XXXIX. On Luminous and Obscure Radiation.
By John Tyndall, F.R.S., &c.*

1. Sir William Herschel discovered the obscure rays of the sun, and proved that the position of maximum heat was beyond the red of the solar spectrum†. Forty years subsequently Sir John Herschel succeeded in obtaining a thermograph of the calorific spectrum, and in giving striking visible evidence of its extension beyond the red‡. Melloni proved that an exceedingly large proportion of the emission from a flame of oil, of alcohol, and from incandescent platinum heated by a flame of alcohol, is obscure§. Dr. Akin inferred from the paucity of luminous rays evident to the eye, and a like paucity of extra-violet rays, as proved by the experiments of Dr. Miller, that the radiation from a flame of hydrogen must be mainly extra-red; and he concluded from this that the glowing of a platinum wire in a hydrogen-flame, as also the brightness of the Drummond light in the oxyhydrogen-flame, was produced by a change in the period of vibration||. By a different mode of reasoning I arrived at the same conclusion myself, and published the conclusion subsequently¶.

2. A direct experimental demonstration of the character of the radiation from a hydrogen-flame was, however, wanting, and this want I have sought to supply. I had constructed for me, by Mr. Becket, a complete rock-salt train of a size sufficient to

* Communicated by the Author.
† Phil. Trans. 1800.
‡ Phil. Trans. 1840. I hope very soon to be able to turn my attention to the remarkable results described in Note III. of Sir J. Herschel's paper.
§ La Thermochrose, p. 304.
¶ Phil. Trans. vol. cliv. p. 327.
|| Reports of the British Association, 1863.

permit of its being substituted for the ordinary glass train of a
Duboscq's electric lamp. A double rock-salt lens placed in the
camera rendered the rays parallel; the parallel rays then passed
through a slit, and a second rock-salt lens placed without the
camera produced, at an appropriate distance, an image of this
slit. Behind this lens was placed a rock-salt prism, while late-
rally stood a thermo-electric pile intended to examine the spec-
trum produced by the prism. Within the camera of the electric
lamp was placed a burner with a single aperture, so that the
flame issuing from it occupied the position usually taken up by
the coal points. This burner was connected with a T-piece,
from which two pieces of india-rubber tubing were carried, the one
to a large hydrogen-holder, the other to the gas-pipe of the labo-
rary. It was thus in my power to have, at will, either the gas-
flame or the hydrogen-flame. When the former was employed,
I had a visible spectrum, which enabled me to fix the thermo-
electric pile in its proper position. To obtain the hydrogen-
flame, it was only necessary to turn on the hydrogen until it
reached the gas-flame and was ignited; then to turn off the gas
and leave the hydrogen-flame behind. In this way, indeed, the
one flame could be substituted for the other without opening the
door of the camera, or producing any change in the positions of
the source, the lenses, the prism, and the pile.

3. The thermo-electric pile employed is a beautiful instrument
constructed by Ruhmkorff. It belongs to my friend Mr. Gassiot,
and consists of a single row of elements properly mounted and
attached to a double brass screen. It has in front two silvered
edges, which, by means of a screw, can be caused to close upon
the pile so as to render its face as narrow as desirable, reducing
it to the width of the finest hair, or, indeed, shutting it off
altogether. By means of a small handle and long screw, the
plate of brass and the pile attached to it can be moved gently to
and fro, and thus the vertical slit of the pile can be caused to
traverse the entire spectrum, or to pass beyond it in both direc-
tions. The width of the spectrum was in each case equal to the
length of the face of the pile, which was connected with an ex-
tremely delicate galvanometer.

4. I began with a luminous gas-flame. The spectrum being
cast upon the brass screen (which, to render the colours more
visible, was covered with tinfoil), the pile was gradually moved
in the direction from blue to red, until the deflection of the gal-
vanometer became a maximum. To reach this it was necessary
to pass entirely through the spectrum and a little way beyond
the red; the deflection then observed was

30°.

When the pile was moved in either direction from this position,
the deflection diminished.
5. The hydrogen-flame was now substituted for the gas-flame; the visible spectrum disappeared, and the deflection fell to 12°.

