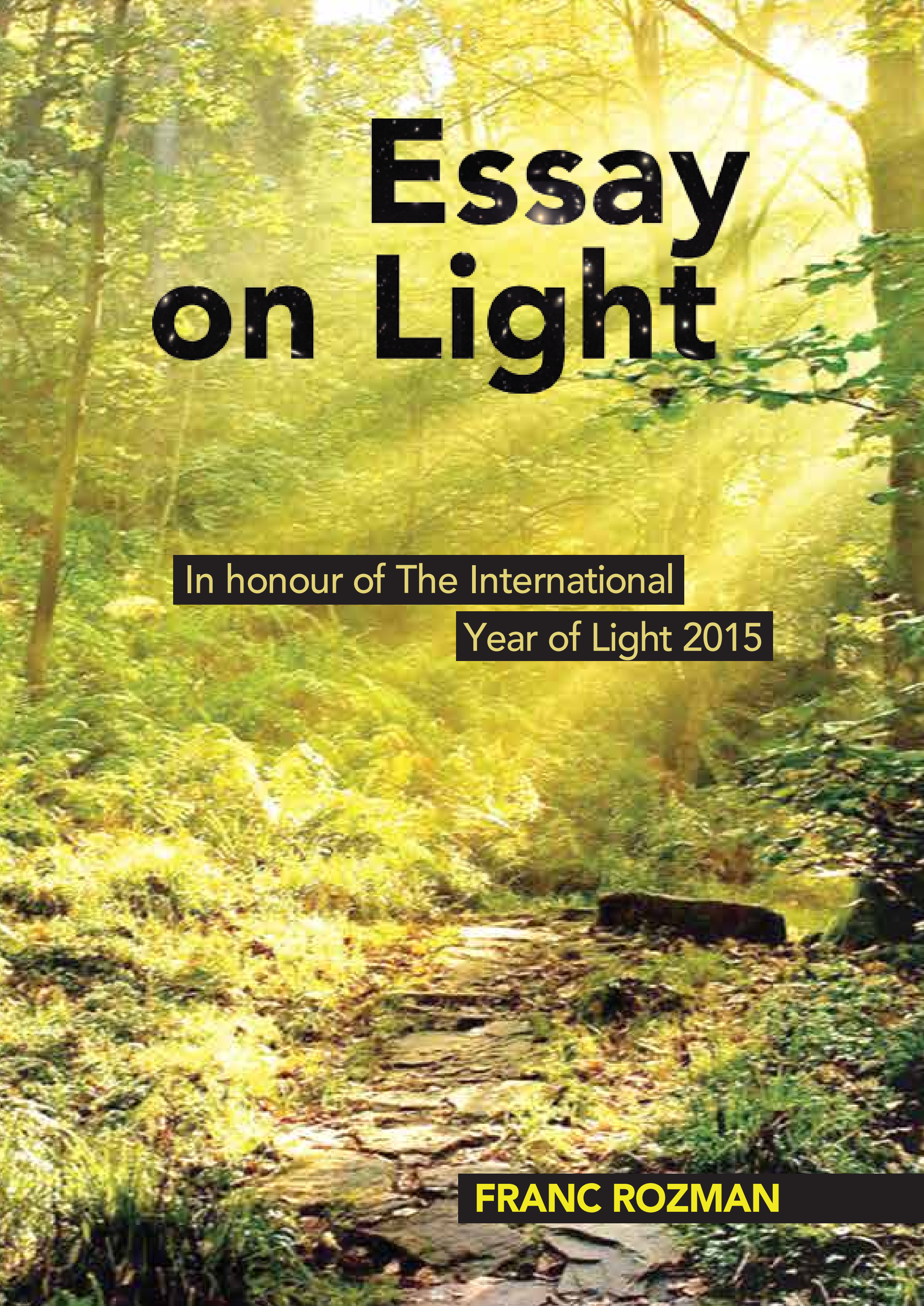

Essay on Light

In honour of The International Year of Light 2015

FRANC ROZMAN

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IN HONOUR OF THE INTERNATIONAL YEAR OF LIGHT 2015

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- Lighting Engineering 2015 conference in Predvor (Slovenia), October 2015

About the author

Franc Rozman (fr.rozman@gmail.com) graduated from the Faculty of Electrical Engineering, University of Ljubljana, Slovenia, 1973. He joined the research and development department in Iskratel, one of the most prestigious telecommunications corporations in Slovenia, where he was a leading software designer. He published a series of articles and pioneered a number of ideas, including the patent. He designed the software for learning languages, which was underpinned by artificial intelligence. In the meantime he examined the nature of physics and its relationship with philosophy. He published three books on physics and philosophy of nature in Slovene language. From the year 2010 the author investigates the physics as independent researcher.

Table of Contence

Essay on light consists of two autonomous topics. The first chapter describes the structure of light waves, while the second the measurements of the speed of light in different circumstances. The reader may decide to read one or the other chapter or the both of them in any order.

Introduction

The speed of light in vacuum between a stationary source and a sink is measured. The issue of the speed of light occurs in cases where a light source is approaching a sink, when light travels in the high gravity conditions or in the case of passage of light through a magnetic field. In these cases, the speed of light has not yet been measured.

Electric current in the power lines is measured on a base of optical fiber around the transmission line. The magnetic field generated by the electric current in the power line affects the speed of light in optical fibers, as is described in more detail in Figure 22.

Similarly, Canon contactless speedometer of the base (ground) is based on the measurement of the speed of light reflecting off a moving base.

In the technical devices we recognize various impacts on the speed of light, while theoretical physics chooses to disregard them.

Industry is not burdened with the views of theoretical physics. In interpreting measuring devices the interpreters of instruments usually relinquish the discussion on the speed of light. Thus, industry has no impact on the basic findings of physics.

Online forums generally promote debates on scientific disciplines by urging readers to ask question, which are followed by answers. However, things are different in case of the theory of relativity. Questions casting doubt on the theory of relativity are usually unwanted when it comes to online forums. Even if such issues do occur, forums escape a response by resorting to cant. As a result, readers of various forums are divided into those who believe that the theory of relativity knows all the answers to such questions, without even answering them, and the readers who have developed doubts about the credibility of the theory of relativity, due to the multitude of unanswered questions.

Without finding answers to the questions the theory of relativity relies more on trust than on facts. Discussions on the theory of relativity thus become emotional. The theory of relativity is therefore thrown into a spiral leading from science to dogmatic.

It is not enough for a scientific discipline to merely exist as a dogma of a few individuals. Its credibility is generated by confirmation in a wider circle. However, this is not possible without continuous validation on the basis of presenting convincing answers to questions.

The 2015 is the *International Year* of *Light* and *Light*-based *Technologies*. The purpose of this essay, therefore, is to shed light on the overlooked properties of light, as well as to serve as an incentive for the execution of the four measurements of light that will answer the question about the speed of light. Measurements of the overlooked properties of light represent the best way to honor the light in 2015.

Proposed new measurements:

Measurement 1 (p. 41)	The impact of the light source velocity on the diffraction of light at the diffraction grating.
Measurement 2 (p. 56)	The impact of the moving mirrors on the properties of the reflected light.
Measurement 3 (p. 64)	The measurement of the wavelength of the light emitted by the rapidly moving Li-ion.
Measurement 4 (p. 71)	The measurement of the speed of light from a comet.

Measurements are an objective answer to the question of the speed of light and the theory of relativity, which bear a few characteristics that could easily lead physics into a dead end.

The theory of relativity promises a slow aging, which is a prospect with great emotional charge, the perfect theme for the general public looking for immortality. The theory of relativity is hidden behind the veil of secrecy making it even more attractive and seductive, mystical even. Thus, articles about the theory of relativity stir up people‘s imagination.

According to the theory of relativity, space and time are curvilinear and draw their beginnings from the Big Bang, the creation of all matter. The philosophical direction called monism claims that matter is the center and the origin of everything. Advocates of monism welcome the thesis on the origins of time and space at the moment of the Big Bang. If the Big Bang had occurred based on some *a priori* mathematical and physical laws, the questions on the origin of these laws would have been left unanswered. The origin of these laws, which would represent the basis of the Big Bang, should be searched for in the sources from before the Big Bang. When an argument, such as the speed of light, is presented as a basic reality, it obtains the properties of an axiom, or even a dogma.

History teaches us that many cognitive leaps in physics were subject to objections. Even in the matter of the speed of light we can expect opposition to those measurements which would endanger and put into question the existing paradigm.

The speed of light is therefore more an issue of sociology than of physics. Further development of physics in this area could be attained by promoting debates on measurements of the speed of light, as proposed in this essay.

