LXXVI. Facts relating to Optical Science. No. IV.

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§ 1. Experiments on the Interference of Light.

Although so much has been explained in optical science by the aid of the undulatory hypothesis, yet when any well-marked phenomena occur which present unexpected peculiarities, it may be of importance to describe them, for the sake of comparison with the theory.

Such appears to me to be the case with those which I am about to mention, in which, by means of a remarkable compensation of some kind or other, common solar light appears to play the part of homogeneous light, and to achromatise itself, if I may use such an expression, in a very high degree of perfection.

Sir William Herschel was, I believe, the first who took note of the very beautiful coloured bands which are seen passing through two prisms placed in contact. Thus, let A, B, C be two equal right-angled glass prisms in contact. We will suppose the sides A B, B C to be equal, and the height of the prisms to be equal to A B, in which case combination of the two will form a cube. Let the two prisms be gently pressed together by their face A C, which must be previously well cleaned from any adhering dust, and

* Communicated by the Author.
let them be fixed firmly in this position. Then if the observer looks through the cube at a bright white object, or at the sky, he will see a number of coloured parallel bands, the direction of vision being supposed to be perpendicular to two opposite sides, as AB, CD. If instead of this he looks through AB at a light coming from the direction XX and then reflected internally on the face AC, he will again see numerous coloured bands upon AC, but these will be complementary in their tints to the former ones. These coloured bands are analogous in their nature to Newton's rings, differing only in being formed between two plane surfaces either parallel or very nearly so, and viewed by the observer at an incidence of 45°.

But the beauty of the appearances may be surprisingly increased by transporting the apparatus into a dark chamber, and suffer- ing a single pencil of the brightest solar light to pass through the prism, or to be reflected from the face AC. If then a sheet of white paper be held up, at any distance from the prism, the coloured bands are depicted upon it with the greatest vividness and distinctness. The transmitted bands have altogether a different character from the reflected ones, so that it is impossible to mistake one for the other, even without reference to the path of the ray.

This experiment, easily tried, is one of the most beautiful in optical science; I shall not, however, dwell upon it, because I believe it is sufficiently well-known; and that it has been exhibited in some public lectures.

Now, in making this experiment with care, I have observed some remarkable circumstances.

The coloured bands are not, as has been supposed, isochromatic lines. The deviation is sometimes very great, so that a band in the course of its progress acquires very different tints from those which it possessed originally. This fact may be considered of some importance with respect to the theory. It takes place when the prisms are in close contact, and the bands few in number. But the following is still more deserving of attention. When the contact of the prisms is diminished by interposing a hair between them, (still pressing them together,) the coloured bands depicted upon the paper, become more numerous, narrow and crowded. Frequently they alter-
be reflected horizontally by a mirror. I will relate a few, out of several experiments which were made in this manner.

1. About ten or twenty feet from the radiant point, I placed in the path of the ray an equidistant grating* made by Fraunhofer, with its lines vertical. I then viewed the light which had passed through this grating with a lens of considerable magnifying power. The appearance was very curious, being a regular alternation of numerous lines or bands of red and green colour, having their direction parallel to the lines of the grating. On removing the lens a little further from the grating, the bands gradually changed their colours, and became alternately blue and yellow. When the lens was a little more removed, the bands again became red and green. And this change continued to take place for an indefinite number of times, as the distance between the lens and grating increased. In all cases the bands exhibited two complementary colours.

It was very curious to observe that though the grating was greatly out of the focus of the lens, yet the appearance of the bands was perfectly distinct and well defined.

This however only happens when the radiant point has a very small apparent diameter, in which case the distance of the lens may be increased even to one or two feet from the grating without much impairing the beauty and distinctness of the coloured bands. So that if the source of light were a mere mathematical point it appears possible that this distance might be increased without limit; or that the disturbance in the luminous undulations caused by the interposition of the grating, continues indefinitely, and has no tendency to subside of itself.

2. Another grating was then placed at right angles to the first, and the light transmitted through both was examined by the lens. The appearance now resembled a tissue woven with red and green threads. It seemed exactly as if each colour disappeared alternately behind the other. An alteration in the distance of the lens, altered the tints of the two complementary colours.

