



Retinal oscillations

M. Charpentier

To cite this article: M. Charpentier (1891) Retinal oscillations, Philosophical Magazine Series 5, 32:197, 397-399, DOI: [10.1080/14786449108620202](https://doi.org/10.1080/14786449108620202)

To link to this article: <http://dx.doi.org/10.1080/14786449108620202>



Published online: 08 May 2009.



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The Structure of the Sidereal Universe. By T. W. BACKHOUSE,
F.R.A.S. Demy 4to. Hills & Co., Sunderland.

No. 1 of the 'Publications of the West Hendon House Observatory, Sunderland,' by T. W. Backhouse, has just been issued, and gives the details on which the author's previous papers "On the Structure of the Sidereal Universe" (published in the 'Monthly Notices,' vol. i. p. 374, and in the 'Sidereal Messenger,' vol. ix. p. 337) were founded. The work is illustrated with figures and maps, and the numerous observations summarized in the text furnish a useful contribution to one of the grandest problems in astronomy. Mr. Backhouse's instruments are a 2-inch field-glass and a $4\frac{1}{4}$ -inch refracting telescope, and he appears to have made excellent use of them. He remarks that certain large diffused nebulosities seen by Sir W. Herschel do not agree with those seen in a field-glass. This is not surprising when we reflect that Herschel used powerful appliances in his unwearying examination of the heavens. Mr. Backhouse says:—"We are brought to the conclusion that the galaxy is probably far nearer us than was at one time believed, and that therefore the greater part of the stars composing it are likely to be much smaller than the sun. The tendency of modern investigations is to diminish our ideas of the extent of the visible universe."

Astronomers will welcome further publications from the observatory at Sunderland. Private efforts of this laudable character are none too numerous in this country.

LI. *Intelligence and Miscellaneous Articles.*

RETINAL OSCILLATIONS. BY M. CHARPENTIER.

I HAVE recently investigated certain phenomena which, viewed as a whole, demonstrate experimentally the production of oscillations in the visual apparatus, when excited by light. These oscillations seem rather connected with a reaction of the retina, when it is acted on by light, than with the act of sensation itself. They are none the less interesting to know, and may serve as starting-point for a more minute analysis of the mechanism of the act in question.

The fact which led to these researches, and which I had communicated to the Société de Biologie on May 10, 1890, is the following:—If a black disk, on which is a larger or smaller white sector, is turned rather slowly, and if the centre of the disk is rigidly viewed when it is brightly illuminated, it is observed that that side of the white sector which first penetrates over the dark ground is bordered in its motion by a very sharp black band separated from the ground by a similar white band. These two bands appear in the form of sectors concentric with the disk, provided that certain necessary precautions are taken in the observation, in the detail of which I cannot enter here. The black band is shaded off at the edges; its angular extent, like that of the original white band, increases with the velocity of the disk, and in proportion to

it; but this extent expressed in time is always constant; the band takes always the same time to pass in front of a point of the retina; it commences about $\frac{1}{65}$ or $\frac{1}{70}$ after the passage of the white and lasts appreciably the same time. It is more visible the brighter the illumination of the white; but when it has been seen in these conditions it is found again easily under feebler illumination, in which it is only less striking. But this enfeeblement of the sensation, more or less marked according to the intensity of the excitation, is always observed.

It may be said that in this experiment there is spread out in space what occurs in time. The black band is in fact only a kind of reaction of the retina against the excitation by light, a reaction which may be made evident in a totally different way.

I have in fact observed that if in complete darkness we produce an instantaneous luminous excitation, or rather one of a duration which can be neglected in comparison with the first, the sensation appears *doubled*; that is to say, that when once it is formed it disappears, and again shows itself anew. This takes place, for instance, if we pass either through a Crookes or Geissler tube, or simply, but with less effect, through air, a *single* discharge from a Ruhmkorff coil. This doubling is more or less precise according to various circumstances which I have mentioned, but it is readily found again when it has once been observed; it is particularly marked with indirect vision. I have shown that it cannot be attributed to a reaction of the pupil, as I at first believed when I made my observations in a room not perfectly dark; it is in fact a retinal phenomenon.

There is then in this experiment, as in the first, a negative reaction under the influence of the excitation; the difference is that in the first case the excitation lasts when this reaction is seen, while here the excitation has come to an end, and only an obscuration of its persistent or consecutive image is seen.

Is this reaction, this negative excitation, unique? I do not think so; for in certain cases I have seen the dark band followed by other analogous bands uniformly spaced but much less distinct. The observation is moreover difficult, for a pretty great velocity of the disk is required, and then the bands, as they become larger, contrast less strongly with the ground, and become less perceptible. What is certain is that the first dark band is much less marked, and it dominates the phenomenon.

It would be difficult, and in any case premature, to indicate the causes of this appearance, but it may be permitted to characterize it as the result of a retinal oscillation formed under the influence of the start of the luminous excitation. What confirms this interpretation is that this oscillation travels along the retina with a uniform velocity from the point where it starts; and that by placing ourselves under certain experimental conditions we may, thanks to it, produce true phenomena of interference in the sensation.

The most convenient way of realizing these interferences is to turn a large black disk of about 0.4 metre with a velocity of about

one turn in a second, after having fixed on the periphery of this disk a very small white sector of 1° or 2° , and a height of 5 to 10 millin. In this way two necessary conditions are realized—a motion so rapid that there is a persistent image of this sector as extended as possible, and at the same time excitations at such intervals that the persistent images do not run into each other. If, then, the view is fixed rigidly towards a point at which the sector passes, which is the delicate and essential condition of the experiment, the persistent annular image of the object is seen to be channelled, and presents a certain number of dark zones regularly spaced out on the light ground. An intense light is not needed for this experiment.

The extent of the successive zones on the retina as well as their frequency is easily calculated.

It is found that the apparent interval between two dark zones on the disk diminishes with the distance from the eye. The image on the retina of this interval, on the contrary, remains constant.

For the same distance of the disk from the eye the interval in question varies with the velocity of the former, and, what is a point of capital importance, *inversely as this velocity*. This is not, then, a case of direct oscillations due to excitation; for they are, on the contrary, spaced out in proportion to the velocity of the disk.

This fact can only be explained by assuming that the object in moving over the retina is, in relation to the induced oscillation, in analogous conditions to those of an observer who moves away from a source of sound. If the retinal undulation which we have actually observed in the experiment with the black band travels with a constant velocity over the retina, the passage of a luminous image moving with a suitable rapidity should find this membrane in conditions periodically varying, in which the perception of the object will be alternately favoured or opposed. The distance of two neighbouring maxima and minima, which represents the apparent wave-length of this retinal undulation, should obey the relation expressed by Doppler's formula. This is what in fact is confirmed by experiment.—*Comptes Rendus*, July 20, 1891.

LECTURE-ILLUSTRATION OF COMPLEMENTARY COLOURS.

BY NIK. VON KLOBUKOW.

The method consists in dissolving the pigment-colours in suitable proportions in solvents which, differing considerably in specific gravity, are not soluble in each other, and neither of which dissolves the body in the other, and then, by violently shaking the solutions, and thus as it were effecting a mixture of the physical molecules, to bring about a mixture of colours.

The perception of colours is here brought about by direct action, as in the experiment of mixing colours by reflexion, and not, as in the colour-disk, by after-action of the luminous impression.

Owing to the above-mentioned properties of the solutions, the