The step, leading from the conversations about the speed of light to its actual measurement, is just a small one. The technology of measuring the speed of light, for example from a moving source (comet) or in the magnetic field, is well-known and technologically undemanding.

The text of this essay is substantively complex, but deliberately written in a manner to allow its understanding by anyone with a secondary school knowledge of physics. Due to all simplifications, the focus is set on the verbal description of physical phenomena with only a few mathematical notes in the background.

The author

Structure of light waves

Light allows observation of the environment and helps us to orient in space. It shows us the structure of the Universe. The infrared light keeps us warm.

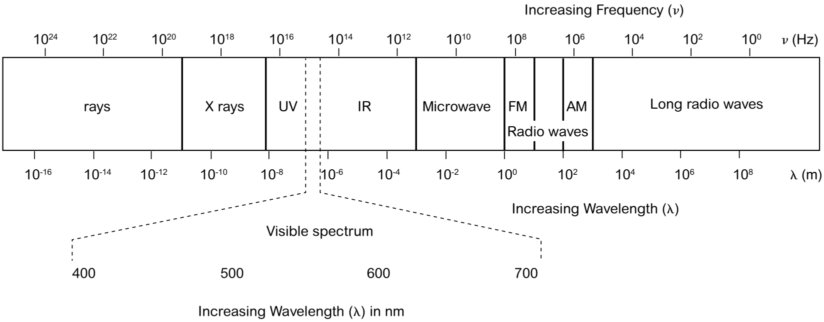

Figure 1 – The electromagnetic spectrum, the range of all possible frequencies of electromagnetic radiation

Light consists of electromagnetic (EM) waves, which include radio waves, X-rays, etc.

Electric and magnetic fields

Magnetic field attracts metal. Electric field attracts small particles, such as a comb, if it is rubbed with a dry cloth. Electric and magnetic fields may be interconnected in wave motion, which is called electromagnetic (EM) waves. Figure 1 shows the types of EM waves in relation to the wavelength.

Source of EM waves

EM radio waves are generated by alternating electrical current. Figure 2 shows a magnetic dipole or magnetic coil which is fed with alternating electric current. Sketches above the coil show the time development of the EM wave at the magnetic dipole.

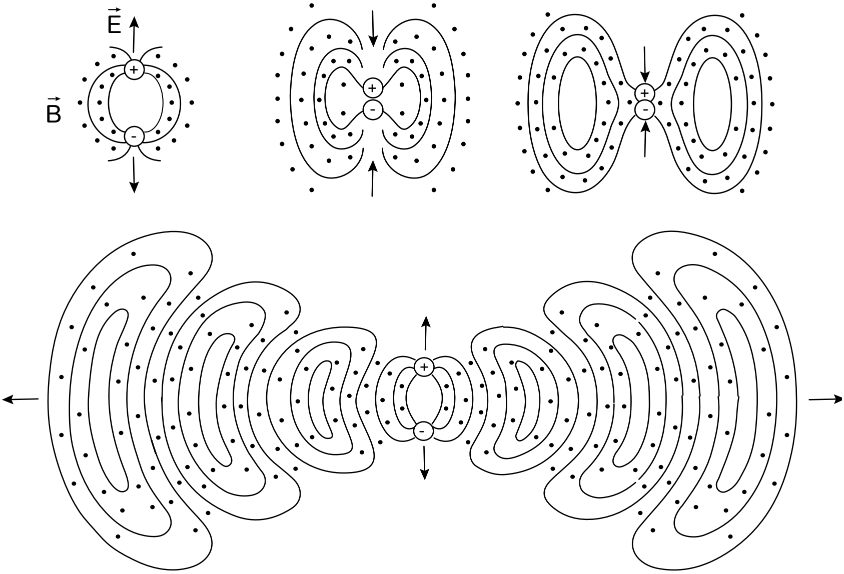

Figure 2 – Electromagnetic radiation from oscillating dipole.

EM waves are generally formed in different ways. EM light waves are generated, for example, by a lamp, laser light source, fire or a glowing spark, stars, and so forth.

The structure of an EM wave

I watch litter, which is swaying on a water wave. Litter does not travel with the wave. It is lifted and lowered vertically up and down by the water wave.

Just like litter changes its position or level, the electric and magnetic fields in an EM wave increase and decrease. The changing of an electric field at the observed point is denoted with **dE/dt**, while **dB/dt** designates how quickly a magnetic field is changing at a certain point.

During ascent and descent the litter is located at different angles of the water wave. Similarly, electric field in an EM wave creates electric field gradients so that there are different electric field strengths at various points, denoted by **Rot (E)**.

Designation **dE/dt** determines how rapidly the electric field is changing at the observed point, while **Rot (E)** determines the strength of the electric field around the observation point.

Interconnecting EM waves

Maxwell described the propagation of EM waves in a mathematical form[1]. In the scientific literature, an EM wave is usually displayed as shown in Figure 3.

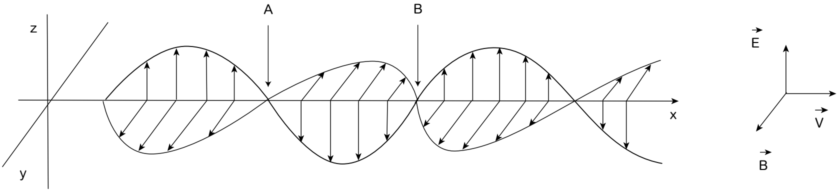

Figure 3 – The electromagnetic waves that compose electromagnetic radiation can be imagined as a self-propagating transverse oscillating wave of electric and magnetic fields. This diagram shows a plane linearly polarized EMR wave propagating from left to right. The electric field is in a vertical plane and the magnetic field in a horizontal plane.

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[1]
$$\nabla \cdot \mathbf{D} = \rho_V$$
$$\nabla \cdot \mathbf{B} = 0$$
$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t}$$
$$\nabla \times \mathbf{H} = \frac{\partial \mathbf{D}}{\partial t} + \mathbf{J}$$

At points A and B on the x-axis there are no electric and magnetic fields. Consequently, electric and magnetic fields at points A and B can not combine the half-waves of EM waves in the linked chain of EM waves, as they do not exist.

During their travel EM waves hit certain obstacles. Each obstacle is more or less trying to redirect EM waves with the use of force. EM waves resist these forces by interconnecting. Links between EM waves protect the chains of EM waves from disintegration.

Displacement current

The manner of the interconnecting of EM waves in a coherent chain is described by the fourth Maxwell's equation which states that Rot (B) equals dE/dt. Rot (B) or the derivative of the electric field according to time creates a displacement current.

Displacement current[2] was introduced by Maxwell in 1860. It is a current that is not the result of an electrical charge travel. Displacement current is generated by changes in the electric and magnetic fields.

Displacement current is strongest at points A and B in Figure 3, where there are no electric and magnetic fields, nevertheless, there are the greatest changes of the electric and magnetic fields.

Maxwell's equations indicate that the voltage set by Rot (E) also occurs along the path of a displacement current. Rot (E) shows how an electric field is changing in space, from point to point. The change of the electric field in the observation distance, i.e. on the path of the displacement current, represents the electric voltage. Electric current in the presence of electric voltage is a form of energy.

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[2] Certain aspects of the fourth Maxwell's equation – Anton R. Sinigoj

The energy of the displacement current varies along the x-axis. Where the electric and magnetic fields are at their greatest, there is no displacement current. In the nodes of EM waves, i.e. at points A and B in Figure 3, we have the maximum displacement current at the maximum voltage and thus the maximum energy of the displacement current.

Displacement current energy in waves' nodes creates forces for the integration of EM waves in a coherent chain of EM waves. In the case of EM waves we can observe streaming between the energy of the electric and magnetic fields and displacement current energy, as shown in Figure 4.

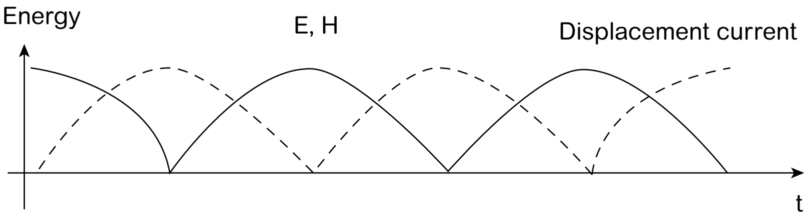

Figure 4 – EM waves constitute a continuous streaming of energy of electric and magnetic fields (E, B) into the energy of the displacement current, and vice versa.

The dwindling (sinking) of electric and magnetic fields creates displacement current in their neighborhood. Even the displacement current is not stable and begins to collapse at the next moment. The collapse of displacement current at the third location again starts to generate electric and magnetic fields. EM waves constitute a continuous streaming of energy of electric and magnetic fields (E, B) into the energy of the displacement current, and vice versa.