Hence, as regards rays of this particular refrangibility, the emission from the luminous gas-flame was two-and-a-half times that from the hydrogen-flame.

6. The pile was now moved to and fro, and the movement in both directions was accompanied by a diminished deflection. Twelve degrees, therefore, was the maximum deflection for the hydrogen-flame; and the position of the pile, determined previously by means of the luminous flame, proves that this deflection was produced by extra-red undulations. I moved the pile a little forwards, so as to reduce the deflection from 12° to 4°, and then, in order to ascertain the refrangibility of the rays which produced this small deflection, I relighted the gas. The rectilinear face of the pile was found invading the red. When the pile was caused to pass successively through positions corresponding to the various colours of the spectrum, and to its extra-violet rays, no measurable deflection was produced by the hydrogen-flame.

7. I next placed the pile at some distance from the invisible spectrum of the flame of hydrogen, and felt for the spectrum by moving the pile to and fro. Having found it, I without difficulty ascertained the place of maximum heating. Changing nothing else, I substituted the luminous flame for the non-luminous one; the position of the pile when thus revealed, was beyond the red.

8. It is thus proved that the radiation from a hydrogen-flame is sensibly extra-red. The other constituents of the radiation are so feeble as to be thermally insensible. Hence, when a body is raised to incandescence by a hydrogen-flame, the vibrating periods of its atoms must be shorter than those to which the radiation of the flame itself is due.

9. The falling of the deflection from 30° to 12° when the hydrogen-flame was substituted for the gas-flame is doubtless due to the absence of all solid matter in the former. We may, however, introduce such matter, and thus make the radiation originating in the hydrogen-flame much greater than that of the gas-flame. A spiral of platinum wire plunged in the former gave a maximum deflection of 52° at a time when the maximum deflection of the gas-flame was only 33°.

10. It is mainly by convection that the hydrogen-flame disperses its heat: though its temperature is higher, its sparsely-scattered molecules are not able to cope, in radiant energy, with
the solid carbon of the luminous flame. The same is true for the flame of a Bunsen’s burner; the moment the air (which destroys the solid carbon-particles) mingles with the gas-flame, the radiation falls considerably. Conversely, a gush of radiant heat accompanies the shutting out of the air which deprives the gas-flame of its luminosity. When, therefore, we introduce a platinum wire into a hydrogen-flame, or carbon-particles into a Bunsen’s flame, we obtain not only waves of a new period, but also convert a large portion of the heat of convection into the heat of radiation.

11. The action was still very sensible when the distance of the pile from the red end of the spectrum on the one side was as great as that of the violet rays on the other, the heat-spectrum thus proving itself to be at least as long as the light-spectrum.

12. Bunsen and Kirchhoff have proved that, for incandescent metallic vapours, the period of vibration is, within wide limits, independent of temperature. My own experiments with flames of hydrogen and carbonic oxide as sources, and with cold aqueous vapour and cold carbonic acid as absorbing media, point to the same conclusion*. But in solid metals augmented temperature introduces waves of shorter periods into the radiation. It may be asked, “What becomes of the long obscure periods when we heighten the temperature? Are they broken up or changed into shorter ones, or do they maintain themselves side by side with the new vibrations?” The question is worth an experimental answer.

13. A spiral of platinum wire suitably supported was placed within the camera of the electric lamp at the place usually occupied by the carbon points. This spiral was connected with a voltaic battery; and by varying the resistance to the current, it was possible to raise the spiral gradually from a state of darkness to an intense white heat. Raising it to a white heat in the first instance, the rock-salt train was placed in the path of its rays, and a brilliant spectrum was obtained. The pile was then moved into the region of obscure rays beyond the red of the spectrum. Altering nothing but the strength of the current, the spiral was reduced to darkness, and lowered in temperature till the deflection of the galvanometer fell to 1°. Our question is, “What becomes of the waves which produce this deflection when new ones are introduced by augmenting the temperature of the spiral?”