3. A plate of copper pierced with small circular holes of equal diameter and in regular rows, was substituted for the gratings. When this plate was held perpendicular to the ray, it produced a beautiful pattern consisting of rows of circles divided by coloured lines or bars. When the lens was approached to the plate, there was a particular distance between these at which there appeared in the centre of each circle a

4. A plate of glass covered with gold leaf, on which several hundred parallel lines are cut, in order to transmit the light at equal intervals.

black spot, as small and well defined in appearance as a full point in a printed book, being a curious instance of the well-known fact, of the interference of rays of light producing darkness. This black spot was seen in all the circles at once, in consequence of their having equal diameters.

4. When the copper-plate was placed obliquely and held in various positions, a great variety of very singular patterns were displayed, which can be compared to nothing so well as to tissues woven with threads of various colours. It would be impossible to describe these, any more than the ever-changing figures of the kaleidoscope. They seem to vary ad infinitum, and in whatever position the plate is placed, they appear always as distinct as if they were in the focus of the lens.

5. In some optical experiments it is essential that vision should be performed along the axis of the lenses which are employed, or very nearly so. But in these experiments this singularity occurs, that the lens may be placed in any position; so that when held even very obliquely the only effect is a considerable alteration in the pattern, which in other respects remains as distinct to the eye as before. The experiments hitherto related, are some which I had the pleasure of showing to some distinguished members of the British Association a short time previously to the late meeting at Bristol; and are communicated in the hope that they may prove interesting to the cultivators of optical science.

§ 3. Remarkable Property of the Iodide of Lead.

This substance possesses a property of a singular nature, which I believe differs from anything previously described; or if it is reducible to known laws of chemical and molecular action, offers at least a very striking and beautiful example of them.

If a solution of acetate of lead is mixed with a saturated solution of hydroxide of potash, and the mixture well stirred, the iodide of lead which is formed in abundance, though at first yellow, speedily grows pale, and afterwards becomes perfectly white. A small quantity of this is taken when freshly made and moist, and squeezed between two plates of glass, it may be seen by the help of a microscope to be entirely composed of very delicate capillary crystals; and if in this state it be laid aside, I do not find that it undergoes any change after being kept several months.

But if, while fresh, it be warmed over a spirit-lamp, it suddenly turns yellow, the first impression of the heat being sufficient to produce that effect. As soon as this happens, it should be removed from the lamp and again examined with
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The manner of change of this substance from its white to its yellow crystalline form. And the following is nearly what happened during its return to its former state.

When it cools, the white crystals begin to shoot, and if the microscope is adjusted upon one of the yellow hexagons, it is seen to remain quiet and undisturbed until one of the white needles, which elongate rapidly, passes near it. But when the needle passes it, even at what appears in the microscope a considerable distance, the hexagon becomes corroded on its edges, and then breaks up irregularly, and quickly dissolves.

I observed that when a needle, during its growth, happened to strike a hexagon, this seemed to check it for an instant, and then it subdivided itself into a number of ramifications or smaller needles which diverged from that point; as if the force (probably of an electrical nature) which caused the growth or formation of the needle-crystal had been deranged or subverted by the disturbing influences which it had met with.

The change from the white to the yellow form may be repeated four or five times; but when too much water has been evaporated by the heat, it ceases to occur. The white crystals then merely dissolve when heated, without the formation of the yellow ones.

Remarks.—Are the white and yellow crystals identically the same substance, assuming different forms at different degrees of temperature? Is this a case of what has been termed di-morphism? If I may venture a conjecture, I should say that the yellow crystals are a definite compound of the white crystals with water. But however this may be, it appears to me that this and other properties of the iodide of lead are worthy of being more particularly examined.*


I had the opportunity of studying on the upper series of Shale-tracks and the relative positions of the deposits of bituminous and anthracitic coals in Pennsylvania, with various detailed illustrative sections which I had procured.*

* These two forms of iodide of lead are united in the English Ed. extract from his Prize Essay on Indium,” Lond. and Edinb. Phil. Mag., vol. viii. p. 15. — Eor.
† Communicated by the Author.