Fields E and H drawn in Figure 4 are the cosine functions. The energy of their fields is the vector product of E x H. Displacement current varies according to the sine function, while the energy of the displacement current is proportional to the squared displacement current.

Quantum of light

EM light waves tend towards quantum energy values determined by quantum laws. In physics, the minimum energy values of EM light waves are called photons. Planck measured the energy of a photon (a particle of light) by ejecting electrons from the atomic shells through light. He measured that the ejection of the electron is affected only by the frequency of light and not by the brightness of the beam.

He first used a light frequency on the atom, which did not eject the electron from the atomic shell. Then, he increased the brightness of the beam, but did not change the frequency of the light. Light did not eject the electron from the atomic shell, despite the increased brightness. An electron was ejected from the atomic shell only by increasing the frequency of the light.

Light is equally successful in ejecting electrons from the atomic shell, regardless if it originates from Earth or far away in space. Even more, if a certain chain of photons on a semipermeable mirror is split in two, we note that part of the photons with undisturbed energy is reflected in one direction and another part in the opposite direction.

Energy of an EM wave

Let us compare the energy of a photon with the energy of an EM wave. The Domžale medium-wave transmitter is transmitting power in the class of 100 kW at a frequency of approximately 1 MHz Transmitter transmits a million EM waves per second, which means that the energy of one EM wave is in the class of 0,1 joules. According to the Planck's law $\mathbf{W = h \cdot f}$, the energy of a photon at a frequency of 1 MHz equals $6{,}6 \cdot 10^{-34} \cdot 10^{6} = 6{,}6 \cdot 10^{-28}$ joules. One EM wave of the Domžale transmitter therefore contains 10^{27} photons.

Photons in an EM wave do not collaborate in ejecting an electron. If you throw a stone in the glass, this would demand the participation of all the stone‘s molecules and their joint mass. On the other hand, when light strikes an electron the photons operate in an uncoordinated way. If a certain photon can‘t eject an electron from the atomic shell, the neighboring photons do not join in this endeavour.

Photons with high frequencies

The photon of visible light is capable to eject an electron from the outer atomic shell of certain elements. Visible light has a frequency in the class of 10^{15} Hz. In nature we can detect higher frequencies of EM waves, reaching over 10^{20} Hz. According to the Planck‘s law, photons with high frequencies should have a million times greater energy than photons of visible light.

These high energies would eject electrons even from the lower atomic shells. After ejection the electrons would return to the emptied atomic shells, while at the same time emitting photons. If the EM waves with high frequencies, and according to Planck also with high energy, would shine on matter, the latter would glow. For example, if a person would be illuminated by X-rays, that part of the body would glow, however that does not happen.

Planck‘s law therefore dose not determine the energy of a photon in the entire frequency range. In the field of high frequency Planck‘s law is not confirmed by measurements. Thus, we need to deepen the research into the properties of photons.

Electron in the vastness of an EM wave

Let us compare the size class of an electron with the size class of an EM light wave. The wavelength of the EM wave of visible light falls in the size range of 10^{-6} m. The electron[3] size is less than 10^{-12} m. The EM wave of visible light is therefore very large compared with the electron.

The EM light wave and the electron generate their own electric and magnetic fields. At the overflight of an electron through an EM wave their fields influence each other. Electron is small, therefore its field only disrupts the very small part of the electric and magnetic fields of the EM wave. The Domžale transmitter‘s radio waves exert a powerful energy, but only act upon an electron with a weak thrust of force, as only a tiny fraction of the energy of an EM wave comes in contact with the electron.

Also stationary electric and magnetic fields transfer nonsignificant energy to an electron in atomic shell. Stationary electric and magnetic fields thus have negligible influence on the ejection of electrons from the atomic shell. The ejection of electron from atomic shell has not been recognized in condition where the atom occurs in stationary electric or magnetic field. Electrons get plentiful energy from the EM wave displacement current that is Rot E and dB/dt.

Atom occupies an insignificant fraction of the volume of an EM wave. By the other hand EM waves are randomly met with electrons on many different geometric situations. Consequently, the EM wave on the electron impacts with a random trust of force in a random direction of force. As a result, only a few geometric situations of their meetings are able to eject out an electron from the atomic shell.

EM wave displacement current dB/dt depends on a magnetic field density amplitude (B) and an EM wave angular velocity. The magnetic density of EM wave oscillates as $b = B \cdot \sin(\omega t)$. The derivative of sine functions at small angles is equal to the angle derivative according to time, $d(\sin(\omega t))/dt = d(\omega t)/dt = \omega$. When ejecting the electron from the atomic shell, the EM wave, therefore, impacts the electron with the energy of $W = k \cdot B \cdot \omega$. The constant k is determined by the form of an atom, the electron charge and its binding energy, whereas B is the amplitude of the magnetic density of the EM wave and ω the angular velocity of the EM wave.

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[3] David L. Bergman: *Shape & Size of Electron, Proton & Neutron*, May 2004.

The quantum amplitude of the magnetic density of EM waves

The equation $W = k \cdot B \cdot \omega$ represents another form of the Planck's equation, which states $W = f \cdot h$. Pertaining to the equation $W = k \cdot B \cdot \omega$, if we unite $2 \cdot \pi \cdot k \cdot B$ with the Planck's constant h, the equations obtain the same form.

Connection of equations is only possible in the case where the amplitude of the magnetic density of the EM waves is constant for all frequencies, as shown in Figure 5.

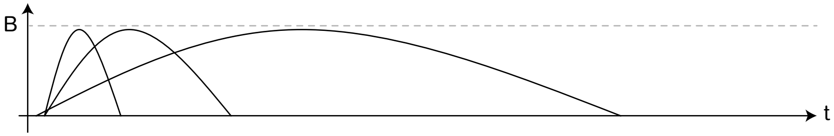


Figure 5 – The quantum amplitude of the magnetic density of EM waves

On the basis of the Planck's law we realize that the amplitude of the magnetic density of EM waves in the case of non-forced-energy EM waves tends toward a set amplitude of the magnetic density of EM waves, equal for all frequencies. This, amplitude of the magnetic density of non-forced-energy EM waves is equal in all conditions and deserves to have a name. We shall call it *quantum amplitude of the magnetic density of EM waves*.

Photon

There is a difference in the understanding of equations $W = f \cdot h$ and $W = k \cdot B \cdot \omega$. In the Planck's equation the energy of a photon is understood as the smallest particle of light. The equation concerns only the light and not the characteristics of an electron. In the equation $E = k \cdot B \cdot \omega$, however, the concept of energy is not exclusively tied to the properties of light. B and ω are bound to the properties of light, while k determines the material properties of an electron, i.e. its charge, the form of the circumference in the atom and its binding energy.

Forced EM waves

The amplitude of the magnetic density of EM waves, which is equal at all frequencies, applies to the energy-balanced waves. Each wave may also include imposed, energy-enriched or energy-depleted states. In the case of the energy-enriched or energy-depleted waves, the amplitude of the magnetic density of EM waves may be greater or smaller than the quantum amplitude of the magnetic density of EM waves.

The radiation from a light source

The example of an EM light wave which exceeds the quantum magnetic density at the source, is represented by the radiation of strong light sources, such as the Sun. In this case, the magnetic density at the source may highly exceed the quantum amplitude of the magnetic density. After radiation, the magnetic density gradually decreases and changes to waves with balanced energy values, as shown in Figure 6.

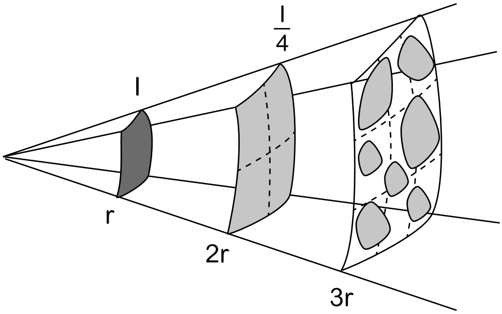


Figure 6 – When the magnetic density of the EM wave reaches the quantum value, its surface area no longer increases. The EM wave is randomly torn into individual and autonomous EM patches of the EM field, subsequently preserving their sizes and energy along the way.

At its source, an EM wave may have a greater amplitude of the magnetic density than its balanced or quantum value.

With its distance from the source an EM wave receives a growing surface area, as shown in Figures 2 and 6. This reduces the EM wave energy per surface area, as well as the magnetic density. When the magnetic density of the EM wave reaches the quantum value, its surface area no longer increases. As shown by the last EM wave, positioned on the right side in Figure 6, the EM wave is randomly torn into individual and autonomous EM patches of the EM field, subsequently preserving their sizes and energy along the way.

