DEMONSTRATION THAT FRESNEL'S CONVECTION OF LIGHT BY MATTER DOES NOT EXIST

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1. Introduction. Trying to explain the results of Arago's experiment [1], Fresnel proposed the existence of some convection of the aether by matter in motion. This is known by the name of Fresnel's partial convection. To test this theory, Hoek conceived a famous experiment, which we shall examine. Max Born [2] describes this experiment in the following terms.

2. Hoek's Experiment. Hoek (1868) invented the interferometer of fig. 1.

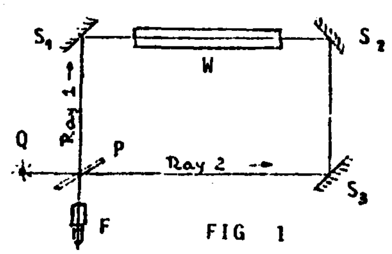

FIG 1

The light falls from the source Q onto a half-silvered glass plate inclined at 45° to the direction of the ray. This glass divides the ray into two parts. The reflected ray (ray #1) strikes consecutively the mirrors S_1, S_2, S_3 and on its return to P is reflected into the telescope F. The ray #2 traverses the same path in the opposite sense. The two rays interfere into the telescope F.

A transparent body - say a tube W filled with water - is next interposed between S_1 and S_2 and the whole apparatus is mounted so that the straight line connecting S_1 and S_2 can be placed alternately in the same direction as, and opposite to, the earth's motion about the sun.

Let the velocity of light in water that is at rest be C_1. This value is a little less than the velocity in vacuo and the ratio $C/C_1 = n$ is called the refractive index of the water.

If the ether in the water were not to participate in its motion at all, then the velocity of light in the water relative to the absolute ether (in outside space) would be unaltered; that is, it would be equal to C_1, and, for a ray travelling in the direction of the earth's motion, it would be C_1 -

The Toth-Maatian Review, 3101 20th Street, Lubbock, TX 79410, U.S.A.
Vol. 9, #2, July 1990, pp. 4423-30.

V relative to the earth. If the ether were carried completely with the water, the velocity of light relative to the ether would be $C_1 + V$, and C_1 relative to the earth. We shall assume neither of these cases to begin with, but shall leave the amount of convection undetermined. Let the velocity of light in the moving water relative to the absolute ether be a little greater than C_1, say $C_1 + \Theta$, and hence $C_1 + \Theta - V$ relative to earth. We wish to determine the unknown convection coefficient Θ from experiment. If it is zero, no convection occurs; if it is V, complete convection occurs. Its true value must lie between these limits. We shall, however, make one assumption, namely, that the convection in air may be neglected in comparison with that of water.

So nuch for Max Born's words. He then proceeds to set out the travel time for ray #1 along the tube W and along a corresponding length in air between S_3 and P. It is:

$$T = \frac{L}{C_1 + \Theta - V} + \frac{L}{C + V} \qquad (1)$$

With respect to ray #2, the total time would be:

$$T = \frac{L}{C_1 - \Theta + V} + \frac{L}{C - V} \qquad (2)$$

From (1, 2), by means of some mathematical operations based on successive approximations, Max Born obtained the convection formula of Fresnel. We shall not repeat these manipulations here, as it is unnecessary.

The author does not believe in the existence of such partial convection, at least in connection with transparent mediums in translation.

Returning to fig. 1, Max Born continues:

The experiment shows that the interferences do not shift in the slightest when the apparatus is turned into the direction opposite to the earth's motion, or indeed, into any other position whatsoever.

This would mean that $T_1 = T_2$ in both positions of the apparatus. Hence, from (1, 2) we get:

$$\frac{L}{C_1 + \Theta - V} - \frac{L}{C_1 - \Theta + V} = \frac{L}{C - V} - \frac{L}{C + V} \qquad (3)$$

Thus, the difference of travel time to and fro along L, is equal in both water and in air. For this to be true, the same thing must occur in the direction perpendicular to the motion, i.e., V = 0. Equation (3) implies this is not so, unless Θ = 0.

3. Another Arrangement. Consider fig. 2. The arrangement has the advantage over Hoek's interferometer that we analyse only one ray to and fro in the direction of the translation, instead of two rays in opposite directions. Besides there are no paths in

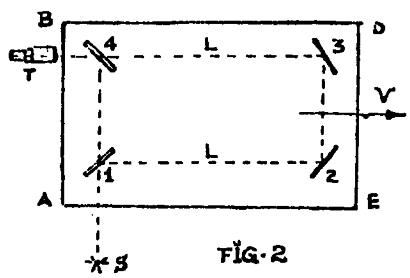

FIG. 2

...or. The interferometer is immersed into a container of glass, ABDE, filled with water. In the figure, T is a telescope, 1 and 4 are two half-silvered mirrors, S is the source and 2 and 3 are ordinary mirrors.

