On the determination of the illuminating-power of the simple radiations

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ON THE DETERMINATION OF THE ILLUMINATING-POWER OF THE SIMPLE RADIATIONS. BY MM. A. CROVA AND LAGARDE.

One of the most delicate problems of photometry is the measurement of the illuminating-power of lights of different tints. One of us has already indicated how this question might be solved, by employing a spectrophotometer. That solution supposes that the coefficients of illumination of the different simple radiations composing the light which is to be compared are known.

If the determination of the radiant energy of a vibration of a determined wave-length can be expressed exactly in thermal or mechanical units, that of its illuminating-power admits of all the uncertainties inherent to the measurement of physiological sensations variable with each eye. There exists no known relation between these two quantities; we have therefore to commence by seeking out what are, for a determined eye, the illuminating-powers of the various simple radiations of the normal spectrum of two sources of light—the sun, and the Carcel standard.

The best-known treatise on this subject is that of Fraunhofer on the Sun; the results obtained by him are not very concordant. The following is, briefly, the method which we have followed.

The illuminating-power of a simple light may be regarded as the property possessed by the latter of rendering distinguishable, upon a white screen illumined by it, minute details (lines, characters); it will be possible to measure them approximately, as several physicists have done, by weakening this light until the characters can no longer be distinguished, and taking the ratio of the initial intensity to this limit of intensity. The absolute value of these numbers will vary with the fineness of the characters; but their ratio will be sensibly constant, and will depend only on the wave-length of the light examined.

The light to be studied (sun or Carcel standard) is received perpendicularly upon the slit of a spectrophotometer covered with a strip of glass on which is photographed a series of very fine and very close dividing-lines; the direction of these lines cuts the slit normally. A pure spectrum is then seen furrowed by a considerable number of very fine longitudinal striae. If the ocular slit of the telescope be brought onto a region of the spectrum, the simple radiations comprised between two very close known limits are isolated; and by a suitable rotation of the nicol, their intensity is weakened until the striae cease to be perceptible. The phenomenon of the disappearance of the striae is more delicate than one would have at first been inclined to believe; by practice one arrives at being certain about the degree or the fraction of a degree, according to the region of the spectrum.

1. We have traced the curve of the wave-lengths as functions of the divisions of the micrometer, and calculated its equation by

† Gilbert's Annalen, xxvi. p. 207 (1817).
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the method of least squares. The derivate of that equation gives, for each wave-length, the factor by which the intensities of the prismatic spectrum must be multiplied to reduce them to those of the normal spectrum.

2. We have measured for wave-lengths comprised between 480 and 740, at intervals of 20 units, the rotations which cause the vanishing of the striae.

3. The variations of the Carcel standard are corrected so as to reduce the intensity to the constant value corresponding to the consumption of 42 grams per hour; for this we made use of M. Deleuil's automatic balance, which registers, during the time of the experiments, the successive times required for burning 10 grams of oil. The solar light was diffused by a wooden screen whitened with carbonate of magnesia. We operated when the sky was very clear, about noon.

4. The prismatic curves have been reduced, as we have said, to the normal spectrum; and, lastly, the absolute maximum being set off upon the curve, we have reduced the ordinates to those corresponding to a maximum equal to 100.

The curves obtained are tangents at their two extremities to the axis of the wave-lengths; they rise at first slowly, afterwards very quickly in the vicinity of the maximum. For the lamp, the curve is nearly symmetrical on both sides of the maximum. For the sun, the ascent and descent are more rapid than for the lamp; the descent towards the violet is more rapid than the ascent on the red side.

The following results are deduced from the two most regular series, selected from amongst numerous determinations:

<table>
<thead>
<tr>
<th>Wave-length</th>
<th>740</th>
<th>720</th>
<th>700</th>
<th>680</th>
<th>660</th>
<th>640</th>
<th>620</th>
<th>600</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illuminating</td>
<td>Lamp</td>
<td>0.1</td>
<td>0.7</td>
<td>1.6</td>
<td>5.7</td>
<td>14</td>
<td>28</td>
<td>52.5</td>
</tr>
<tr>
<td></td>
<td>Sun</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>0.5</td>
<td>1.5</td>
<td>4</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Wave-length</th>
<th>560</th>
<th>540</th>
<th>520</th>
<th>500</th>
<th>480</th>
</tr>
</thead>
<tbody>
<tr>
<td>Illuminating</td>
<td>Lamp</td>
<td>72.5</td>
<td>37.5</td>
<td>23.5</td>
<td>13.0</td>
</tr>
<tr>
<td></td>
<td>Sun</td>
<td>62.5</td>
<td>98.5</td>
<td>30.5</td>
<td>17.2</td>
</tr>
</tbody>
</table>

The maximum, = 100, corresponds, for the lamp, to the radiation 592, and for the sun to 564.

The discussion of these results leads to conclusions which are in accordance with the theory of the emission of the radiations emitted by incandescent bodies *.

The numbers obtained require a slight correction, on account of the absorption exerted towards the violet by the material of the prisms. We purpose to continue these determinations with prisms exerting no appreciable absorption upon the visible radiations.—


* Journal de Physique, viii. p. 357.