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THE THEORY OF THE NEW HELIOCHROMIC PROCESS.

From the time of the production of Becquerel's heliochromic photographs half a generation ago, it has often been speculated that the colours might or might not be those of thin plates, and it is pleasing that the true theory of their production was first put forth in this country by Lord Rayleigh, the successor of Professors Tyndall, Faraday, Davy, and Young, as Professor of Natural Philosophy at the Royal Institution.

As Lord Rayleigh set forth in these pages on March 6th last, he published the explanation in the *Philosophical Magazine* of August, 1887, in which he says of Becquerel's photographs that the film "may be conceived to be subjected during exposure to *stationary* luminous waves of nearly definite wavelength, the effect of which might be to impress upon the substance a periodic structure recurring at intervals equal to *half* the wave-length of the light." He then speaks of hoping to follow up the subject experimentally, but did not do so; M. Lippmann, later on, working with the same theory, has obtained brilliant results. It is some satisfaction to know that the true fundamental principle of heliochromy was first enunciated by one of the ablest mathematicians and physicists in this country, although, afterwards, first proved to be true in France.

Early in 1888 Lord Rayleigh brought under the notice of the Royal Institution some remarkable researches and experiments of his own on the diffraction of sound, and, by the suitable manipulation of sound-waves, he produced phenomena analogous to those of the interference of light; in other words, just as in M. Lippmann's films, waves of light, by interference with each other, produce stationary bands of darkness, so did Lord Rayleigh cause waves of sound to act upon each other to produce in mid air stationary bands of silence. Just as Wiener applied a photographic film to search for and register interference bands of light, so did Lord Rayleigh employ a sensitive flame to indicate the presence of interference bands of sound.

The waves of sound to which the human ear is sensitive are long; the wave-length of middle C on the musical scale is four feet, and of the C one octave above it two feet. The sound-waves used by Lord Rayleigh were about half an inch in length, so short and sharp as not to be audible to the human ear; they were made by causing a current of air to blow steadily through a kind of small whistle. This was placed opposite the flaring sensitive flame and at a few yards distance; whenever the lecturer placed his hand between the whistle and the flame a sound-shadow was cast; the flame then ceased to flare and became quiescent, but whenever the hand was removed began to flare once more.

He then placed a board on the opposite side of the flame to the whistle, to act as a sound-reflector, and said:—"The places of greatest variation of density are the places of no motion; the places of greatest motion are places of no variation of density. By the operation of a reflector, such as this board, we obtain a system of stationary waves, in which the nodes and loops occupy given positions relatively to the board. You will observe that, as I hold the board at different distances behind, the flame rises and falls. I can hardly hold it still enough. In one position the flame rises, farther off it falls again; and as I move the board back, the flame passes continually from the position of the node—the place of no motion—to the loop or place of greatest motion, and no variation of pressure."* Here, then, in sound, we have a reflecting board exercising functions analogous to a reflecting surface in light; in the one case we have alternate bands of sound and silence in front of the board, and their presence indicated by a sensitive flame; in the other case—in M. Lippmann's process—we have bands of light and darkness in front of the mercury, and their presence indicated by effects produced in the interior of a transparent photographic film.

The ingenuity of this production of silence bands by means of sound-waves of air reflected from a wooden board is obvious; but the phenomenon is not parallel at all points with that of the interference of the waves of light, for the interstellar ether is almost entirely

* *Journal of the Royal Institution*, vol. xii., page 189, January 20th, 1888.