The ray which strikes 1 is divided into two branches which traverse the following paths:

Ray #1 follows the path 12 + 23 + 34 and then enters into the telescope;
Ray #2 follows the path 14 and then enters into the telescope.

Observe that path 14 = 23. The path difference is:

$$12 + 23 + 34 - 14 = 12 + 34$$

That is: the difference of time between the two rays corresponds to a ray moving to and fro along the path L.

First Position: This corresponds to fig. 2, in which the line 12 is placed in the direction of the translation of V as pictured there. The time difference is:

$$T_d = \frac{L}{C_1 + \Theta - V} + \frac{L}{C_1 - \Theta + V} \qquad (4)$$

Second Position: We now turn the container around a vertical axis, so as to place the plane of the apparatus perpendicular to the motion. The time difference in this position would be:

$$T_d' = \frac{L}{C_1} + \frac{L}{C_1} \qquad (5)$$

If the fringes remain unmoved with the change of position (as will occur), then $T_d = T_d'$; that is:

$$\frac{L}{C_1 + \Theta - V} + \frac{L}{C_1 - \Theta + V} = \frac{L}{C_1} + \frac{L}{C_1} \qquad (6)$$

For this to be so, we must have $\Theta = 0$ and $V = 0$. And now we see that if we insert these two values in (6), the result is, indeed, in agreement with physics. In other words, (4) involves implicitly the condition: $V = 0$, $\Theta = 0$. C.f.: [3].

Observe that we have not taken into consideration the contraction of the rod L in the rays 12 and 34. Firstly, because we have demonstrated by numerous means that the contraction does not exist. Second, here the contraction is superfluous. After assuming the proposition $V = 0$ (in the direction of motion) the Fitzgerald coefficient of contraction becomes 1; that is, there is no contraction.

Conclusions: 1) The so-called Fresnel partial convection does not exist, at least in what concerns the transmission of light in dispersive media.
2) The optical apparatuses behave as if they were unmoved in space (that is, in outside space).

These conclusions are in agreement with the author's new theory of the natural transformation, according to which light of a local source on earth is propagated in all directions with the same frequency, the same wavelength, and thus with the same velocity that would occur if the source were placed at rest in outer space.

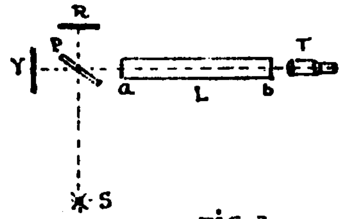

FIG. 3

4. All Color Rays Have the Same Velocity. Consider fig. 3. To prove our assertion, we have invented [4] a new type of interferometer. P is a half-silvered mirror. A ray from S moves back and forth along PR and PY. R is a red glass mirror and Y a yellow one. It is known that colored glasses behave as filters, allowing only the radiation of their own color. We shall consider only two positions of the apparatus: 1) with line PT in the direction of the motion; 2) PT in the direction opposite to the motion. Any possible contraction of YP is the same in both positions. A tube filled with water is introduced between a and b. T is the telescope. Hence the two color rays will enter the tube at a at the same time independent of the orientation of the apparatus.

Now, to test this theory we assume that the red ray has velocity C_1 and the yellow one the velocity C_2. Again, to test the theory, we assume that the convection factor of the red ray is Θ_1 and that corresponding to the yellow ray is Θ_2.

In the first position we have the following velocities:

Red ray: $C_1 + \Theta_1 - V$
Yellow ray: $C_2 + \Theta_2 - V$ (10)

the difference between which is:

$$(C_1 - C_2) + (\Theta_1 - \Theta_2) \tag{11}$$

When the apparatus is turned around by 180° (rod ab in the direction opposite to the motion), the two velocities of the two rays would be