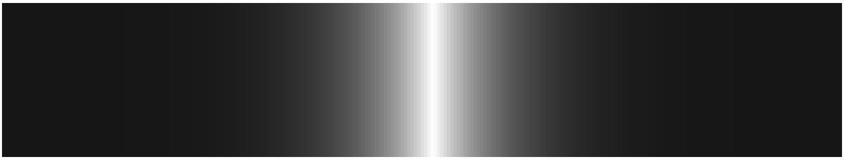


Figure 7 – Preservation of the geometric size of an EM wave is confirmed by the experiment carried out by Thomas Young. The experiment shows that the EM wave traveling through space does not change its spatial form.

Preservation of the geometric size of an EM wave is confirmed by the experiment carried out by Thomas Young at the beginning of the 19th century. The experiment shows that the EM wave traveling through space does not change its spatial form. An EM wave travels through space like a spatially rounded energy formation. When Young let the light through a narrow vertical slit, he noticed a narrow beam of light on the screen behind the slot. This is shown in Figure 7. The EM wave has a size and shape corresponding to the energy, similarly as a substantial particle.

Energy reconstruction of EM waves

On its way, light hits dust particles or other barriers that deplete the energy of EM waves. Such energy depletion results in the reduction of the EM wave surface area shown in Figure 6. Quantum laws of the light wave ensure the preservation of the quantum amplitude of the magnetic density of EM waves at the expense of surface area reduction of the EM wave.

Figure 8 shows the surface area reduction of the EM wave. The surface area of the disk represents the size of the EM wave. The thickness of the disc in this case symbolically represents the amplitude of the magnetic density in the EM wave.

EM wave is losing energy by reducing its size, while the amplitude of the wave‘s magnetic density is maintained. Such an EM wave thus maintains intact the ability of ejecting an electron from the electronic shell. In this case, the concept of the photon as a quantum of light is not even needed, as the size of the EM wave may be decreasing continuously, while at the same time always creating the same effect with its constant magnetic density in ejecting an electron from the atomic shell.

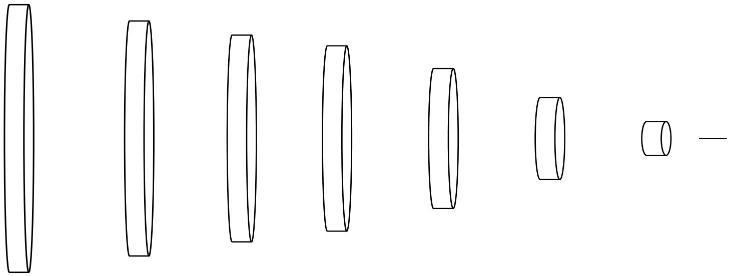


Figure 8 – The surface area of the disk represents the size of the EM wave. The thickness of the disc in this case symbolically represents the amplitude of the magnetic density in the EM wave. EM wave is losing energy by reducing its surface area, while the amplitude of the wave’s magnetic density is maintained.

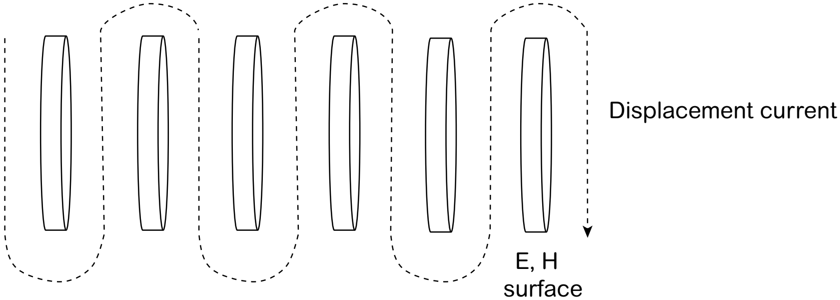
EM wave is experiencing a depletion of energy in many places. At the bottom of the oceans there is no light. EM wave loses its energy by penetrating through the aqueous layer. The loss occurs as the EM wave reduces its surface area (size). However, the always equal quantum amplitude of the magnetic density does not change until the EM wave energy weakens to the extent of simply disappearing, as shown in Figure 8.

EM waves may also be subjected to energy depletion in high gravity environments. When a light wave is trying to leave a celestial body, the gravitational force impedes the EM wave in its raising from gravity. EM wave overcomes gravity with the force along the way, whereby losing its energy. EM wave fails to escape from a black hole, spending all its energy while trying to raise itself from gravity, before leaving a black hole.

Nevertheless, when we look at EM waves which manage to leave the celestial bodies with big gravity, we do not see a reduction in the quantum amplitude of the magnetic density of EM waves. The stability of the magnetic density of EM waves could be attributed to the size reduction of EM waves due to the raising from gravity.

Quantum phenomena

What creates always the same amplitude of the magnetic density of EM waves and thus the quantum properties of light? If we combine Figures 4 and 6 and draw them in the form of Figure 9, the discs in Figure 9 show the EM field moving from left to right. Between the EM fields flows the displacement current.



Figuge 9 – A displacement current moves around electric and magnetic fields. According to the principle of minimum energy, the electric and magnetic fields try to maximize their dilation in space. The displacement current also tends toward minimizing the energy by trying to shorten its curved path. Form of EM waves is a compromise between the attempt of extending electric and magnetic fields in space and the tendency of displacement current to round the electric and magnetic fields in the smallest possible space.

Induction and Kirchhoff's law state that at the edge of an EM field a displacement current moves around electric and magnetic fields and continue its way on the other side of the EM field.

According to the principle of minimum energy, the electric and magnetic fields try to maximize their dilation in space and thereby reduce the magnetic density and strength of the electric field, similarly as liquid is spilled over level surface.

The displacement current also tends toward minimizing the energy by trying to shorten its curved path. A shorter route of the displacement current represents lesser energy. Consequently, the displacement current is restricting the dissemination of electric and magnetic fields.

Form of EM waves is a compromise between the attempt of extending electric and magnetic fields in space and the tendency of displacement current to round the electric and magnetic fields in the smallest possible space. Material constants determine the optimum at a certain amplitude of magnetic density, which is the same for all wavelengths of light.

Quantum physics is often presented as something difficult to understand, close to mysticism, although the quantum physics of EM waves is only about nature's tendency towards minimizing the energy state of electric and magnetic fields, and displacement current, as shown in Figure 9. Similar modes of quantization formation can also be expected in nuclear physics.

Coherence of light

As a rule, two EM waves imperceptibly pass through each other when colliding. However, there are examples of collisions where the electrical and magnetic field of an EM wave intertwine in such a way that the fields affect each other.

Intermodulation in optical fiber

When we guide light of one wavelength into an optical fiber, it arrives to the exit of the fiber without distortion. However, if we feed two similar wavelengths of light in an optical fiber, at the output we obtain, in addition to the basic two wavelengths, several newly formed wavelengths of light that are distanced from the basic wavelengths by the difference between the basic wavelengths Δλ, due to nonlinear distortion and intermodulation, as seen in Figure 10.

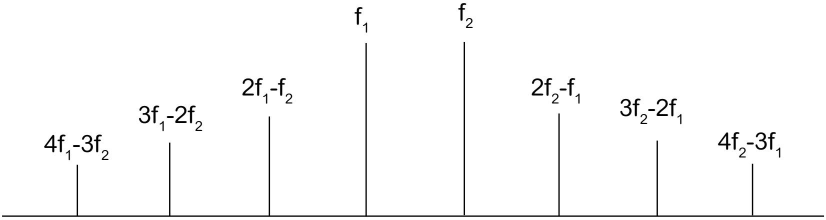


Figure 10 – Intermodulation in optical fiber; when we guide two similar wavelengths of light in an optical fiber, at the output we obtain several newly formed wavelengths of light that are distanced from the basic wavelengths by the difference between the basic wavelengths Δλ.

Nonlinear distortion is not the result of electrostriction, as reported by some authors. Above all, because electrostriction would cause nonlinear distortion in the case of a single wavelength of light. On the other hand, electrostriction can not explain why the newly created wavelengths are spaced apart by exactly Δλ.

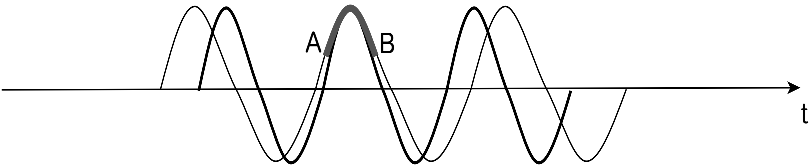


Figure 11 – EM waves of similar wavelengths exert similar phases in the AB segment. Equalized phases do not permit the two EM waves to maintain their own properties. The properties of the both EM waves are so overlapped and similar that the two EM waves in the AB segment blend into each other, forming a single EM wave.

