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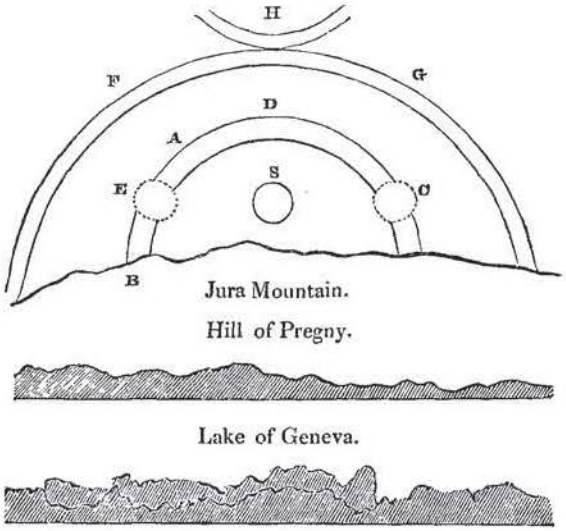
LXI. *Observations on some remarkable Optical Phænomena seen in Switzerland; and on an Optical Phænomenon which occurs on viewing a Figure of a Crystal or geometrical Solid. By* L. A. NECKER, *Esq. Professor of Mineralogy at Geneva. In a Letter to* SIR DAVID BREWSTER.

My Dear Sir,

I MUST not delay any further fulfilling my promise of writing to you, respecting the subjects of our conversation in the too short moments I had the very great pleasure and good fortune of seeing you in London. I am the more bound to write soon, as my first object must be to correct a wrong statement in the date of my observation of the parhelia, as stated in my letter to Mr. Forbes (Edinb. Journal of Science, No. 12. p. 251.). As this mistake, into which I was led by trusting too much to my memory, and to some wrong inferences, has had the effect of weakening some circumstances which were in favour of your explanation, I am the more anxious to do it all justice, so that you may be in time to announce in your next Number the consequences of this mistake, for which I beg leave to apologize to you, to Mr. Forbes, and to your readers, whom I have unwillingly led into error. The true date of the day when I saw the parhelia, was the 1st of June 1830, as I observe by the little memorandum I kept of this remarkable, and to me entirely new phænomenon,—and not the middle of July, as I stated in my letter, written from memory in Edinburgh. Here I transcribe the whole note, together with the little sketch which it contains.

Parhelia seen the 1st of June 1830, from $5\frac{1}{2}$ o'clock P.M. till sunset at $7\frac{1}{4}$ o'clock, represented in the most complete state, as I saw it at 6 o'clock:—S is the sun; EADC the inner halo, which was much the brightest; C and E the two luminous images or mock suns; FG the outer halo, which was



weak, and seen only for a few moments, as well as the inverted arch H. All the various points of these arches were not equally distinct at the same moment as they are represented here. On the contrary, when the image or mock sun at the right hand, C, was strong, the one at the left hand, E, was pale, or did not appear; such was the case at the beginning of the apparition. At the end, the left image, E, was very luminous and coloured, shining with prismatic colours; while the right image C was less visible, and sometimes altogether wanting. The strength of illumination of the various parts of the halo was constantly variable. Often certain portions, sometimes very considerable, entirely disappeared, and afterwards reappeared again. A little before the sun had set, the only part visible was that between A and B, and it was vividly lighted and coloured, and reflected by the lake; at the same time the single point C was also shining brilliantly, coloured with iridescent colours. At the moment of sunset, there remained nothing but a small arch in D. The phænomenon ended almost immediately after the sun had disappeared behind the Jura at $7^h\ 20^m$. All this time the parts

of the sky situated to the west and north-west were hazy, and with some little clouds; while the eastern and southern parts were perfectly pure and clear, and the chain of the Alps quite pure and bright.

The very rough and inaccurate sketch is a copy of the one which I made rapidly at the time, to preserve the memory of the fact. I well know that the halos and arches must be portions of perfect circles, and parallel to each other; but it being easy to make this correction in the mind, I preferred giving the thing as I sketched it in haste two years ago.