14. Causign the spiral to pass from this state of darkness through various degrees of incandescence, the following deflections were obtained:—

* Phil. Trans. vol. cliv. p. 327.
Prof. Tyndall on Luminous and Obscure Radiation.

Table I.

<table>
<thead>
<tr>
<th>Appearance of spiral.</th>
<th>Deflection by obscure rays.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark</td>
<td>1</td>
</tr>
<tr>
<td>Dark</td>
<td>6</td>
</tr>
<tr>
<td>Faint red</td>
<td>10.4</td>
</tr>
<tr>
<td>Dull red</td>
<td>12.5</td>
</tr>
<tr>
<td>Red</td>
<td>18.0</td>
</tr>
<tr>
<td>Full red</td>
<td>27.0</td>
</tr>
<tr>
<td>Bright red</td>
<td>44.4</td>
</tr>
<tr>
<td>Nearly white</td>
<td>54.3</td>
</tr>
<tr>
<td>Full white</td>
<td>60.0</td>
</tr>
</tbody>
</table>

15. The deflection of 60° here obtained is equivalent to 122 of the first degrees of the galvanometer. Hence the intensity of the obscure rays in the case of the full white heat is 122 times that of the rays of the same refrangibility emitted by the dark spiral used at the commencement. Or, as the intensity is proportional to the square of the amplitude, the height of the ethereal waves which produced the last deflection was eleven times that of the waves which produced the first. The wave-length, of course, remained the same throughout.

16. The experimental answer, therefore, to the question above proposed is, that the amplitude of the old waves is augmented by the same accession of temperature that gives birth to the new ones. The case of the obscure rays is, in fact, that of the luminous ones (of the red of the spectrum, for example), which glow with augmented intensity as the temperature of the radiant source is heightened.

17. In my last memoir* I demonstrated the wonderful transparency of the element iodine to the extra-red undulations. A perfectly opake solution of this substance was obtained by dissolving it in bisulphide of carbon, and it was shown in the memoir referred to that a quantity of iodine sufficient to quench the light of our most brilliant flames transmitted 99 per cent. of the radiation from a flame of hydrogen.

18. Fifty experiments on the radiant heat of a hydrogen-flame, recently executed, make the transmission of its rays, through a quantity of iodine which is perfectly opake to light, 100 per cent.

To the radiation from a hydrogen-flame the dissolved iodine is therefore, according to these experiments, perfectly transparent.

19. It is also sensibly transparent to the radiation from solid bodies heated under incandescence.

20. It is also sensibly transparent to the obscure rays emitted by luminous bodies.

* Phil. Trans. vol. cliv. p. 327. [This memoir will appear in the December Number of the Philosophical Magazine.]
To the mixed radiation which issues from solid bodies at a very high temperature, the pure bisulphide of carbon is also eminently transparent. Hence, as the bisulphide of carbon interferes but slightly with the obscure rays issuing from a highly luminous source, and as the dissolved iodine seems not at all to interfere with them, we have in a combination of both substances a means of almost entirely detaching the purely thermal rays from the luminous ones.

If vibrations of a long period, established when the radiating body is at a low temperature, maintain themselves, as indicated in paragraph 14, side by side with the new periods which augmented temperature introduces, it would follow that a body once pervious to the radiation from any source must always remain pervious to it. We cannot so alter the character of the radiation that a body once in any measure transparent to it shall become quite opaque to it. We may, by augmenting the temperature, diminish the percentage of the total radiation transmitted by the body; but inasmuch as the old vibrations have their amplitudes enlarged by the very accession of temperature which produces the new ones, the total quantity of heat of any given refrangibility transmitted by the body must increase with increase of temperature.

