moon. TEMPEL, in his drawing of the corona, gives a broad radial ray springing from about the centre of the north-east