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A Proposed Experiment Regarding Photon's Existence

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Abstract.
The light is one of the most investigated phenomena. According to mainstream Physics, the light source emits a light quantum, then it does not care, what happens to the light later (let us call it photon or wave). In other words, the light source does not need a detector to emit the light.
The problem with this approach is, that the light cannot be detected "on the fly". If we observe a light quantum, we annihilate it at the same time. This fact encouraged some physicists to develop an alternate view: the light source and the (necessary) detector are in entanglement during the light emission-detection process. That is, light emission cannot occur without an available detector.
Because of the mentioned difficulties, it is almost impossible to decide between the two theories in a pure theoretical way. Therefore, we propose an experiment, which is based on the following assumption:
In order to emit a light quantum, the source must find a suitable detector, this may be a black plate, but a distant cloud too. If the detector is very far, it makes a little difficulty for the source to find it, this results in a delay in the characteristic of the light source. Therefore, by interrupting the light with a definite frequency causes a far-near order. If our assumption is true, this frequency can be noticed in the U-I characteristic of the light source. The final conclusion would be: the light emission and detection are not independent processes, but they form one single entanglement feature.

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I. Introduction

Light is a very strange phenomenon. On the pragmatic level, everyone knows, what light is. However, on the scientific level, if we try to study it more deeply and deeply, it seems more and more mysterious.

Much effort has been made to the discover the light's basic features. For a historical overview see e.g. Ogun's excellent presentation, with original sources. [1]. Today, despite of some debates, the majority of the scientists agree on these obvious attributes of light, as collected by J. Walker: [2]: (Only relevant ascertainments listed)

1. sometimes appears as corpuscles
2. sometimes appears as waves
.
.
9. wave & particle does not apply simultaneously to the same phenomenon (Bohr's complementary)
.
12. upon emission, light achieves /instant/ light speed (186000 mps).
.
19. has no mass
20. has a stable lifetime
.
24. mathematically appears as e=hv. The higher the frequency (v), the higher the energy.
.
27. In a double-slit experiment, the photon seems to go through both slits at the same time!

Most items in the above list are trivial facts, however, few of them have been subject of debates until today- We will list some of them, especially those which are in close connection with our present article.

- Ad 1. and 2. Both particles and waves are macroscopic objects, these can be observed while traveling. However, nobody has seen a traveling light wave [2,3,4] Therefore, it has no meaning to compare the two. For example, the present author proved in a previous paper, [5], that for the derivation of the Doppler effect one does not need to include light waves or photons.
- Ad 12. Mainstream Physics says, that light propagates *in vacuo* with constant speed. Some physicists contradict to this statement, stating that in vacuum there is no metric space, no time, therefore no speed too. We

agree with this view, namely the speed of light is not a "normal" velocity (displacement/time), but the expression of this opinion is beyond the scope of this article.

II. The Experiment

In the followings, we describe a feasible experiment, which possibly helps deciding the question: can light emission occur without detection? Or, a little more detailed: will the light emission hampered or retarded, if all possible detectors are very far?

2.1 Background

The light and its most common properties had been engrained in our mind. However, the scientists have always been interested to know its deep meaning: is it a piece of matter, a pure energy of something else? It is evident, that they compared the light to previously known objects and phenomena: pieces of stone, mechanical levers and others. The so called "particle" model was the main theory of the light for centuries, perfected by Newton.

However, some features of the light proved to contradict the particle model, first of all the diffraction and interference: the wave theory, symbolized by Huygens and followers.

The situation was the following: shall we accept the particle or the wave model of the light. Different theories arose, in chronological order. (Without source references)

- The light consists of particles
- The light consists of waves
- The light can be a particle, and wave, but not both at the same time
- Light can be a particle and wave, but the sum of "particleness" and 'waveness" cannot exceed unity. (Complementary principle [7])
- The complementary principle can be violated [8]

We do not want to interfere in this debate, namely when the light can be treated as a particle and when as a wave. As stated above, light is a quantum phenomenon, the straight comparison with macroscopic objects is unjustified. However, the Physics society agrees on two issues:

a. the light consists of quanta, thanks to Planck and Einstein. This is an undeniable fact.

b. the light emission and detection are two independent phenomena, emission can occur without detection. This statement is what we doubt, and to prove our opinion, we propose the experiment. However, because the experiment is performed in an indirect way, the result of our expectation cannot be 100%.