The basic frequencies of light are shown on the time axis in Figure 11. EM waves are of similar wavelengths and also exert similar phases in the AB segment. Equalized phases do not permit the two EM waves to maintain their own electric field strengths, magnetic density and particularly displacement current in the AB segment. The properties of the both EM waves are so overlapped and similar that the two EM waves blend into each other, forming a single EM wave. Thus, they create coherence between the both waves.

EM waves are coherently linked only on the AB segment of their path, where there is sufficient match of their phases. Beams travel the remaining part of the path in the optic fiber autonomously, individually.

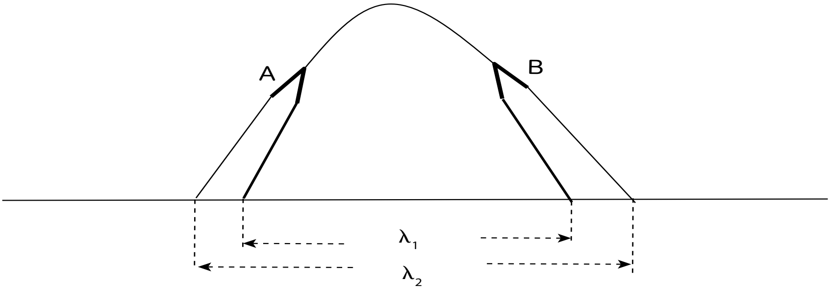


Figure 12 – At the time of their phase alignment, at points A and B, due to the establishment of their coherence, a distorted shape of the two EM waves appears. Nonlinear distortion of EM waves in the optical fiber creates new wavelengths.

At the time of their phase alignment, especially at points A and B in Figure 12, due to the establishment of their coherence, a distorted shape of the two EM waves appears. Nonlinear distortion of EM waves in the optical fiber creates new wavelengths, as shown in Figure 10.

In the optic fiber the newly created wavelengths are increasingly reinforced and coherently connected along their path. A way of strengthening the lateral EM waves is described and shown later in Figure 15.

Coherent connections are formed particularly among those newly formed wavelengths of light where there is a whole number of wavelengths between the successive AB nodes of basic frequencies in Figure 11. This explains the spacing between newly formed wavelengths in ranges of multiples of the differences between the basic wavelengths of $\Delta\lambda$.

The measurement of the length of a coherent chain of EM waves

When there is an oil slick on a wet surface, light is reflected in the form of a coloured rainbow. The reflection of light occurs both at the top, as well as on the bottom side of the oil film. When the thickness of the layer of oil is a multiple of the wavelength of light, both coherent reflections meet and coherently connect at the upper layer of the oil slick, which reinforces a particular wavelength of light.

The reflection of light on the oil slick enables the measuring of the length of a coherent chain of EM waves. By increasing the thickness of the oil layer, the intensity of the rainbow reflection decreases. Coherent chains of EM waves are becoming too short to enable the meeting of the beginning and the end of a coherent chain of the same wave on top of the oil slick. The thickness of the oil layer, which still enables the observation of modest remains of iridescent reflection, represents the half of the length of the longest coherent EM waves that are incident on the oil layer.

Measuring the diameter of an EM wave

An EM light wave has a greater or smaller surface area, as shown in Figures 6 and 8. The surface area of an EM wave may be measured by Young‘s double-slit experiment. The diagram of the measurement is shown in Figure 13.

Let us shine a light at the screen with two parallel slits.

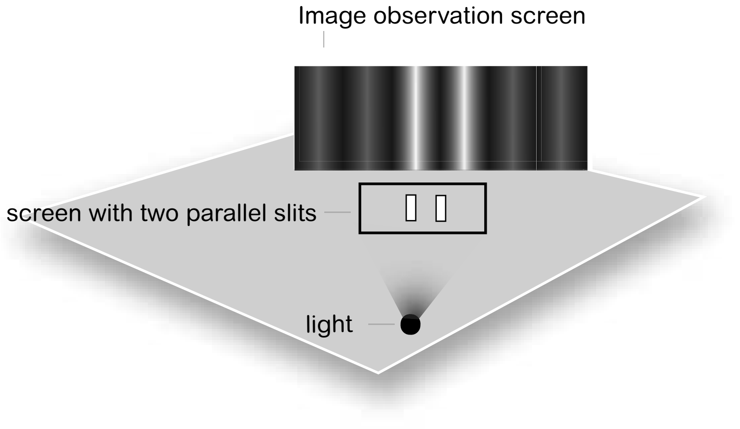


Figure 13 – The surface area of an EM wave may be measured by Young's double-slit experiment.

When Young enabled light to concurrently travel through both slits, he noticed the lateral spots on the screen, in addition to the two main spots, as shown in Figure 13.

Source of lateral spots

EM waves travel through the slit in a more or less obstructed way, they more or less brush up against the edge of the slit. At the edge of the slit they get more or less shattered.

When an EM wave brushes up against the edge of the slit, it can get broken into several smaller waves at the impact that is to say into waves with less energy, which fly in different directions from the slit. Despite the hitting of EM waves into the edge of the slit, the basic beam, at the appropriate size of the slit, still maintains its bright energy, as shown in Figure 13.

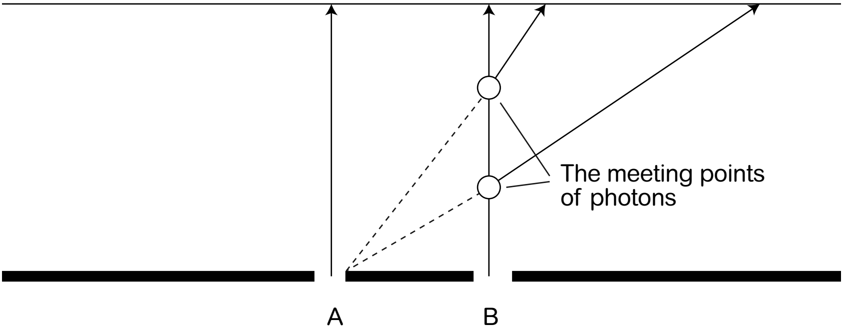


Figure 14 – Energy-depleted EM waves of the first slit pass through the energy-rich EM waves of the second slit. EM waves move through one another. At the intersections of EM waves a coherent integration and mutual exchange of energy occurs. The energy of the energy-depleted chains of EM waves from the slit A is strengthened, while the energy-rich chains of EM waves from the slit B lose a part of their energy.

Energy-depleted EM waves of the first slit, marked with dashed lines in Figure 14, pass through the energy-rich EM waves of the second slit, through the beam B. EM waves move through one another. At the intersections of EM waves a coherent integration and mutual exchange of energy occurs. The energy of the energy-depleted chains of EM waves from the slit A is strengthened, while the energy-rich chains of EM waves from the slit B lose a part of their energy.

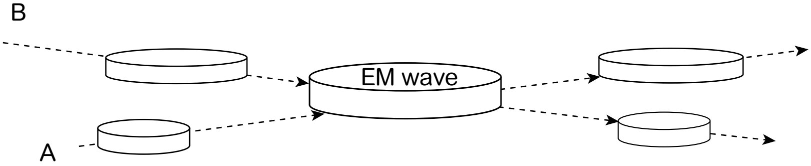


Figure 15 – EM waves move through one another. At the intersections of EM waves a coherent integration and mutual exchange of energy occurs. The energy of the energy-depleted chains of EM waves from the slit A is strengthened, while the energy-rich chains of EM waves from the slit B lose a part of their energy.

Figure 15 shows the smaller EM wave, when comparing its energy and surface area, resulting from the slit A, and the larger EM wave, regarding its energy and surface area, of the slit B. Their meeting is converted, on the basis of coherent integration, into an EM wave with stronger energy and larger surface area, depicted in the middle of the image. The meeting also generates turbulence and distortion of EM waves. In comparison, we could imagine the collision of two galaxies. When two sufficiently harmonized EM waves meet, coherent force unites these two waves into a joint and connected EM wave. In the case of a small coherence of both EM waves, for example when the angle of incidence between the EM waves is too high, the turbulence again splits the EM wave into two waves, as shown in Figure 15. In doing so, it is not necessary to maintain the energy of one or the second wave in a given direction. One EM wave can be enhanced at the expense of the other.

The exchange of energy is occurring between the EM waves with matching phases

The lines on the screen during Young‘s measurement show that the EM waves from the slit A are strengthened at the expense of the energy of the beam B. The side lines in Figure 13 show that EM waves only create coherent links and exchange energy upon their impact when phases of one or the other wave are coherent enough.

The energy exchange between light beams A and B is not only indicated by the side lines but also by the reduced energy of the basic beam B. The measurements suggest energy depletion of the beam B when it faces the energy-weak EM waves from the A slit.

