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Propagation Speed of Electromagnetic Waves as a Function of the Density of the Space

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Abstract

To define the speed of propagation of light, we need to consider the properties of the medium in which it propagates. This is in line with Maxwell's teaching, when Einstein made this velocity a Universal Constant independent of the propagation medium.

With this note we show that the speed of propagation of wavefronts depends on the density of the medium. However, the density of space varies according to the presence of stars which, according to Newton's law, exert an infinitely far-reaching force of attraction on the surrounding matter. This leads to a decrease in density as a function of distance from a celestial body.

Thus, in a previous *Note [7]* we showed that the density of space in the solar system allows us to calculate the age of our sun and we show here that this same density allows us to calculate the speed of light in our environment.

This also allows us to offer a solution to the Pioneer anomaly.

Keywords: Speed of Light, Maxwell's Laws, Einstein's Law, Refraction, Snell-Descartes' law, Viscosity, Navier-Stokes Law, Empty Space, Pioneer Anomaly.

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Intrdouction

The speed of light in a vacuum has thus been accepted as the greatest possible speed. But this speed was measured in our immediate environment and, by accepting the value found and making this speed a universal standard, physicists did not take into account the work of Maxwell, whose formula unequivocally shows that the speed of light depends on the properties of the medium in which it propagates. But let us also note that Maxwell does not define the cause of the propagative movement. His formula shows that this speed depends only on the electromagnetic properties of the radiation and those of the surrounding environment.

In this paper, we show that, according to Maxwell's statement, the speed of light depends on the properties of the medium and that in a completely empty space, the speed of light should be infinite. We also show that we have a way to check whether the speed of light varies with the properties of space by observing the Pioneer probes.

Current Theory of Propagation

Maxwell could only conceive of the propagation of light in two ways [2]:

1. Space is full of a certain medium (the ether) which is impacted by the transmitter and transmits the signal from one step to the next.
2. The waves carry something emanating from the source and propagate towards the receiver.

After studying all the suggestions made by the researchers of his time, he chose the first hypothesis: the waves interacted with the medium and therefore, he concluded that the speed of light is given by the formula:

$$c = \frac{1}{\sqrt{\varepsilon_0 \mu_0}} \qquad (1)$$

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where $\mu_x \approx \mu_0$ is the dielectric constant and μ_0, the magnetic permeability of space [3, 4]. Thus, according to this formula, he established that the speed of light depends solely on the properties of a medium whose substance he could not define, and which he named the ether.

Einstein's Properties of Space

Then Einstein said that space should be empty and that the anther does not exist. Thus, according to Einstein, space can only bend the path of light. But this property of space does not depend on its content, but only on a consequence of its geometric structure according to the theory of general relativity.

It is easy to show that the curvature of light rays is a consequence of refraction according to the Snell-Descartes law and to undermine Einstein's proposal, which, however, was confirmed with Eddington's observations in 1919. Indeed, according to these observations, the light rays of distant stars must have brushed the edge of the sun during this eclipse, which forced them to pass through the atmosphere of the star. Now, it is obvious that the density of this atmosphere cannot be zero. The pressure exerted by the sun's atmosphere at the level of the photosphere would be about 11000 terrestrial atmospheres (10^9Pa). And it is the **matter** of this atmosphere that has the properties defined by Maxwell and Descartes.

And it is also this material that has the property of bending the path of light. The above formula can only be correct if it takes into account the properties of the propagation medium and explains the curvature of the light path. Thus, it will be more consistent to write the above equation in the form:

$$c = \frac{1}{\sqrt{\varepsilon_x \mu_x}} \tag{2}$$

where the x-index refers to the content (or density) of the propagation medium.

