Fizeau experiment

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In 1851 H. Fizeau carried out an experiment to measure relative speed of light in moving water [1]. He found that the result is in agreement with the prediction of Fresnel who assumed that the luminiferous ether within material bodies consists of two parts, free ether in the empty space - i.e. between subatomic particles - with lower density and ether bound to subatomic particles – including the particles itself - with higher density. Index of refraction was defined as square of the ether density, so Fresnel predicted that the drag correction factor should be $x = 1 - \frac{\rho_e}{\rho_m} = 1 - \frac{1}{n^2}$. Later repetitions of the experiment [2] confirmed the measurements of Fizeau.

It is well known that matter consists of atoms (molecules) and that atoms are composed of atomic nucleus and atomic shell. Atomic nucleus is built up of protons and neutrons and atomic shell is "filled" by electrons. Electrons and nucleus have very small dimensions, so the area between shell and nucleus is practically very large and empty (filled only with the luminiferous ether according to Fresnel, Maxwell, Lorentz etc.). The radius of the shell is about 10,000 to 100,000 times the radius of the atomic nucleus. It is important to notice that the matter is not uniformly distributed in the atoms and that the speed of light cannot be the same in all regions of the atom (this is what Fresnel, Fizeau and Michelson have tried to explain).
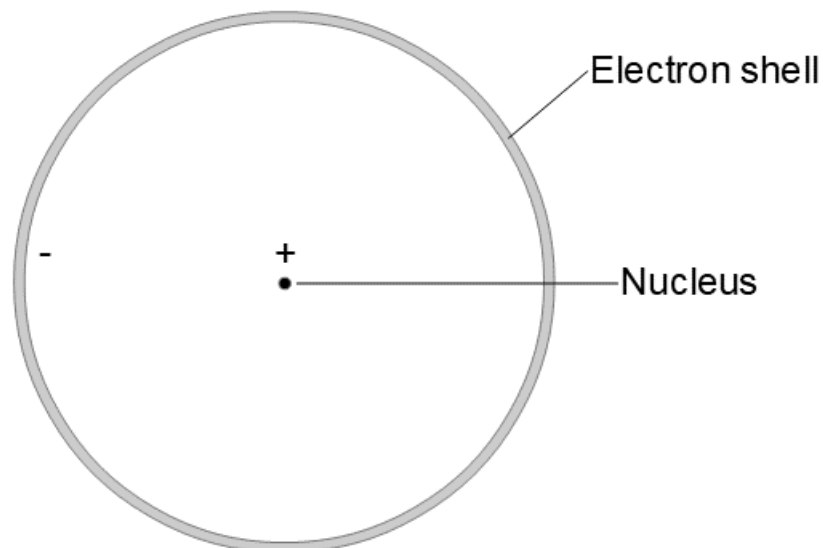

Figure 1: Schematic illustration of cross section of an atom.

It is obvious that the electrons (atomic shell) – which were not known at that time – are also regarded as ether of higher density. That is not wrong because according to Dirac the ether is made of electrons in the energetic ground state (Dirac sea). Likewise, QED requires the existence of an ether with electron-positron pairs in ground state (ether particles) which fill whole space. To free an electron from the ether ground state an amount of energy of 1.022 MeV must be introduced (remark: this entire energy is used up to build only the electric fields of electron and positron). If energy is lower the electron falls back into ground state.