I am happy now to be able to give accurate information about the state of the atmosphere in the day itself of the phænomenon, and in the days preceding it, by referring to the meteorological tables of the *Bibliotheque Universelle*, to which you may look for more particular details. I see that on the 24th of May 1830, the thermometer of Reaumur had stood between 10° minimum and 20°·8 maximum; then came rain; and by my notes I see that snow fell on the 25th on the Jura, which was melted on the 26th. On the St. Bernard (1278 toises above the level of the sea), the 24th of May, the temperature was between +2° R. minimum, and +8° R. maximum, when rain fell, and the thermometer on the 25th of May descended to −0°·2 R. minimum, and +4°·5 R. maximum. On the 27th and 28th of May, snow fell on the St. Bernard, and the temperature decreased till the 29th of May, when it was so low as to reach −6°·1 R. minimum, and +4°·5 maximum. On the 30th of May it had risen again to −4°·8 R. minimum, and +5°·4 maximum; and on the 31st to −1°·1 minimum, and +5°·7 maximum: so much for the temperature of the high parts of the atmosphere at the St. Bernard. During the same time, in the lowland at Geneva, since the rain of the 25th of May, the thermometer had gradually lowered till the 30th of May, when it had attained +3°·2 R. minimum, and +15°·4 R. maximum. On the 31st of May it had already risen to +10° R. minimum, and +14°·4 R. maximum.

Now on the 1st of June 1830, the day of the parhelia, the thermometer at Geneva was between +3°·5 R. minimum, and +17°·3 R. maximum. The last must have been nearly the temperature during the phænomenon in the plain. At the St. Bernard on the same day, the thermometer was between −3°·6 R. minimum and +9° R. maximum. This last temperature may give an idea of that of the atmospheric strata at 1000 toises above Geneva, at the time of the parhelia. The whole day was serene and cloudless at the St. Bernard. At Geneva it was likewise so, except in the afternoon, when a thin mist or haze, and some light clouds, appeared in the west.

From the combination of all these circumstances, it remains not unlikely, nay, even probable, that icy particles may have been floating in those light mists which gave rise to the parhelia, if we suppose their height to exceed a good deal that of 1000 toises above Geneva, or 1280 toises above the level of the sea.

Although mistaken in my former statement of the epoch on which the parhelia took place, considering that June, though not the hottest, as I said of July, is at least a hot month of our summer, that the occurrence of a parhelion in that season, and in such a latitude as ours (46° 12′ N. lat.), is a very rare thing, and that by the knowledge we have been able to get of the meteorological circumstances attending such a phænomenon (circumstances which I do not believe have been mentioned in similar accounts of parhelia),—we are able to form an idea at least of the minimum of height at which the refracting medium causing the parhelia must have been placed. I do not regret to have drawn your attention to this fact, which, instead of militating against, will rather tend to corroborate your ideas as to the necessity of supposing minute crystals of ice to explain the phænomenon.

I now come to the point which you particularly wished me to describe to you: I mean the luminous appearance of trees, shrubs and birds when seen from the foot of a mountain, a little before sun-rise. The wish I had to see again the phænomenon before attempting to describe it, made me detain this letter, a few days, till I had a fine day to go to see it at the Mont Saleve; so yesterday I went there and studied the fact, in elucidation of which I made a little drawing, of which I give you here a copy: it will, with the explanation and the annexed diagram, impart to you, I hope, a correct idea of the phænomenon. You must conceive the observer placed at the foot of a hill interposed between him and the place where the sun is rising, and thus entirely in the shade; the upper margin of the mountain is covered with woods, or detached trees and shrubs, which are projected as dark objects upon a very bright and clear sky, except at the very place where the sun is just going to rise; for there all the trees and shrubs bordering the margin are entirely, branches, leaves, stem, and all, of a pure and brilliant white, appearing extremely bright and luminous, although projected on a most brilliant and luminous sky, as that part of it which surrounds the sun always is. All the minutest details, leaves, twigs, &c. are most delicately preserved, and you would fancy you saw these trees and forests made of the purest silver, with all the skill of the most expert workman. The swallows and other birds flying in those parti-

cular spots appear like sparks of the most brilliant white*. Unfortunately all these details, which add so much to the beauty of this splendid phænomenon, cannot be represented in

Fig. 1.

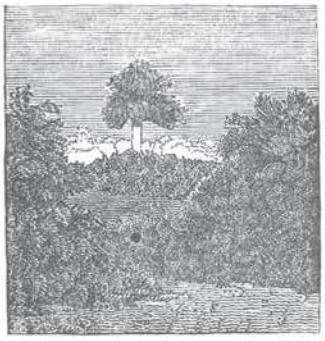
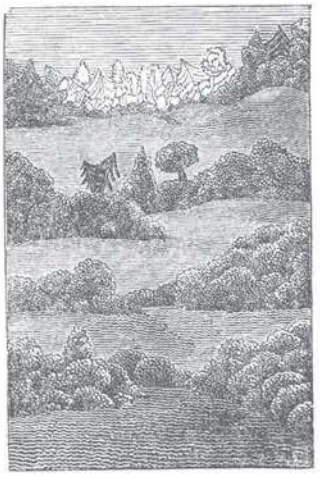


Fig. 2.