Young’s experiment allows the measurement of EM waves surface area

EM waves behind the slit can interfere in the form of bars shown in Figure 13 only in the case where the EM wave is wide enough to be simultaneously incident on both slits.

In the experiment by Thomas Young both slits must therefore be close enough to one another, for one part of the EM wave to pass through one slit and the other part of the same EM wave through the other slit. Only EM waves that are phase coherent at the entrance are united in the form of bars shown on the other side of the slot.

When the slits are too widely spaced, more than is the width of the EM wave, they can not be encompassed by the same EM wave. In such cases we do not see the typical interference which is shown in Figure 13.

Therefore, the Young‘s experiment offers the possibility of measuring the width of the EM waves. The greater the distance between the slits, the fewer the EM waves captured by the one or the other slit, and the less visible are the side lines. The distance between the slits that still enables us to see the faint outlines of the side lines represents the maximum width of the observed EM waves.

On the oil slick, we can measure the length of a coherent chain of EM waves, while with the Young‘s experiment we can measure the diameter and thus the surface area of the EM waves in a coherent chain. In this manner, we are measuring the size of the coherent EM light waves traveling in a package. With the concept of a *coherent EM wave* a chain of interconnected EM waves is denoted, as shown in Figure 16.

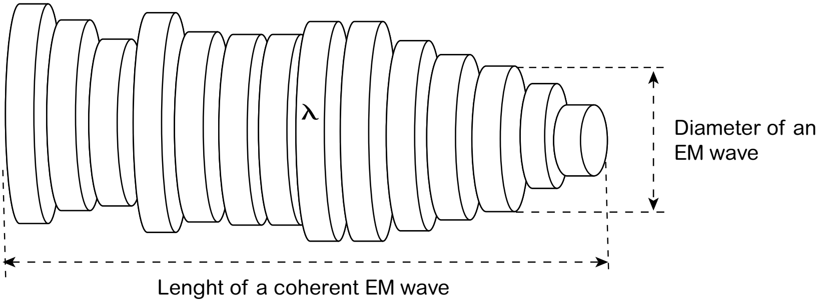


Figure 16 – The size of the coherent EM light waves traveling in a package (length and the diameter of the EM waves patches in a coherent chain) can be measured.

The speed of light

Light in matter

Light can reach a medium where it is refracted, reflected, absorbed or diffracted on a diffraction grating.

Refraction of light

EM light wave is several classes bigger than the molecules of matter. Within each EM wave of visible light there is a great multitude of molecules. These molecules change the conductivity of space for an electric field (permittivity) and the conductivity of space for a magnetic field (permeability).

EM light wave after the incidence into matter is no longer in the optimum energy state, due to changes in the electrical and magnetic conductivity. Electric and magnetic forces in the EM wave ensure that after the incidence the EM is geometrically transformed into an energy state which is optimal for that matter. After the incidence in the material medium the wavelength of light subsequently, after a transitional phenomenon, shortens and the speed is reduced. When light exits the medium, the process of transforming of the EM wave occurs in the opposite direction and light regains the speed with which it has entered the medium.

The same entry and exit speed of light to and from the medium is shown by the characteristics of lenses. Sharpness of a telescopic image does not depend on the speed of light.

The same entry and exit speed of light on the lens of a telescope should not be mistakenly understood as the speed of light being always and in all circumstances the same. Sharp image from a telescope only allows for the conclusion that the speed of light is the same at the entry and exit of the lens, but does not permit the inference that the speed of the light in question at the entry and exit of the glass is the same as the constant c.

In case of refraction of light we also notice an interesting phenomenon where the refractive index of the matter is less than one. In such materials, the speed of light does not slow down, but rather increases above the speed of light[4]. This “fast light” is known for a whole century and creates various discussions among physicists.

Light reflectance

The mirror directs each EM wave arriving at the parabolic reflector toward the telescope‘s focal point. Telescopic images of all celestial bodies are sharp, no matter how fast the incident light is on the mirror.

Optics of a telescope may be the same for all the rays of light in the case where the light reflectance is symmetric. Symmetric light reflectance at the mirror of a telescope means that the speeds of incident and reflected light are the same, however, that does not mean that the speeds of incident and reflected light are the same as the constant ‘c’.

Similarly as with the phenomenon of refraction of light, light reflectance also provides us with surprising phenomena.

Let us direct two mutually synchronous beams of coherent light on the transversely moving surface. The beams are created by a stationary laser that splits a beam into two beams, which are incident on the surface at different angles, as shown in Figure 17.

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[4] Daniel J. Gauthier, Duke University, and Robert W. Boyd, University of Rochester **Fast Light, Slow Light and Optical Precursors: What Does It All Mean?**

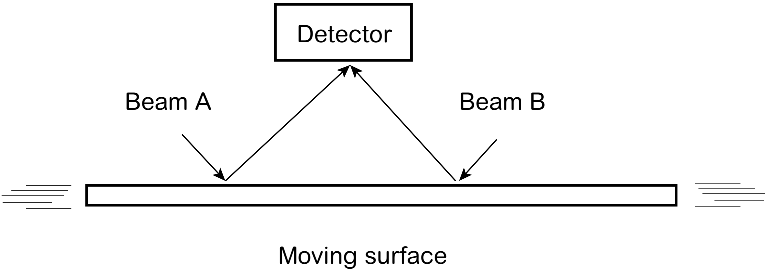

Figure 17 – Detector detects the phase difference between the light beams, which is dependent on the speed of the base.

The beam A is incident in the direction of the movement of the base, while the beam B is incident in the direction opposite to the movement of the base. The reflected light creates interference at the detector, which is utilized by **Canon's** contactless speedometer measuring the speed of the base.

The detector does not detect the interference flashing of the two beams, which means frequencies of the two beams at the detector are the same.

Detector detects the phase difference between the light beams at a constant speed of the base, which is dependent on the speed of the base. The phase difference between rays on the detector can only be the result of differences in the wavelengths of reflected light. The different wavelengths of the reflected light at the same frequency imply that the speeds of the reflected light are mutually different.

Similar measurement, in a different way demonstrating the influence of the lateral speed of the base on the wavelength of the reflected light, is described in Figure 26.

Diffraction grating

EM light wave has a certain volume, as shown in Figures 6, 8, or 16. The slit has a certain size. Let us select a slit, which is in the size class of the EM light waves, and direct light towards the slit. EM wave is too big to smoothly pass through the slit. It collides with its edge, which distorts the shape of its electric and magnetic fields. After passing through the slit, EM wave renews its EM field into the form established by the *Maxwell's equations.*

The *Huygens*–Fresnel *principle* states that each point of a wave front is the source of a new spherical wave which continues to travel at the same speed as the original wave.

Let us ask ourselves: What happens if the light incident on the slit has a speed which is not equal to the speed of light? Does light, in this case, follow the Huygens' principle and continue to travel with the same speed, different from the speed of light? Or does the slit behave like an illuminant, which radiates light with the speed of light? This question would be meaningless, if it wasn't for a measurement which gives the answer.

Let us say that the light from the Sun's corona enters the slit, the hypothetical speed of which is not necessarily equal to the speed of light, due to the turbulence of the Sun's corona. The measurement is to show whether the light exits the slit at a speed equal to the speed of entry, or does its speed at the slit adapt to the speed of light, as shown in Figure 18.

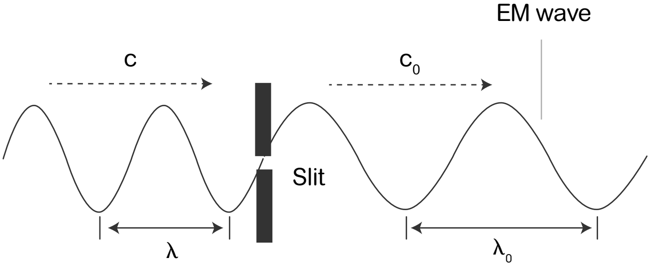

Figure 18 – The slit can adapt the speed of light.

Diffraction of light at the diffraction grating is shown in Figure 19. For this example, a diffraction grating that transmits light is especially interesting.