According to Einstein, the critical density of the Universe is given by the formula [5]:

$$\rho_c = 3H^2 q/8\pi G \tag{3}$$

With $\boldsymbol{H}$, Hubble's constant of 60 km/sec/Mpsec, we obtain a density of $\boldsymbol{\rho = 10^{-26}}$ kg/m^3

We see that this formula does not explicitly refer to the material content of space. It only takes into account its consequence, which would result from the presuppositions generated by the theory of relativity. Because, for Einstein, space is empty, it contains nothing. The weight of galaxies and intergalactic gas is not taken into account. The factors in this formula apply only to its geometric properties and not to its material content.

Contents of the Space

Space is not empty. It contains hydrogen (atoms or molecules) that fill the entire space by expanding according to the ambient pressure. ***Space also contains all electromagnetic waves of all frequencies emitted by all stars and propagating in all directions of space***. Each wavefront, each beam of radiation contains a part of the electrical charge emitted and all these charges can be absorbed by the atoms of space. These interactions are indeed very slight, but they exist and we cannot neglect them. Maxwell did not neglect them, as we have just seen. But he did not know what they were, he just admitted the existence of a certain substance, *ether*, which interacts with electromagnetic waves, hence the value he attributed to the coefficients e and m.

Thus, we can easily understand that electromagnetic waves interact with the gas and radiation that fill space and that this interaction has a visible effect. This effect is refraction. It depends on the density of the medium according to the *Snell-Descartes law of refraction*.

Speed of Light According to Maxwell

The speed of light has been measured in our immediate environment and the values of the coefficients of Maxwell's formula are defined according to this measurement. Indeed, one of the factors (permeability **ε**) of Maxwell's equation above has been adjusted to allow us to find the value of this speed of light as it has been measured and is not the result of any experiment or measurement. Thus, these factors may have smaller values in spaces of lower density, and as a result, the speed of light in such spaces may be much greater. In an absolutely empty space, the factors $1\mu_0 v_2$ and μ_0 must be ***strictly equal to zero***, and therefore in such a medium, the speed of light will be infinite.

Because, unlike Einstein, Maxwell did not impose a limit on the speed of light. His equations are based on physical measurements of electrical phenomena under experimental conditions and he did not propose a method of calculating maximum velocity or even a law of a compelling nature.

Thus, when we calculate the distance of a star by means of optical or trigonometric measurements, and express this measurement in light-years, we cannot be sure that its light has traveled all that time to reach us

Moreover, it is obvious that Maxwell's equation is purely formal. It is based only on the dimensional consistency of the physical factors involved in the calculations of this speed. Moreover, as mentioned above, the factor m0 of the magnetic permeability of the vacuum is adjusted in an ad hoc way to allow a result in accordance with the observations.

Radiation Propagation Force

The driver of radiation propagation is an interaction between wavefronts.

Indeed, the wavefronts contain an electric charge and they repel each other according to Coulomb's law. It is remarkable that present-day physics has not yet admitted that the substance of wavefronts is the same as that of electrons, that these wavefronts emanate from electrons and are absorbed by them. This leads physicists to fantasies worthy of children's tales to describe the interactions between radiation and matter.

The distance between two wavefronts is wavelength l. A radiation is therefore made up of spherical and concentric wavefronts and has the emitting atom as its common center. This is how the same emission can be perceived in any direction of space. Each observer therefore receives a tiny part of the charge emitted. Suppose that q is the electric charge emitted over the entire wavefront, each surface element s will have a charge:

$$\epsilon = q\sigma/4\pi R^2 \quad (4)$$

where R is the distance traveled by the wavefront from the source. Two neighboring wavefronts therefore have the same electric charge density because the distance $(R+\lambda)-R$ is negligible after a journey of a few millimeters. Thus, the propagation force is:

$$f = \frac{\epsilon^2}{\varepsilon\lambda^2} \quad (5)$$

An expression wherein:
- ϵ is the charge of the wavefront
- ε is the Dielectric Constant
- λ is the wavelength of the radiation.