such small sketches. Neither the hour of the day, nor the angle which the object makes with the observer, appears to have any effect; for on some occasions I have seen the phænomenon to take place at a very early hour in the morning. Yesterday it was 10 o'clock A.M., when I saw it as represented in fig. 1. I saw it again on the same day at 5 o'clock P.M., at a different place of the same mountain, for which the sun was just setting. At one time the angle of elevation of the lighted white shrubs above the horizon of the spectator was about 20°; while at another place it was only 15°. But the extent of the field illuminated is variable, according to the distance at which the spectator is placed from it. When the object behind which the sun is going to rise, or has just been setting, is very near, no such effect takes place. In the case represented, fig. 1, the distance was about 194 metres, or 636 English feet, from the spectator, in a direct line; the height above his level being 60 metres, or 197 English feet, and the horizontal line drawn from him to the horizontal projection of these points on the plane of his horizon being 160 metres, or 525 English feet, as will be seen in the following diagram, fig. 3. In this case only small

[* This appearance seems to be connected with that assumed by flying birds when seen, under certain circumstances, through a telescope, during observations on the sun, and which, it has been alleged, has occasionally been mistaken for that of small meteors seen in the day-time: see the next two pages.—EDIT.]

shrubs, and the lower half of the stem of a tree, are illuminated white, and the horizontal extent of this effect is also comparatively small; while at other places when I was nearer the edge behind which the sun was going to rise, no such effect took place. But, on the contrary, when I have wit-

Fig. 3.

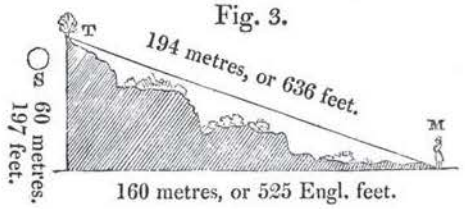
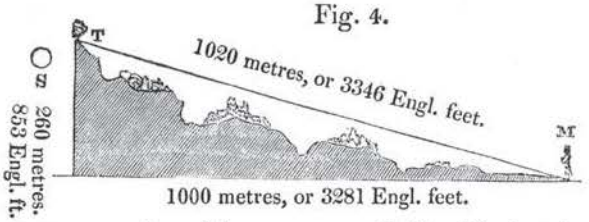


Fig. 4.



S. Apparent place of the sun. T. Tree illuminated white.
M. Spectator.

nessed the phænomenon at a greater distance and at a greater height, as I have seen it other times in the same and in other mountains of the Alps, large tracts of forests and immense spruce firs were illuminated white throughout their whole length, as I have attempted to represent in fig. 2. and the corresponding diagram, fig. 4. Nothing can be finer than these silver-looking spruce forests. At the same time, though at a distance of more than a thousand metres, a vast number of large swallows or swifts (*Cypselus alpinus*), who inhabit those high rocks, were seen in the shape of small brilliant stars or sparks moving rapidly in the air. From these facts, it appears to me obvious that the extent of the illuminated spots varies in a direct ratio of their distance; but at the same time that there must be a constant angular space, corresponding, probably, to the zone, a few minutes of a degree wide, around the sun's disk, which is a limit to the occurrence of the appearance: this would explain how the real extent which it occupies on the earth's surface varies with the relative distance of the spot from the eye of the observer, and accounts also for the phænomenon being never seen in the low country, where I have often looked for it in vain. Now that you are acquainted with the circumstances of the fact, I have no doubt that you will easily observe it in some part or other of your Scotch hills: it may

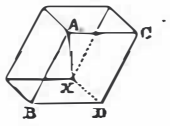
be, some long heaths or furze will play the part of our alpine forests; and I would advise you to try to place a bee-hive in the required position, and it would perfectly represent our swallows, sparks or stars.

I now only wonder that such a phænomenon, which must necessarily take place in every mountain of the earth, every day and at every hour of the day when the sun shines, should never have been noticed before.

I now come to another subject which you also desired me to mention: I mean the varying colours exhibited by Mont Blanc during and after sunset. Lord Minto was perfectly right in the account he gave you of these appearances. But he may have omitted some circumstances which will assist in leading us to an explanation of these varying appearances. I shall here state the facts in the order in which they appear. When the sun is near setting, and the weather is serene, all the mountains of the Alps, facing the west, are tinged with a fine purplish hue, which on Mont Blanc, on account of its bright covering of snow, takes a tinge more verging towards a light orange. When the sun has set for the plain, these mountains appear more vivid and more illuminated, by the effect of contrast. When, some minutes after, the lower mountains are in the shade, their purple hue is changed into a dark blueish tinge, the contrast between their shaded parts and those that were lighted by the sun has disappeared, and an almost uniform grayish blue shade covers them all; at this time Mont Blanc remains the only terrestrial object still lighted by the rays of the sun, and that circumstance causes its immense mass of snow to appear more bright, and its yellowish orange colour more vivid: at the same time the contrast between the projected and other shadows and the lighted parts is at its maximum (I have two or three times seen Mont Blanc at that moment, and when dark clouds were behind it, look almost as bright and red as a live coal). When, however, the sun has set for Mont Blanc, which happens about a quarter of an hour after it has set for the plain round Geneva, then the whole of Mont Blanc assumes a dull blueish white hue, and a flattened appearance, owing to the absence of contrast from the once shaded parts with those that were lighted. And so its new aspect is to that which it offered a few minutes before, like that of a dead body to a living and healthy one. This pale and, as it were, morbid appearance of the mountain is owing to the fact, that above it exists still a wide zone of atmosphere loaded with thin and light vapours, for which the sun has not yet set, and which on that account are still lighted vividly, and coloured with a purple hue. When,