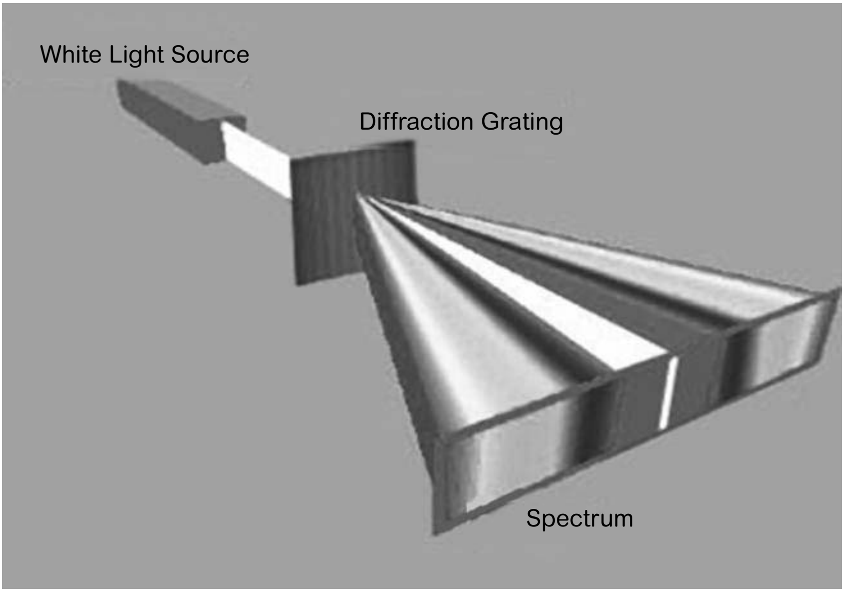

Figure 19 – Diffraction of light at the diffraction grating.

The light in Figure 16 forms a white line in the middle after passing through a diffraction grating. This is the zero-order mode diffraction, which contains the light of all wavelengths. At the sides is the color spectrum, where the diffraction of light depends on its wavelength.

The light is incident on the diffraction grating at an angle. The incident wave front of the light beam is shown by the AC line in Figure 20, while the BD front line indicates the outgoing light-front after crossing the grating.

Zero-order mode diffraction beam is not refracted on the diffraction grating in laboratory conditions. Rectilinear path of the beam after passing the grating is the result of an equal number of EM waves of the same wavelength, both on the AB and CD lines.

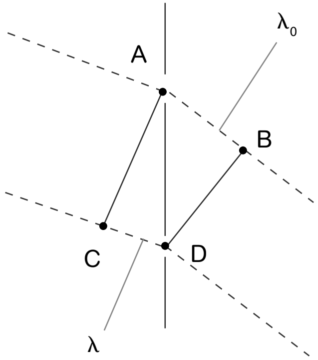

Figure 20 – A beam of white light of zero-order mode diffraction can changes its direction.

Next, we focus the light from a turbulent light source at the grating, such as the corona of the Sun, representing the light with hypothetically different speeds. If during the passing of the grating its speed is adapted to the speed of light, a beam of white light of zero-order mode diffraction changes its direction. The beam is refracted.

At the passing of the grating the light may change its speed, and thus its wavelength, as shown in Figure 18. This results in the fact that the AB distance in Figure 20 is not equal to the CD distance at the same number of wavelengths, which affects the diffraction of white light.

Sources of light in the solar corona have varied speeds, which can create various diffractions of EM waves at the diffraction grating. The consequence of the various angles of diffraction of light at the diffraction grating is the increase in the dispersion of light of the white dot.

The hypothesis about the impact of speed of a light source at the speed of light can therefore be confirmed or refuted by measurement. If the influence of the speed of a light source on the zero-order mode diffraction of light is detected at the diffraction grating, this may only be a result of different speeds of the light incident on the diffraction grating.

> ***Measurement 1:*** *Change in the speed of light at the diffraction grating is confirmed / disproved by measuring the zero-order mode diffraction of light from a moving source of light at the diffraction grating. The visibility of white dots of light under laboratory conditions is compared to the recognition or the scattering of white dots, created by light from the Sun, i.e. from the light source with high turbulence.*

Described features of a diffraction grating provide excellent opportunities for measuring the speed of light from a moving source. The measurement of the differences between the wavelength of light in front of and behind the diffraction grating in Figure 18 allows for an unambiguous measurement of the speed of light from a moving light source.

The frequency of light is the same in front of and behind the diffraction grating. Based on the wavelength differences the speed of light in front of diffraction grating can be calculated, according to the equation $c = f. \lambda$.

I described the method of measurement in detail, in the article[5] entitled "*The impact of the light source movement on the EM properties of light*", which I published in 2011 on the WSEAS Conference in Venice, while a brief summary[6] of the method of measurement is shown and described in Figure 32 of this essay.

Measurement the speed of light

Several questions appear concerning the speed of light. Only measurements are the right answer to the lack of clarity in the understanding of the speed of light.

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[5] http://www.frozman.si/pdf/WSEAS.pdf

[6] http://www.frozman.si/pdf/The_properties_of_light.pdf

Paths toward disclosures of physical laws are often long and intertwined, with many surprises and byways. This also applies to the unveiling of the speed of light.

Science has no real problems with the measurement of the speed of light coming from a stationary light source, i.e. in a situation where the light source and the observer are in the same system of observation.

The history of measurements of the speed of light was described by Philip Gibbs in 1997, in the article entitled ‚'How is the Speed of Light Measured?“[7] The descriptions of the mentioned measurements are easily intelligible, so I shall only mention them. Measurements show that light in a vacuum always leaves a light source with the speed of 2,99792 10^8 m/s. This speed is denoted with the constant c and called the speed of light.

All the measurements mentioned in the article are carried out in situations where both the source and the sink of light are stationary in relation to each other, and when neither the magnetic field nor gravity affect the speed of light. The speeds of the light source, the magnetic field and the gravitational field should not be underestimated, as shown in the examples described below.

The impact of the magnetic field at the speed of light

Sunspots are the result of strong magnetic fields. A magnetic field reduces the brightness of the Sun in the area where there is strong magnetism, which indicates that a magnetic field effects the properties of light.

At the Faculty of Electrical Engineering in Ljubljana we are measuring the impact of a magnetic field on the properties of light, based on optical interferometers. For certain of these cases similar measurements already

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[7] Philip Gibbs: ‚'How is the speed of light measured?“ (1997)

exist in scientific literature, which facilitates the implementing of our measurements. We analyze different interpretations of the already published measurement results in professional journals and try to understand the properties of light on the basis of our own measurements.

Types of optical interferometers

To measure the speed of light the Sagnac interferometer is perfectly suitable. There are two types of Sagnac interferometers. Some operate on the basis of reflection of light from mirrors (overhead version), while others are based on fiber optics and optocoupler (fiber version).

Sagnac interferometer, which is shown in Figure 21, operates on the basis of an optocoupler and single-mode optical fiber.

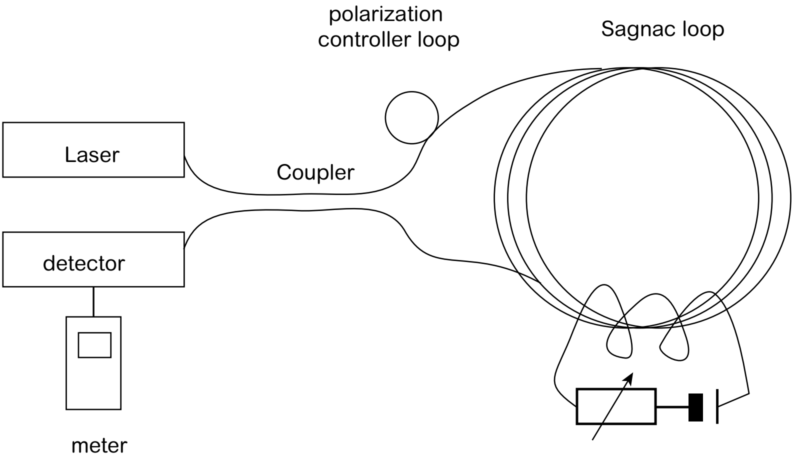

Figure 21 – Sagnac interferometer operates on the basis of an optocoupler and single-mode optical fiber. An optocoupler splits a laser beam into two beams and sends them in opposite directions, leading into the optical fiber. As the end they are united by the same optocoupler and directed toward the detector.

An optocoupler splits a laser beam into two beams and sends them in opposite directions, leading into the optical fiber. As the beams travel through the optical fiber in opposite directions, they are united by the same optocoupler and directed toward the detector.

For the purpose of measuring the impact of magnetic field on the speed of light in the optical fiber, we used a 30 cm long coil in which a magnetic field is created with a magnetic density of 20 mT, and impulsively up to 200 mT for the time of 15 ms. We can use this magnetic field to influence the two beams of light in the optical fiber of the Sagnac interferometer.

We used the laser light source, type HP8168F, with a wavelength of 1,550 nm. Luminous flux at the exit of the interferometer was measured using a spectrum analyzer, type AQ6317.

When an EM wave of light comes into contact with the magnetic field, there is an interaction between the electric and magnetic fields of the light wave and the external magnetic field.

This phenomenon is used for the operation of industrial meters. Two of them are presented in the following.

