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A Theoretical Assay on the similarity of Light Refraction in a medium and the Compton Effect

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"Je pense donc je suis" Descartes 1637

Abstract

A further mathematical analysis of electromagnetic waves (EMWs) laws, namely the Planck law $E = h\nu$ and an authorless law $\lambda\nu = c$, reveals several issues in the interpretation of EMW refraction in a medium like glass, water etc. According to the current opinion, upon refraction EMWs keep their frequency before refraction. Such an interpretation overlooks many aspects of EMWs, and I am challenging it by stating that upon refraction the frequency of an EMW cannot stay as it was, it diminishes, and its wavelength becomes larger. This new opinion shows the similarity of EMWs refraction and the Compton effect and opens to new developments in physics such as new types of computers depending not on moving electrons but EMWs.

Keywords: Electromagnetic waves; Refraction

Introduction

The misleading representation of EMWs

In the new quantum mechanics era the Planck law $E = h\nu$ shows that the EMW energy depends on the frequency not the wavelength. Later Einstein came to the same conclusion for the interpretation of the photoelectric effect. Therefore, the current representation of EMWs in physics textbooks is an undulating line loose in the large wavelengths like the radio waves and very strained from the UV to the gamma EMWs. The line is continuous which is wrong since the frequency is represented by integrals numbers (1, 2, 3 etc). There is no EMW between the frequency of 1 Hz and the 2 Hz. In addition, the EMW law $\lambda\nu = c$ gives the wavelength. The combination of both information will show the frequency 1 Hz has a wavelength equal to c, the speed of light in vacuum 300000 km. So, the correct representation combining frequency and wavelength will show that EMW are *separate entities* made of one frequency and one wavelength like atoms are made of the combination of three particles (protons, neutrons and

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electrons). Therefore, there is quantization of wavelengths of EMWs. I demonstrated in a separate paper submitted to the Journal of Physics and Astronomy [1] that EMWs are quantized in a double way: the first because they are separate entities, the second their energy is governed by the Planck law $E = h\nu$.

This double quantization of EMWs will show us a peculiar aspect unique in the universe. The 1 Hz EMW has a wavelength of 300000 km, much bigger than planet earth, and represents the lowest energy (represented by the quantum of energy h introduced by Planck) in all electromagnetism field. The X and gamma rays carry a huge energy in a very small wavelength. This double (wavelength and frequency) representation of EMWs is more accurate and will have dramatic consequences for the interpretation of light refraction.

The Current understanding of EMWs Refraction in a medium

There is a general agreement on five statements concerning EMWs refraction [2-6].

- The Snell's law gives the refraction angle when an EMW passes from air to glass, or water or any other medium having a refractive superior to air refractive index.
- The EMW speed v in the new medium is smaller (according to the law $\lambda\nu = v$) than its speed c in the air and in vacuum.
- The EMW frequency remains the same in the new medium as it was in the air.
- The EMW wavelength in the medium is smaller than it was in the air.
- When the EMW exits from the medium to the air it recovers its speed c and its wavelength according to the law $\lambda\nu = c$.

It is my opinion that statements 3, 4 and 5 are not correct. I have two arguments to support my position. First: even there is slowing down of an EMW in glass or any other medium having a higher refractive index, the transition from the law $\lambda\nu = c$ to the law $\lambda\nu = v$ is *unacceptable*. The reason is that $\lambda\nu = c$ is quantized and $\lambda\nu = v$ is not quantized. The law $\lambda\nu = v$ is for water waves. For such waves the wavelength, speed and frequency are determined by the energy falling on the ocean. A raindrop cannot cause a tsunami because it lacks the necessary energy. A massive meteorite from outer space, like the one that killed the dinosaurs, can cause a tsunami. For radio EMWs, the wavelengths are large, the frequency low and the energy low. X and gamma rays carry a huge energy, a very small wavelength and very high frequency. In addition, Planck law $E = h\nu$ is valid for EMWs in the air, in water, in diamonds, and it is *not* dependent on refractive index at all. Planck law $E = h\nu$ is not valid for water waves. There is no Planck h constant for water waves. The great merit of Maxwell was to demonstrate that the speed of light is the same for all EMWs from the 1 Hz huge wave to the gamma rays. It was Einstein after the failure of Michelson-Morley experiment and his special relativity to demonstrate that EMWs can propagate in empty space. Water waves cannot propagate in empty space. It is tempting to say that EMWs are quantized because they can propagate in vacuum. Water, sound and seismic waves are not quantized because they need a medium to propagate.

What happens to EMWs during refraction

Saxena [4] went back to Maxwell equations and demonstrate that EMW λ is getting shorter upon refraction. It is the same thing as using the law $\lambda\nu = v$, in both cases it is returning-back to classical physics the era before quantum mechanics. Maxwell equations are linear and not appropriate for quantum events. The way of going forward mandates a *paradigm shift* based on a new hypothesis:

since the EMW frequency cannot increase as I will explain later, and since the EMW frequency cannot stay the same upon refraction, during refraction the EMW frequency will diminish and the λ becomes larger. Therefore, the EMW upon refraction loses energy and that will invalidate Spencer *et al* hypothesis that after refraction an EMW comes back as it was before refraction [5]. Let me explain.