The Redshift

Radiation propagates by Coulomb repulsion. Each wavefront exerts pressure on the front emitted from an earlier period and is pressured by the inner front emitted after it. As long as the emission lasts, the thrust will be in the direction of the transmitter towards space. If the transmitter stops. The last wave front emitted remains in place. No longer pushed, the distance between the latter and the penultimate increases, the strength of interaction decreases but does not disappear. The interaction between all the wavefronts persists but decreases in intensity and the distance between each wavefront becomes greater and greater. This is redshift.

Propagation Medium

We assume that space is completely filled, that there is no empty space. Consequently, the atoms or molecules of hydrogen contained in space must have radii that can be calculated according to the formula:

$$r = \sqrt[3]{\frac{3M\mu}{4\pi\rho}} \quad (6)$$

Equation in which:
M is the atomic mass of the hydrogen molecule;
μ is the unit of atomic mass UMA;
ρ, the density of the medium.

In this calculation, we take into account the fact that a molecule does not occupy the volume of 2 atoms because, as we have shown elsewhere, the atoms pulse, and when one of the atoms is in the phase of maximum extension, the other atom of the molecule has a negligible volume [6].

The molecules are thus surrounded by the electric charge of the electron of one of the atoms and it is this charge that interacts with the radiation wavefront. It is obvious that the larger the radius of the molecule, the lower the charge density of the electron will be. The same is true for the charge density of the wavefront. It is inversely proportional to the square of the distance from the source as indicated by formula (3) above. Thus, the interaction of space molecules with wavefronts is always very weak.

Wave Front/space Molecule Interaction

We have just seen that the electric charge densities of wavefronts and molecules in space are very low and that, although of the same sign, they will not repel each other according to Coulomb's law. In fact, because these charges are small, each of them will tend to want to absorb the other in order to complete its own charge. However, the arrival of the next front will force the molecule to give up the charge absorbed previously. This game of absorption and rejection takes place at the frequency of the incident radiation. So much so that each edge immediately replaces the previous front without passing through the molecule, regardless of its radius. The arrival of the next wavefront instantly triggers the departure of the previous front. Thus, the radiation propagates in leaps of a constant duration regardless of the distance covered at each of its hops.

The speed of propagation of radiation is thus all the greater the greater the radius of the molecules in space, the lower the density of space.

Radiation Propagation Velocity

The radiation that concerns us is that of visible light. All visible stars emit these wavelengths of radiation and their atoms are therefore necessarily in the same physical conditions as those on the surface of the sun. But what interests us is not the physical conditions in which the emitting atoms are found but the physical conditions of the medium in which the radiation propagates. In a Note published in February 2022, I demonstrated that it was possible to calculate the age of the sun with a density of hydrogen in space close to 10^{-6} kg/m^3 [7].

The speed of propagation of radiation would therefore be the product of its frequency by the diameter of the molecules in the medium. Either:

$$v=2r\nu \quad (7)$$

The table below is based on this formula. It is only valid for molecular hydrogen. It would not be suitable for the atmosphere composed of gases of greater molecular weights.

Table 1: Velocity of visible light radiation as a function of the density of space.

densité	rayon	vitesse 1	vitesse2		densité	rayon	vitesse 1	vitesse2
Kg/m^3	m	m/s	m/s		Kg/m^3	m	m/s	m/s
1,00E-04	2,0E-08	2,66E+07	1,41E+07		1,00E-16	2,0E-04	2,66E+11	1,41E+11
1,00E-05	4,3E-08	5,74E+07	3,04E+07		1,00E-17	4,3E-04	5,74E+11	3,04E+11
1,00E-06	**9,3E-08**	**1,24E+08**	**6,55E+07**		1,00E-18	9,3E-04	1,24E+12	6,55E+11
1,00E-07	2,0E-07	2,66E+08	1,41E+08		1,00E-19	2,0E-03	2,66E+12	1,41E+12