As said, nobody has seen a flying photon, therefore, a direct observation is impossible. Therefore, only a very careful, very indirect experiment can be performed.

Our idea is the following:

A light source needs a suitable detector, otherwise it cannot emit the light quantum (let us call it photon or wave). If a detector is in the vicinity of the source, it is easy for the source to find it. However, if the "nearest" source is located far, the source needs time to find it, maybe this fact can probably cause a delay in the driver characteristic of the light source. So, if the light path is interrupted periodically, the light source "feels" the difference between "remote" and "near" detectors. When the chopper frequency is high enough, the light source is unable to find a detector within the short time, thereby the light emission is blocked, or at least reduced. Of course, this light intensity difference cannot be measured, because of the separated detectors. However, the chopper frequency is hopefully reflected in the driver characteristic of the light source.

This measuring method is very indirect, but we do not see other, more representative ways to discover the source-detector connection.

2.2 The measuring equipment

As stated above, the measuring apparatus must contain the following device:

- a stable light source, with easy controllable driver characteristic (Current-voltage interrelation)
- a high frequency optical chopper
- a frequency generator
- an optical bench, with necessary accessories
- two light detectors: the near one is the chopper itself, the remote one is the sky, through an open window.
- a high-resolution amplifier, synchronized to the chopper frequency
- an indicating device (oscilloscope for AC, gauge for DC)
  Remark: when we say "detector", we mean on it any light-absorbing object, e. g. a chopper blade or an atmospheric particle.

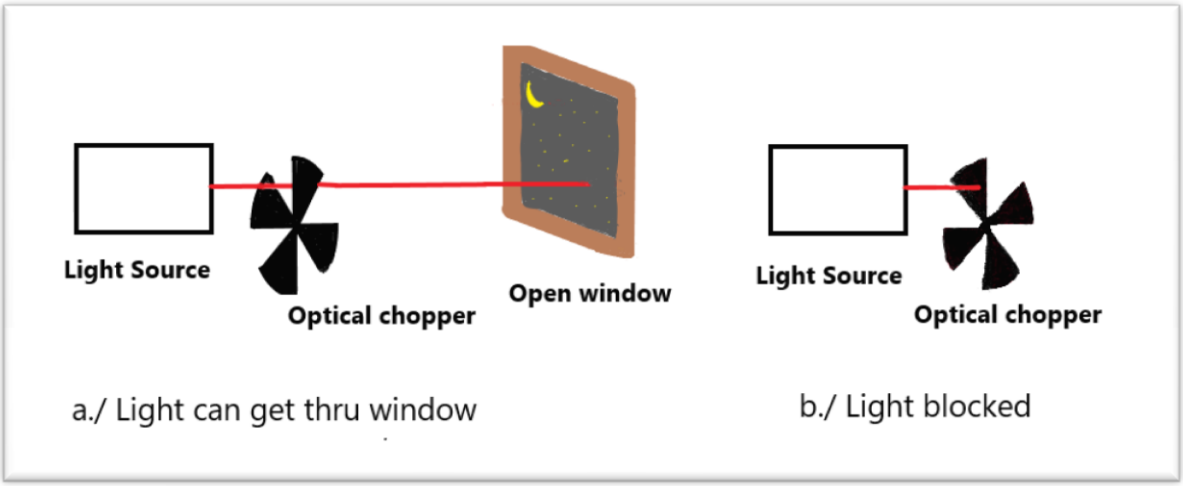

Fig. 1. Two cases are on the figure: In case a./ the chopper is open, the light can reach the sky thru an open window. In case b./ the light is blocked, therefore the light path is few cm.

Fig. 1 shows the two cases: near and remote detectors. If the chopper blocks the light, Fig 1.b./, the source-detector distance is few cm, so the delay is negligible. However, when the light gets through the open windows, the distance will be huge, maybe several hundred kms, therefore the delay can be in the μs or ms range.