Red ray: $C_1 - \Theta_1 + V$
Yellow ray: $C_2 - \Theta_2 + V$ (12)

the difference between which is:

$$(C_1 - C_2) - (\Theta_1 - \Theta_2) \tag{13}$$

We now see that (11, 13) are not equal; but if the fringes remain unaltered in both positions, the rays must preserve the same displacement, that is to say, difference of velocities, in both directions. Putting, then, (11) equal to (13), we obtain:

$$\Theta_1 = \Theta_2 = 0 \tag{14}$$

As for the values of C_1 and C_2, let t_1 be the travel time of the red ray along the tube ab, and t_2 the time of the yellow ray:

$$t_1 = \frac{L}{C_1 - V} \qquad t_2 = \frac{L}{C_2 - V} \tag{15}$$

The time difference would be:

$$T_d = t_1 - t_2 = \frac{L}{C_1 - V} - \frac{L}{C_2 - V} \tag{16}$$

When the rays move against the translation, the times would be:

$$t_1' = \frac{L}{C_1 + V} \qquad t_2' = \frac{L}{C_2 + V} \tag{17}$$

and the time difference is:

$$T_d' = t_1' - t_2' = \frac{L}{C_1 + V} - \frac{L}{C_2 + V} \tag{18}$$

If the fringes remain unaltered in the two positions of the interferometer, then $T_d = T_d'$. From this:

$$\frac{L}{C_1 - V} - \frac{L}{C_1 + V} = \frac{L}{C_2 - V} - \frac{L}{C_2 + V} \tag{19}$$

$$2\frac{LV}{C_1^2 - V^2} = 2\frac{LV}{C_2^2 - V^2} \tag{20}$$

so then

$$C_1 = C_2 \tag{21}$$

Conclusions: 1) The so-called Fresnel partial convection does not exist.
2) All rays of all colors are propagated into a dispersive medium with exactly the same velocity in all directions. There is only one refractive index for each medium [7].

5. Fizeau's Experiment on the Convection of Aether. In connection with Fresnel's partial convection, Max Born has said [5]:

It is very difficult to test Fresnel's formula by means of experiment on the earth because it requires that transparent substances be moved with extreme rapidity. Fizeau succeeded in carrying out the experiment (1851) by means of a sensitive interferometer arrangement.

Fizeau made use of Hoek's interferometer, to which he inserted a transparent bent tube in which circulated water. See fig. 4. Unlike the case of fig. 1, the two rays travel in opposite directions to one another. Ray #1 runs with the water and ray #2 against it. Fizeau tested whether the water carries the light with it by observing the displacement of the interference fringes when the water was set into rapid motion.

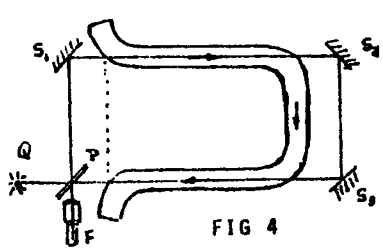

FIG 4

Born continues:

Such displacement actually occurred, but very much less than would correspond to a complete convection. Exact measurement disclosed perfect agreement with Fresnel's convective formula.

We are in disagreement with Born and consider this case from a very much different point of view. First of all, let our demonstration above be remembered which shows the non-existence of Fresnel's partial convection. In the second place, we shall show the true reasons of the phenomenoa observed by Fizeau, which have nothing to do with any kind of aether convection by matter in motion.

To do this, we start by making use of a Mach-Zehnder interferometer in place of Hoek's, for the same reasons already mentioned above, as it is much easier to analyse a problem with a single ray moving in one direction, than with two rays travelling in opposite directions to one another.

6. Verification of Fizeau's Results. In our arrangement we employ two bent tubes. We use one with water at rest, closed at both ends, and the other with running water, fig. 5, which circulates always in the same direction, from A to B. The tube AB is contrived so that it can turn 180° about the vertical axis XX', thereby reversing the direction of flow of the water through it; the rest of the apparatus remains fixed in the meantime. The fixed tube, DE, is closed but filled with water at rest and acts as a control to compare with the ray through the moving water.

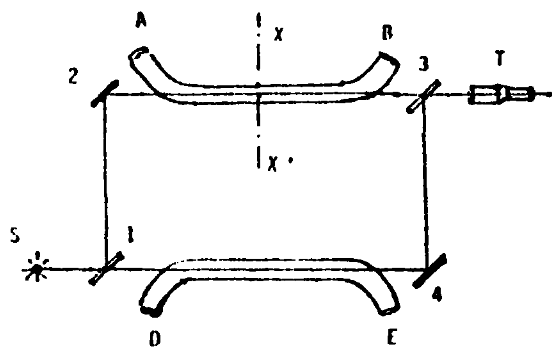

FIG 5

What we really can observe in this experiment is the shift of the light fronts produced by the water in motion relative to those through the water at rest. However, these shifts are not caused by any motion or convection of the aether. Simply, we are observing a Doppler effect, as we shall show.