This conclusion is thus experimentally illustrated. A cell with parallel sides of polished rock-salt was filled with the solution of iodine, and placed in front of the camera within which was the platinum spiral. Behind the rock-salt cell was placed an ordinary thermo-electric pile, to receive such rays as had passed through the solution. The rock-salt lens was in the camera in front, but a small sheaf only of the parallel beam emergent from the lamp was employed. Commencing at a very low dark heat, the temperature was gradually augmented to full incandescence with the following results:

<table>
<thead>
<tr>
<th>Appearance of spiral</th>
<th>Deflection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark</td>
<td>1</td>
</tr>
<tr>
<td>Dark but hotter</td>
<td>3</td>
</tr>
<tr>
<td>Dark but still hotter</td>
<td>5</td>
</tr>
<tr>
<td>Dark but still hotter</td>
<td>10</td>
</tr>
<tr>
<td>Feeble red</td>
<td>19</td>
</tr>
<tr>
<td>Dull red</td>
<td>25</td>
</tr>
<tr>
<td>Red</td>
<td>35</td>
</tr>
<tr>
<td>Full red</td>
<td>45</td>
</tr>
<tr>
<td>Bright red</td>
<td>53</td>
</tr>
<tr>
<td>Very bright red</td>
<td>63</td>
</tr>
<tr>
<td>Nearly white</td>
<td>69</td>
</tr>
<tr>
<td>White</td>
<td>75</td>
</tr>
<tr>
<td>Intense white</td>
<td>80</td>
</tr>
</tbody>
</table>
24. To the luminous rays from the intensely white spiral the solution was perfectly opaque; but though by the introduction of such rays the transmission, as expressed in parts of the total radiation, was diminished, the quantity absolutely transmitted was enormously increased. The value of the last deflection is 440 times that of the first; by raising therefore the platinum spiral from darkness to whiteness, we augment the intensity of the obscure rays which it emits in the ratio of 1:440.

25. A rock-salt cell filled with the transparent bisulphide of carbon was placed in front of the camera which contained the platinum spiral raised to a dazzling white heat. The transparent liquid was then drawn off and its place supplied by the solution of iodine. The deflections observed in the respective cases are as follows:—

Radiation from White-hot Platinum.

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>73°9</td>
<td>73°0</td>
</tr>
<tr>
<td></td>
<td>73°8</td>
<td>72°9</td>
</tr>
</tbody>
</table>

All the luminous rays passed through the transparent bisulphide, none of them passed through the solution of iodine. Still we see what a small difference is produced by their withdrawal. The actual proportion of luminous to obscure, as calculated from the above observations, may be thus expressed:—

26. Dividing the radiation from a platinum wire raised to a dazzling whiteness by an electric current into twenty-four equal parts, one of these parts is luminous and twenty-three obscure.

27. A bright gas-flame was substituted for the platinum spiral, the top and bottom of the flame were shut off, and its most brilliant portion chosen as the source of rays. The result of forty experiments with this source may be thus expressed:—

28. Dividing the radiation from the most brilliant portion of a flame of coal-gas into twenty-five equal parts, one of those parts is luminous and twenty-four obscure.

29. I next examined the ratio of obscure to luminous rays in the electric light. A battery of fifty cells was employed, and the rock-salt lens was used to render the rays from the coal points parallel. To prevent the deflection from reaching an inconvenient magnitude, the parallel rays were caused to issue from a circular aperture 0·1 of an inch in diameter, and were sent alternately through the transparent bisulphide and through the opaque solution. It is not easy to obtain perfect steadiness on the part of the electric light; but three experiments carefully executed gave the following deflections:—
Radiation from Electric Light.—Experiment No. I.
Through transparent Cs. Through opaque solution.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>72°.0</th>
<th>70°.0</th>
</tr>
</thead>
</table>

Experiment No. II.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>76°.5</th>
<th>75°.0</th>
</tr>
</thead>
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Experiment No. III.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>77°.5</th>
<th>76°.5</th>
</tr>
</thead>
</table>

Calculating from these measurements the proportion of luminous to obscure heat, the result may be thus expressed:

30. Dividing the radiation from the electric light emitted by carbon points, and excited by a Grove’s battery of forty cells, into ten equal parts, one of those parts is luminous and nine obscure.