however, the sun has also been setting for these higher regions of the atmosphere, the contrast between their illumination and the shade existing all over Mont Blanc, to which was owing that blueish and deadly colour assumed by the eternal snows, having ceased to take place, the Mont Blanc assumes once more, but in a much fainter and darker manner, its orange yellow colour; and the lower and nearer mountains recover their purplish hue. All the objects then being uniformly and altogether illuminated by the much paler and less powerful light of the twilight, as they were before all lighted at once by the brighter, but equally uniformly spread, light of the sun; so that every thing being placed in the same relative quantity and quality of illumination as before, an analogous aspect is seen in both cases, though much darker under the latter than under the former circumstances. Hence it appears to me that the whole of the phænomenon is most naturally and easily explained by contrast.

The object I have now to call your attention to, is an observation which is also of an optical nature, and which has often occurred to me while examining figures and engraved plates of crystalline forms: I mean a sudden and involuntary change in the apparent position of a crystal or solid represented in an engraved figure. What I mean will be more easily understood from the figure annexed. The rhomboid AX is drawn so that the solid angle A should be seen the nearest to the spectator, and the solid angle X the furthest from him, and that the face ACBD should be the foremost, while the face XDC is behind. But in looking repeatedly at the same figure, you will perceive that at times the apparent position of the rhomboid is so changed that the solid angle X will appear the nearest, and the solid angle A the furthest; and that the face ACDB will recede behind the face XDC, which will come forward; which effect gives to the whole solid a quite contrary apparent inclination. I have been a long time at a loss to understand the reason of the apparently accidental and involuntary change which I always witnessed in all sorts of forms in books of crystallography. The only thing I could observe was, that at the time the change took place, a particular sensation was felt in the eye (for it takes place as well when seen with only one eye, as with both eyes), which proved to me that it was an optical, and not merely as I had at first thought a mental, operation which was performed. After, however, a more attentive analysis of the fact, it occurred to me, that it was owing to an involuntary change in the adjustment



of the eye for obtaining distinct vision. And that whenever the point of distinct vision on the retina was directed on the angle A, for instance, this angle seen more distinctly than the others was naturally supposed to be nearer and foremost; while the other angles seen indistinctly were supposed to be further, and behind. The reverse took place when the point of distinct vision was brought to bear upon the angle X. This solution being found, I proved that it was the real one by three different ways.

1st, By being able at my will to see the solid in which position I chose, and to make this position vary at pleasure, in looking alternately, with fixed attention, either to the angle A, or to the angle X.

2ndly, While looking steadfastly to the angle A, and seeing the rhomboid in its proper position with the angle A foremost, if without moving either the eye or the figure, I made a convex lens (such as is used in spectacles for long-sightedness,) pass gently from below upwards between the eye and the figure, at the instant when the figure was visible through the glass, the change had taken place, and the solid had assumed the apparent position in which the angle X was the foremost, and that only because, owing to the refraction through the glass, the image of the angle X had come to take the place of the real angle A, and so the point of distinct vision, without being at all moved, had by this means come to bear on the angle X, or rather on its image.

3rdly, If through a hole made with a pin in a card you look at the figure in such a manner that either the angle A or the angle X be hidden, the visible angle will determine the apparent position of the solid, so that this angle will always appear the nearest; it will be impossible to see it in any other way, and consequently there will be no change.

What I have said of the solid angles is equally true of the edges,—those edges upon which the axis of the eye or the central hole of the retina are directed will always appear forward; so that now it appears to me certain that this little, at first so puzzling, phænomenon, depends upon the law of distinct vision.

You surely will draw from all the above communications, many consequences which my ignorance of the subject prevents me from anticipating. You may do what you think most proper with all these observations.

I remain, my dear Sir, with the kindest regard,
Ever most sincerely yours,

Geneva, May 24, 1832. L. A. Necker.