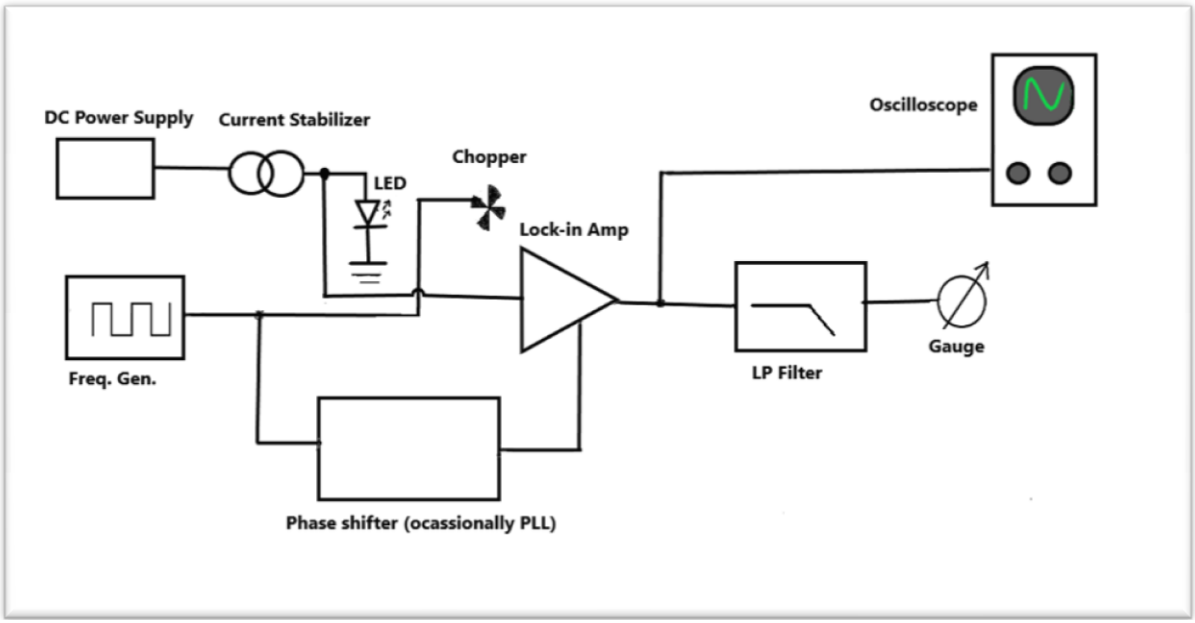

Fig. 2. shows a possible realization of the measuring equipment. It consists of commercially available parts.

On Fig, 2. we can see a possible realization of the measuring equipment. The light source can be preferably a red LED. It is easy to drive, highly efficient. The LED is driven with a constant current source, we expect the effect by the change of its forward voltage. This is the most obscure point in the whole process: so far we know, no one has tested the LED in this process, namely how the LED's U-I curve reacts to a light obstruction.

The equipment contains a variable frequency generator, with double function; on the one hand to drive the chopper, on the other hand to serve a reference signal to the lock-in amplifier (described below). The frequency must be variable, in order to find the best effect.

The chopper must be working at high rev/s, up to kHz range. The different high-speed chopper types are commercially available:

a. Mechanical rotating disks. The shaft speed is limited; therefore, the disk must have multiple segments or holes (up to few hundred) to achieve high interruption speed. The more holes we have, the more precise

optics we need. Moreover, the shaft frequency must be multiplied, in order to get a phase reference signal to the amplifier.

b. Optical choppers, practically Pockels cells. Here we have no frequency limit, but a high voltage supply is needed. Moreover, the efficiency is reduced by the polarization filter.

The detectable signal is probably weak and buried in noise, therefore we need a phase-sensitive (lock-in) amplifier. The reference signal is taken from the frequency generator. A said, incase of mechanical chopper, we also need a PLL (phase-locked-loop) frequency multiplier, corresponding to the number of the holes.

The measurement result can be detected by an oscilloscope, and a voltage meter (in DC) In order to inspect false signals, we can cover the light with a black surface, while the equipment is operating.

Disclaimer: the purpose of the experiment is to answer the question: can light emission exist without detection? If we get a positive result, we think that the question is answered. But the opposite is not true; if the experiment gives a negative result, it does not mean automatically that the light emission can happen without detection; we have seen that the measurement is conducted in a very indirect way, through the U-I characteristic of the LED. As far as we know, no one has tested this feature of the LED. So, if someone conducts the described experiment with a negative result, the author does not take any financial or scientific responsibility.

III. Conclusion

In this paper we proposed an experiment, which hopefully helps to understand the nature of light from a new point of view. The emission of light is commonly believed independently from the detection. However, according to our belief, it is possible that the light must reach a detector to be emitted. The experiment is not destructive, uses commercially available parts, but it is conducted in a very indirect way (no direct method exists), so the result agrees with the theory with a definite, lower than 100% probability.

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