31. The results may be thus presented in a tabular form:

<table>
<thead>
<tr>
<th>Source</th>
<th>Absorption</th>
<th>Transmission</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dark spiral</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Lampblack at 212° Fahr.</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Red-hot spiral</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Hydrogen-flame</td>
<td>0</td>
<td>100</td>
</tr>
<tr>
<td>Oil-flame</td>
<td>3</td>
<td>97</td>
</tr>
<tr>
<td>Gas-flame</td>
<td>4</td>
<td>96</td>
</tr>
<tr>
<td>White-hot spiral</td>
<td>4.6</td>
<td>95.4</td>
</tr>
<tr>
<td>Electric light</td>
<td>10</td>
<td>90</td>
</tr>
</tbody>
</table>

Repeated experiments may slightly alter these results, but they are extremely near the truth.

32. Having thus in the solution of iodine found a means of almost perfectly detaching the obscure from the luminous heat-rays of any source, we are able to operate at will upon the former. Here are some illustrations:—The rock-salt lens was so placed in the camera that the coal points themselves and their image beyond the lens were equally distant from the latter. A battery of forty cells being employed, the track of the cone of rays emergent from the lamp was plainly seen in the air, and their point of convergence therefore easily fixed. The cell containing the opaque solution was now placed in front of the lamp. The luminous cone was thereby entirely cut off, but the intolerable temperature of the focus, when the hand was placed there, showed that the calorific rays were still transmitted. Thin plates of tin and zinc were placed successively in the dark focus and speedily fused; matches were ignited, gun-cotton exploded, and brown paper set on fire. Employing the iodine solution and a battery of sixty of Grove’s cells, all these results were readily obtained.
with the ordinary glass lenses attached to Duboscq's electric lamp. They cannot, I think, fail to give pleasure to those who repeat the experiments. It is extremely interesting to observe in the middle of the air of a perfectly dark room a piece of black paper suddenly pierced by the invisible rays, and the burning ring expanding on all sides from the centre of ignition.

33. On the 15th of this month I made a few experiments on solar light. The heavens were not free from clouds, nor the London atmosphere from smoke, and at best I obtained only a portion of the action which a clear day would have given me. I happened to possess a hollow lens, which I filled with the concentrated solution of iodine. Placed in the path of the solar rays, a faint red ring was imprinted on a sheet of white paper held behind the lens, the ring contracting to a faint red spot when the focus of the lens was reached. It was immediately found that this ring was produced by the light which had penetrated the thin rim of the liquid lens. Pasting a zone of black paper round the rim, the ring was entirely cut off and no visible trace of solar light crossed the lens. At the focus, whatever light passed would be intensified nine hundredfold; still even here no light was visible.

34. Not so, however with the sun's obscure rays; the focus was burning hot. A piece of black paper placed there was instantly pierced and set on fire; and by shifting the paper, aperture after aperture was formed in quick succession. Gunpowder was also exploded. In fact we had in the focus of the sun's dark rays a heat decidedly more powerful than that of the electric light similarly condensed, and all the effects obtained with the former could be obtained in an increased degree with the latter.

35. I introduced a plano-convex lens of glass, larger than the opake lens just referred to, into the path of the sun's rays. The focus on white paper was of dazzling brilliancy; and in this focus the results already described were obtained. I then introduced a cell containing a solution of alum in front of the focus. The intensity of the light at the focus was not sensibly changed; still these almost intolerable visual rays, aided as they were by a considerable quantity of invisible rays which had also passed through the alum, were incompetent to produce effects which were obtained with ease in the perfectly dark focus of the opake lens.

36. Thinking that this reduction of power might be due to the withdrawal of heat by reflection from the sides of the glass cell, I put in its place a rock-salt cell filled with the opake solution. Behind this cell the rays manifested the power which they exhibited in the focus of the opake lens.
37. The rendering of metals incandescent by obscure rays has not yet been accomplished. This is a question on which Dr. Akin has been engaged for some years, and it is not my intention to publish anything relating to it until the very promising arrangements which he has devised have had a sufficient trial.