First, let us explain the fundamentals of our theory. The fronts of light [6] in a transmitting medium behave as the center of emission of elemental waves caused by the material particles. The envelope of these elemental waves constitutes a new front. When the medium is in translatory motion, a layer of particles begins to absorb a wave at some point and finishes the absorption while moving onward in the direction of the motion, so that the point of re-emission becomes displaced onward. This phenomenon represents an 'enlargement' of the wavelength in the direction of the translation, and a shortening of the wavelength when the ray moves in the opposite direction to the motion. Let us explain the two cases in relation to the running water. Consider fig. 6.

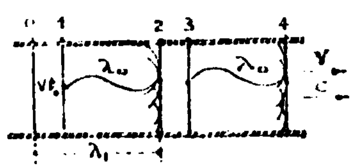

FIG 6

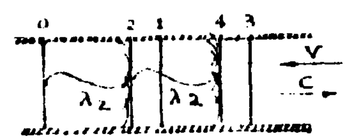

FIG 7

A wave arriving at (0) (namely λ_0) takes one period to end its flight. But at the same time, (0) moves to (1) with (01) = Vt_0 where t_0 represents a period. The reemission of the wave occurs at (1). The new front (2) is the envelope of all the elemental waves, where a new absorption begins. Again the reemission starts at (3) which generates a front or envelope at (4); and so forth. The result is a longer wavelength, namely λ_1. Recalling that C_1 is the velocity of light in water, and $t_0 = \lambda_0/C_1$, we deduce:

$$\lambda_1 = \lambda_0 + Vt_0 = \lambda_0\left(1 + \frac{V}{C_1}\right) \tag{22}$$

As for the ray moving against the water, fig. 7, when a wave λ_0 = (01) impinges on (1) since the particles placed at (1) move backwards, the front appears at (2), being (21) = Vt_0. The same occurs with the wave λ_0 = (23), which appears at (4); and so on. Thus the waves moving against the water have the length λ_2. From the figure we can get:

$$\lambda_2 = \lambda_0 - Vt_0 = \lambda_0\left(1 - \frac{V}{C_1}\right) \tag{23}$$

Accordingg to the foregoing propositions, let us now consider the different positions of the apparatus of fig. 5.

First position: This is the one indicated in the figure but with the water in the tube AB at rest. The interference fringes observed would simply correspond to the structural positions of the different parts of the interferometer. We take pictures and select one of the most clear fringes as line of reference, designating it by (0), fig. 8.

Second position: The same as above, but now with the water set in motion with determined velocity V. According to (22) we can determine the value of ${}_1$ from the known values of ${}_0$, C_1 and V. Again we take pictures and note the displacement d_1 from (0) of the fringe; fig. 8.

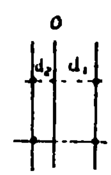

FIG 8

Third position: The tube AB is turned about 180°. Now the light will move against the water. We apply equation (23) to calculate the displacement d_2 (in the opposite direction from (0) than d_1, fig. 8).

Finally, we can set out the proportions

$$\frac{\lambda_1 + \lambda_2}{2} = \lambda_0 \qquad\qquad \frac{d_1 + d_2}{2} = d_0 \tag{24}$$

$$\frac{\lambda_1}{d_1} = \frac{\lambda_2}{d_2} = \frac{\lambda_0}{d_0} \tag{25}$$

Conclusions: Whether the total shift of the observed fringe is in agreement with (22, 23), this would be interpreted as a confirmation of our theory, and, therefore, as a confirmation of our thesis that the Fresnel partial convection does not exist.

References

[1] Morales, J. A.: **From the Natural Transformation to the Lorentz Transformation,** Toth-Maatian Review, V. 8, pp. 4169-75, 1989.
[2] Born, Max: **Einstein's Theory of Relativity,** Dover edition, pages 133 -4, 1965.
[3] Morales, J. A.: **Myths and Incongruities in the Special Theory of Relativity,** p. 26, Málaga, 1978.
[4] Morales, J. A.: Ibid. [3], p. 28.
[5] Born, Max: Ibid. [2], p. 139-40.
[6] Morales, J. A.: **La Transformación Natural,** p. 28, Málaga, 1988; La Relatividad, pp. 88-103, Málaga, 1975.
[7] Morales, J. A.: **New Viewpoints on the Refraction and Dispersion of Light,** Toth-Maatian Review, (this issue), V. 9, pp. 4447-49, 1990.