In summary, Fresnel assumes that free ether is not affected by motion of atoms (atomic shell) and only the atomic shell (with its bound ether) moves through free ether. The speed of light in free ether, i.e. in the space between the atoms and in the space between electron shells is c and in the bound ether (atomic shell) smaller than c and also smaller then c/n (relative to ether). c/n is the average speed of light in the transparent body. At this point should be emphasized that the speed of light is only in the electron shell region frequency dependent because the electrons disturb the propagation of light – the objection of "relativists" that the ether "would have to be dragged by different amounts by different colors of light" is thus absolutely unfounded. Michelson explained in a footnote in his 1886 paper how Fresnel's drag correction can be calculated. To this purpose he defined the two regions through which the light moves as explained here.
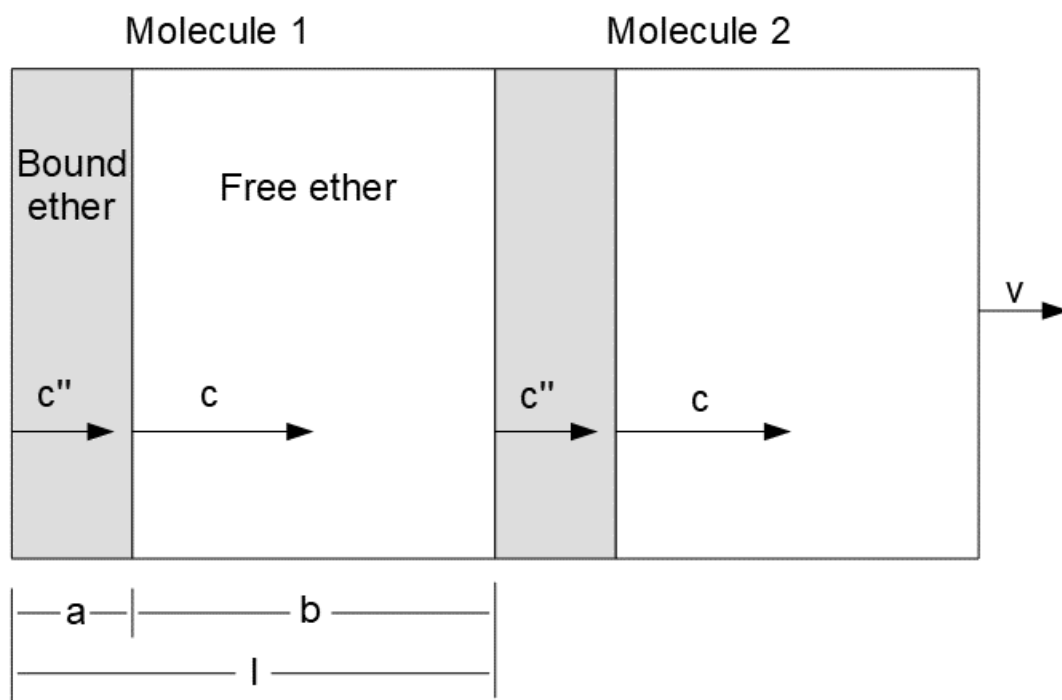

Figure 2: Schematic illustration of ether distribution in a transparent body (for example water, glass, air etc.). The distance between molecules in air is about ten times the diameter of the molecule.

If the distance between two molecules is l and the thickness of all electron shells in the molecule is a then the thickness of free ether is $b = l - a$. In this way Michelson received for the Fresnel's drag correction:

$$x = \frac{n^2 - 1}{n^2} + \frac{1}{n^2}\frac{a}{a + b}$$

For an absolutely homogeneous body is $a = l$ and $b = 0$, so the Fresnel's drag correction would be $x = 1$ and only in this case the "classical" addition formula could be applied. This conclusion is absolutely reasonable.

Another simple explanation of Fresnel's drag correction factor - equivalent to that of Michelson-Morley - was found by G. Antoni and U. Bartocci [3]. It is supposed that light, traveling through the transparent body, is delayed by interactions with many "obstacles" along the path. The number of obstacles is probably proportional to number of molecules (electrons) the light meets. If transparent body (water) is moving in the same direction as light, the light meets less obstacles and if it moves toward light source correspondingly more obstacles. On the other hand, the single delay time is proportional to velocity difference between light and obstacle (or exactly proportional to "doppler factor").

In 1906 Lorentz published a simplified derivation of Fresnel's drag coefficient based on electromagnetic theory of light [4]. He assumed that ether, ponderable matter and electric charge (with opposite sign) permeate each other and that matter and charge are moving relative to stationary ether. Extremely small negative electrons are forced by the electromagnetic field of the light waves to oscillate at the same frequency disturbing thereby the propagation of light in the region with high electron density. In this way Lorentz received the same formula as Fresnel.

Finally, Laue noticed that the Taylor series of so called Einstein's velocity addition formula gives for small speed of moving medium the Fresnel's drag coefficient and he stated: "So, according to the relativity principle, light is completely carried by the body,…" [5]. This claim is untenable. Laue ignores completely the atomistic structure of matter. He presupposes that the matter is extremely homogeneous continuum. Laue's claim was few years later experimentally disproved by experiment of Harres [6]. According to Laue's "relativistic" explanation [5] Harres's experiment should show no effect because the light should be completely carried by the transparent body. Instead to accept the fact that his claim was wrong, Laue and Einstein continued to defend the pseudo theory Einstein's. New fiber optic experiments with linear motion of medium have confirmed Harres and disproved Laue and Einstein [7].

References

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