38. Melloni's experiments led him to conclude that rock-salt transmits obscure and luminous rays equally well, and that a solution of alum of moderate thickness entirely intercepts the invisible rays, while it allows all the luminous ones to pass. Hence the difference between the transmissions of rock-salt and alum ought to give the obscure radiation. In this way Melloni found that 10 per cent. only of the radiation from an oil-flame consists of luminous rays. The method above employed proves that the proportion of luminous heat to obscure, in the case of an oil-flame, is probably not more than one-third of what Melloni made it.

39. In fact this distinguished man clearly saw the possible inaccuracy of the conclusion that none but luminous rays are transmitted by alum; and the following experiments justify the clauses of limitation which he attached to his conclusion:

The solution of iodine was placed in front of the electric lamp, the luminous rays being thereby intercepted. Behind the rock-salt cell containing the opaque solution was placed a glass cell, empty in the first instance. The deflection produced by the obscure rays which passed through both produced a deflection of

80°.

The glass cell was now filled with a concentrated solution of alum; the deflection produced by the obscure rays passing through both solutions was

50°.

Calculating from the values of these deflections, it was found that of the obscure heat emergent from the solution of iodine, and from the side of the glass cell, 20 per cent. was transmitted by the alum.

40. A point of very considerable importance forces itself upon our attention here—namely the vast practical difference which may exist between the two phrases, "obscure rays," and "rays from an obscure source." Many writers seem to regard these phrases as equivalent to each other, and are thus led into grave errors. A stratum of alum solution 1/35th of an inch in thickness is, according to Melloni, entirely opaque to the radiation from all bodies heated under incandescence. In the foregoing experiments the layer of alum solution traversed by the obscure rays of our luminous source was thirty times the thickness of the layer which
Melloni found sufficient to quench all rays emanating from obscure sources.

41. There cannot be a doubt that the invisible rays which have shown themselves competent to traverse such a thickness of the most powerful adiathermic liquid yet discovered are also able to pass through the humours of the eye. The very careful and interesting experiments of M. Janssen *, prove that the humours of the eye absorb an amount of radiant heat exactly equal to that absorbed by a layer of water of the same thickness, and in our solution the power of water is added to that of water. Direct experiments on the vitreous humour of an ox lead me to conclude that one-fifth of the obscure rays emitted by an intense electric light reaches the retina; and inasmuch as in every ten equal parts of the radiation from an electric lamp nine consist of obscure rays, it follows that, in the case of the electric light, nearly two-thirds of the whole radiant energy which actually reaches the retina is incompetent to excite vision. With a white-hot platinum spiral as source, the mean of four good experiments gave a transmission of 11·7 per cent. of the obscure heat of the spiral through a layer of distilled water 1·2 inch in thickness. A larger proportion no doubt reaches the retina†.

42. Converging the beam from the electric lamp by a glass lens, I placed the opaque solution of iodine before my open eye, and brought the eye into the focus of obscure rays; the heat was immediately unbearable. But it seemed to me that the unpleasant effect was mainly due to the action of the obscure rays upon the eyelids and other opaque parts round the eye. I therefore cut, in a card, an aperture somewhat larger than the pupil, and allowed the concentrated calorific beam to enter my eye through this aperture. The sense of heat entirely disappeared. Not only were the rays thus received upon the retina incompetent to excite vision, but the optic nerve seemed unconscious of their existence even as heat. What the consequences would have been had I permitted the luminous third of the condensed beam to enter my eye, I am not prepared to say, nor should I like to make the experiment.

43. On a tolerably clear night a candle-flame can be readily seen at the distance of a mile. The intensity of the electric light used by me is 650 times that of a good composite candle, and as the non-luminous radiation from the coal points which reaches the retina is equal to twice the luminous, it follows that at a common distance of a foot, the energy of the invisible rays

* Annales de Chimie et de Physique, tom. lx. p. 71.
† M. Franz has shown that a portion of the sun's obscure rays reach the retina.
of the electric light which reach the optic nerve, but are incompetent to provoke vision, is 1300 times that of the light of a candle. But the intensity of the candle’s light at the distance of a mile is less than one twenty-millionth of its intensity at the distance of a foot, hence the energy which renders the candle perfectly visible a mile off would have to be multiplied by $1300 \times 20,000,000$, or by twenty-six thousand millions, to bring it up to the intensity of that powerless radiation which the eye receives from the electric light at a foot distance. Nothing, I think, could more forcibly illustrate the special relationship which subsists between the optic nerve and the oscillating periods of luminous bodies. The nerve, like a musical string, responds to the periods with which it is in accordance, while it refuses to be excited by others of vastly greater energy which are not in unison with its own.