The Consequences of Double Quantization of EMWs

Let′s have a simple EMW refraction in a glass prism like Newton did but this time with a blue color. Upon refraction in the first face of the prism, the blue EMW will lose energy because its frequency diminishes. After a short path in the prism the EMW with less energy will exit to the air and we may think that the frequency will increase because the air has a lower refractive index than glass. No, the double quantization of EMWs won't allow that. The peculiar aspect of EMWs is the reason: as we progress from the 1 Hz wave, the 2 Hz wave have a smaller λ 175 000 km, the 10 Hz wave has more energy but a λ of 30 000 km. As the frequency increases the energy becomes more concentrated and that is against the second law of thermodynamics. A hot cup of coffee at room temperature will become colder and never hotter. EMWs energy as all forms of energy in the universe is contained in space. There is no form of energy in infinite space. Therefore, there will be no physical phenomenon in the universe during which an EMW will have its frequency increases. This issue has never been addressed before because the quantization of waves of the EMWs was not considered. Once it is, then the blue EMW will lose energy again upon exiting from the second face of the prism and coming back to air in full disagreement with Spencer [5].

The Similarity of light refraction and the Compton effect

In the Compton effect an EMW releases some of its energy to an electron, its frequency decreases and its λ increases. The EMW will continue with the c speed. During refraction in a glass prism or any other medium an EMW slows down, its frequency diminishes, loses energy because of the medium refractive index. In the Compton effect and refraction there is bending of light.

Experimental Suggestions and old observations to support my view

Multiple prisms experiment

Since after refraction in a single glass prism as it is customary to do, an EWM 1 will lose energy after exiting the prism and becomes EMW2. Then EMW2 will refract in a second prism and becomes EMW3 lower energy than EMW3. After multiple prisms, their number will be determined experimentally; if EMW1 is blue then EMWn will be green, yellow, orange or even red. If EMW1 is in the Ultraviolet range with ionization power, then EMWn will be blue, green, yellow, orange, red and loses its ionization power.

Diamonds

They are multi-prisms by design. Rough stones coming from volcanic eruptions, they need treatment, namely cuting or faceting, until it was found that *prismatic cut* [7] generates the magic properties of diamonds. They have up to 58 facets in the crown and some 20 in the base. The most famous being the Hope Diamond [8]. Diamonds are devices designed to reflect and mostly refract light. Their refractive index (2.4) is higher than glass (1.3). Many of them have no color. Diamonds do not glow in the dark, they need light to generate light. About 30% of diamonds and especially the Hope Diamond [9], in the dark and after irradiation by UV lights they generate fluorescence from blue to red [9]. For the Hope diamonds the fluorescence intensity was stronger in the

crown facets than in the culet and table, suggesting that angle of illumination in large stones affect their phosphorescence [8]. This phenomenon did not have up today the proper understanding. The only hypothesis being that impurities inside the diamond can generate this fluorescence in the dark after UV irradiation. Well with refractive index 2.4 and multi-prism configuration in the crown and the base, the multiple refractions from one prism to another, that fits perfectly the results expected from the last paragraph namely Multiple prisms experiment. Matter of facts the UV irradiation of the Hope diamond causes the red fluorescence: the UV light with a frequency of 3.10^{15}Hz and a λ 100 nm, the red fluorescence has a frequency of 4.10^{14} Hz and a λ 700nm. As I said, after multiple refractions in the diamond, the frequency decreases and the wavelength increase because of the double quantization of EMWs. In addition, the red fluorescence in the dark won't stay much after the UV irradiation stops.

The double diamond experiment

Diamonds were exposed to X rays and the results were many times disappointing [10]. The reason was that upon X rays irradiation the fluorescence was looked for in the visible lights. I am here to say that after X rays irradiation, diamonds will have fluorescence in the UV lights. It is not known if the Hope diamonds were ever irradiated with X rays. So, the double diamond experiment needs two diamonds, one after the other. The expected results would be the first diamond irradiated with X rays will fluoresce in the UV lights and these UV lights will be used to irradiate the second diamond which will fluoresce in the visible light from blue to red.

The opals

These stones are composed of structures with different refractive indexes [11]. They also fluoresce after UV irradiation. So, the refraction of UV lights in these stones will generate many colors.

The future

The interpretation based on the decrease of EMWs frequency upon refraction in a different medium gives a real interpretation of the blue or red fluorescence of diamonds induced by UV irradiation. This *paradigm shift* is necessary and should be considered in the EMWs slowing down in different mediums and methods [12]. Slowing down EMWs in a medium will decrease its frequency. The yablonovite photonic crystal [13] with 3.6 as a refractive index is more impressive than diamonds, but diamonds need no hole drilling. It is possible that yablonovite shaped like diamonds may give more impressive results. And synthetic opals [14] with different refractive indexes layered in specific ways should be considered. At the end computers build and dependent not on moving electrons but photons cannot be made unless understanding that in the Compton effect as well in refraction in a medium EMWs lose energy by having its frequency decreasing and wavelength larger.

Conclusion

The quantization of EMW energy by Max Planck was a critical step after Maxwell equations and the beginning of quantum mechanics era. However, the wavelength of EMWs according to the law $\lambda v = c$ did not get an update to the quantum era. This imbalance allowed a flawed interpretation of EMW refraction that keeps the frequency as it was before refraction and improvising a wavelength from the law $\lambda v = v$. Therefore, the quantization of the wavelength of EMWs is a necessary step. A new interpretation of refraction states that upon refraction an EMW loses energy as it happens in the Compton effect because in both situations the frequency diminishes and the wavelength augments according to a quantized interpretation of the law $\lambda v = c$. This paradigm shift is necessary at least to understand how upon UV light irradiation diamonds release red light: after multiple refraction in the

prismatic diamonds there is a decrease of frequency and a larger wavelength. The possible coming of computers based not on moving electrons but on refraction of EMWs in future transistors is possible.

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