1,00E-08	4,3E-07	5,74E+08	3,04E+08		1,00E-20	4,3E-03	5,74E+12	3,04E+12
1,00E-09	9,3E-07	1,24E+09	6,55E+08		1,00E-21	9,3E-03	1,24E+13	6,55E+12
1,00E-10	2,0E-06	2,66E+09	1,41E+09		1,00E-22	2,0E-02	2,66E+13	1,41E+13
1,00E-11	4,3E-06	5,74E+09	3,04E+09		1,00E-23	4,3E-02	5,74E+13	3,04E+13
1,00E-12	9,3E-06	1,24E+10	6,55E+09		1,00E-24	9,3E-02	1,24E+14	6,55E+13
1,00E-13	2,0E-05	2,66E+10	1,41E+10		1,00E-25	2,0E-01	2,66E+14	1,41E+14
1,00E-14	4,3E-05	5,74E+10	3,04E+10		1,00E-26	4,3E-01	5,74E+14	3,04E+14
1,00E-15	9,3E-05	1,24E+11	6,55E+10		1,00E-27	9,3E-01	1,24E+15	6,55E+14

Velocity 1 corresponds to the speed of red radiation of 850 nanometers,
velocity 2 is that of violet radiation of 450 nanometers.

We see that the speed obtained in a space with a density of 10^{-6} kg/m^3 is very close to the speed of light as it is currently accepted. The density of 10^{-6} kg/m^3 was obtained in the calculation of the age of the sun (Reference [7]). We do not have the concern of today's physicists to seek the precision of measurements (often to the tenth decimal place) but to understand and account for the phenomena observed. The results proposed here unequivocally support the observations of physicists and give them a theoretical justification, whereas this justification is often absent or erroneous in their publications.

Thus, we see that the speed of light, and of electromagnetic waves in general, varies both as a function of the frequency and the density of the medium through which it passes. Thus, this speed is not constant on a given route, it varies according to the density just as a motorist adapts his speed according to his position on the road network. This is how we see distant galaxies *almost* as they are today and not as they were billions of years ago.

The "Pioneer Anomaly"

It seems that we have a way to check whether the speed of light can vary with the variation of space conditions.

The *Pioneer anomaly or Pioneer effect* is the observed deviation from the predicted accelerations of the Pioneer 10 and Pioneer 11 spacecraft after they have traveled about 20 astronomical units ($3{,}10^9$ km) on their trajectories out of the solar system. Anderson and his team at *NASA's Jet Propulsion Laborator*y observed a mismatch between the frequency of the signal received from the probes and the frequency that this signal should have. So, they concluded that these probes were not where they were supposed to be, ***that they were slowing down***. A deceleration towards the Sun of $(8.74 \pm 1.33)\ 10^{-10}$ m/s^{-2}.

The signal from the probes is emitted at a known frequency. The controllers compare the frequency of the received signal with the frequency that this signal should have if the probes were moving at the calculated speed. Indeed, as they move further away, the probes, always subject to the attraction of the sun, slow down by a known value. The frequency of the signal they emit is constant but the frequency received decreases by the Doppler effect since they move away from the ground. As the signal shows a higher frequency (a blue shift) compared to the expected frequency, observers have concluded that the probes are not as far away as they had expected, that they are slowing down.

But another explanation is possible: as the distance of the probes increases, the density of space decreases. (Let's neglect the aerodynamic effects) and the ***speed of the signal to earth increases***. *Thus, the frequency of the signal reaching the observers is higher than expected*.

Note

We should note that, in current physics, the only occurrence of the speed of light as a function of the properties of the medium is Maxwell's law. Since the end of the 19th century, physicists have only been concerned with measuring this velocity in our space using geometric methods and without taking into account the interactions generated during the movement of radiation in the surrounding environment.

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3. The dielectric Constante: $8.854.10^{-12}$ A^{2}sec^4/kgm^3
4. The magnetic permeability μ $(\mu=4\pi\times10^{-7}kgmA^{-2}s^{-2})$ of matter.
5. H is the Hubble constant, the value of which depends on the speed of expansion (here we have taken 60 km/s per megaparsec), q is a factor depending on the type of universe: q<0 for a nearby universe, q=0 for a stable universe and q>0 for an open universe, G is the gravitational constant.
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