44. By means of the opake solution of iodine, I have already shown that the quantity of luminous heat emitted by a bright red platinum spiral is immeasurably small*. Here are some determinations since made with the same source of heat and a solution of iodine in iodide of ethyle, the strength and thickness of the solution being such as entirely to intercept the luminous rays.

<table>
<thead>
<tr>
<th>Radiation from Red-hot Platinum Spiral.</th>
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<tbody>
<tr>
<td>Through transparent liquid.</td>
</tr>
<tr>
<td>43.7</td>
</tr>
<tr>
<td>Through opake solution.</td>
</tr>
<tr>
<td>43.7</td>
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</table>

These experiments were made with exceeding care, and all the conditions were favourable to the detection of the slightest difference in the amount of heat reaching the galvanometer; still the quantity of heat transmitted by the opake solution was found to be the same as that transmitted by the transparent one. In other words, the luminous radiation intercepted by the former, though competent to excite vividly the sense of vision, was, when expressed in terms of actual energy, absolutely immeasurable.

45. And here we have the solution of various difficulties which from time to time have perplexed experimenters. When we see a vivid light incompetent to affect our most delicate thermoscopic apparatus, the idea naturally presents itself that light and heat must be totally different things. The pure light emerging from a combination of water and green glass, even when rendered intense by concentration, has, according to Melloni, no sensible heating power†. The light of the moon is also a case in point. Concentrated by a polyzonal lens more than a yard in diameter

* Phil. Trans. vol. cliv. p. 327.
† Taylor’s Scientific Memoirs, vol. i. p. 392.
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upon the face of his pile, it required all Mellon's acuteness to nurse the calorific action up to a measurable quantity. Such experiments, however, demonstrate, not that the two agents are dissimilar, but that the sense of vision can be excited by an amount of force almost infinitely small.

46. Here also we are able to offer a remark as to the applicability of radiant heat to fog-signalling. The proposition, in the abstract, is a philosophical one; for were our fogs of a physical character similar to that of the iodine held in solution by the bisulphide of carbon, or to that of iodine or bromine vapour, it would be possible to transmit through them powerful fluxes of radiant heat, even after the entire stoppage of the light from our signal lamps. But our fogs are not of this character. They are unfortunately so constituted as to act very destructively upon the purely calorific rays; and this fact, taken in conjunction with the marvellous sensitiveness of the eye, leads to the conclusion that long before the light of our signals ceases to be visible, their radiant heat has lost the power of affecting, in any sensible degree, the most delicate thermoscopic apparatus that we could apply to their detection.

Royal Institution, October 1864.

XL. On Evansite, a new Mineral Species.
By David Forbes, F.R.S., &c.*

This mineral was brought from Hungary in the year 1855 by the late Mr. Brooke Evans of Birmingham, and was then reported to be found in some abundance as an incrustation in drusy cavities which occurred in the brown iron ores. It was regarded as pertaining to the mineral species allophane, with which it agrees in many of its physical properties, as hardness, colour, specific gravity, &c., as well as in the percentage of loss sustained upon heating the mineral to redness.

The specimen I received from Mr. Evans was labelled Allophane from Zsctcznik, Gomar Comitat, and was very beautiful in appearance, consisting of an agglomeration of small stalactites with reniform and globular excrescences on brown haematite, many of these excrescences much resembling artificial or natural pearls, having both the figure and characteristic pearly lustre of such.

I doubted the identity of the mineral with allophane; and a

* Communicated by the Author.
† After whom the species is now named.
‡ A considerable number of specimens had been given by Mr. Evans to private collections in England all labelled "allophane," and I understand that many more had likewise been distributed in Germany under the same name.