Measurement of the electric current in power lines

For the measuring of the electric current in a transmission line the Mach-Zehnder interferometer can be used, so that the optical fiber, along which the beam is traveling, is wound around the electrical conductor. In this way, the light beam is guided through a magnetic field created by the current in the transmission line. The measurement is described in the article *Optical Current Sensors for High Power*[8] and shown in Figure 22.

The measurement shows different time values of passage of the beam through the optical fiber, depending on the density of the magnetic field

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[8] Optical Current Sensors for High Power http://www.mdpi.com/2076-3417/2/3/602/pdf

generated by the electric current of transmission line. Different times of passage of the beam within the optical fiber can be a result of either a change in velocity of the beam within the optical fiber, or a change in the length of the optical fiber.

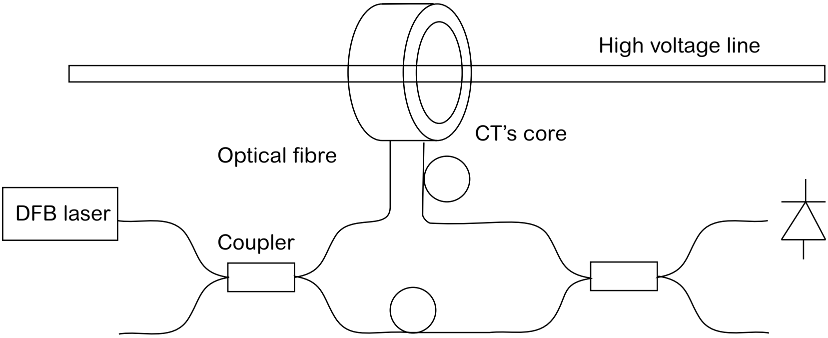

Figure 22 – For the measuring of the electric current in a transmission line the Mach-Zehnder interferometer can be used. The light beam is guided through a magnetic field created by the current in the transmission line.

According to the article, the reason for the impact of magnetic field on the transition time of light through the optical fiber is that the magnetic field influences the changes of the beam's optical path length. This is supposed to be the result of magnetostriction, caused by the magnetic field in the optical fiber. However, the article does not prove that magnetostriction actually is the reason for the impact of magnetic field on the beam's transition time through an optical fiber.

Rating the cause of the time delay

The reason for different time values of the beam's travel in the optical fiber could also be a change in the speed of the beam. The answer to this question is provided by the measurements described in the patent *Sensing unit for*

Sagnac optical fibre current sensor[9]. The measurement in question enables the measurements of the electric current in the transmission line in such a way that the magnetic field generated by an electric current has different effects regarding the time delay of both beams in the optical fiber of the Sagnac interferometer. The method of measurement is shown in Figure 23.

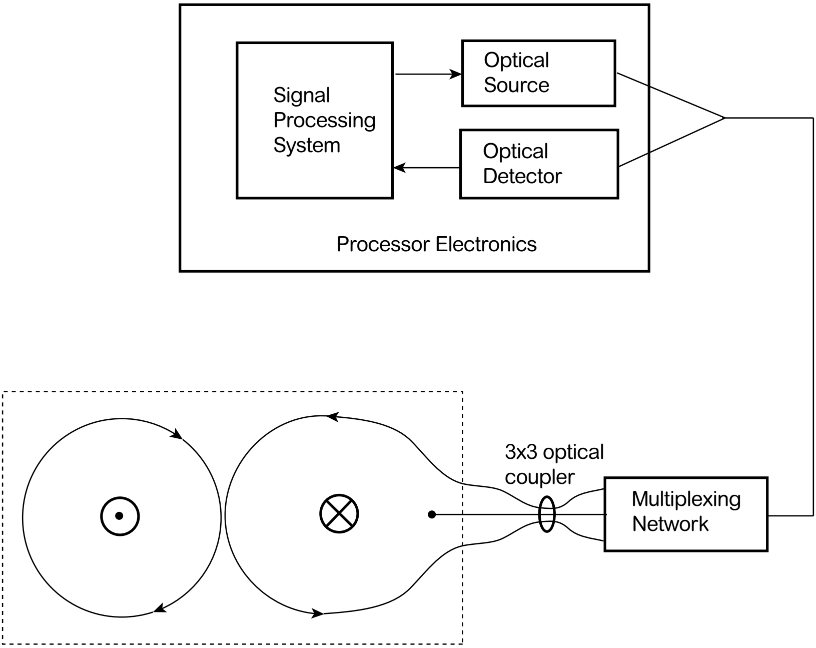

Figure 23 – The electric current in the transmission line has different effects on the time delay on beams in the optical fiber of the Sagnac interferometer.

The laser directs the light toward the optocoupler, which divides[10] it in both directions of the optical fiber. The beams return with different delays,

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[9] Sensing unit for Sagnac optical fibre current sensor http://www.google.com/patents/EP2245426B1?cl=en

[10] Coupler distributes the light in three directions in order to measure the electric current within the entire current range. For our understanding the monitoring of the beam division in both directions of the Sagnac interferometer is sufficient.

depending on the electric current in the conductor and hence the magnetic fields generated by the current.

Laser emits 100 ns pulses, while the detector measures the time delay of the pulse return of both beams directly in nanoseconds. We measured the time delay between the rays and not the interference. The measured time delay is linearly proportional to the current and indirectly proportional to the magnetic density in which the optical fiber is situated.

The measured time delay between the rays cannot be attributed to magnetostriction. The magnetic field impacts the length of the optical fiber for both beams in the same manner, and in both directions. Magnetostriction would change the length of the optical fiber and therefore the optical path length of both beams by the same factor.

The time delay between the two rays can be formed only due to the differences in the speed of light, so that the magnetic field impacts the speed of light in one or the other beam differently, depending on whether the beam of light is traveling in the direction of the magnetic field or in the opposite direction.

The impact of magnetic field on the EM waves

Magnetic field impacts the electric current with a certain force. When light occurs in a magnetic field, the latter impacts the displacement current of the EM light wave with a certain force. The force of the magnetic field therefore transforms the EM wave. Furthermore, the distorted shape of the EM wave affects the speed of movement of the latter.

In the Sagnac interferometer one light beam is traveling in the direction of the external magnetic field, while the other beam is traveling in the opposite direction. The measured different speeds of light in one or the other direction of the Sagnac interferometer indicate that the deformation of the EM light wave, when the light travels in the direction of the external magnetic field, differs from the deformation of the EM wave, when the light travels in the direction opposite to the EM wave.

Deformation of the EM light wave, and thus the different speeds of light under the influence of an external magnetic field, is not necessarily bound to matter. Consequently, the change in the speed of light in the external magnetic field can hypothetically also be expected in a vacuum.

The speed of light in a gravitational field

The gravitational redshift of spectral line described in scientific literature deals with the impact of the gravitational field on the change of the light's wavelength.

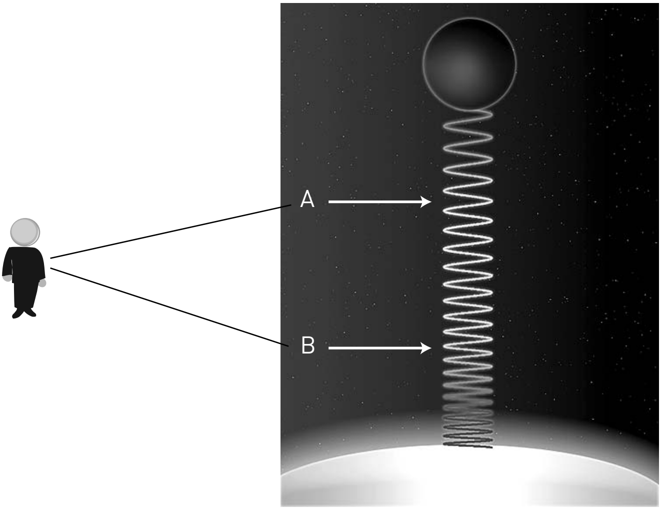

Figure 24 – The observer observes the light in both points at the same time. Without the use of a watch he is able to observe that there are as many light waves passing through point A, as there are light waves passing through point B. An observer, based on all the time the same number of waves between the points A and B, detects the same frequency of EM waves in points A and B.

If point B in Figure 24 represents the area with higher gravity, while the point A is an area of reduced gravity, then according to the findings presented in scientific literature[11] the light in point A should have a greater wavelength than in point B.

For comparison of the frequency of events, such as crossing the EM wave through the points A and B, we can use the measuring of time. When the frequency of events can be compared directly, the measuring of time is redundant and unnecessary. More reliable is direct comparison of the frequency of events without the use of time. Seconds are after all artificially created events for cases, where the original events can not be directly compared.

The observer in Figure 24 observes the light in both points at the same time. Without the use of a watch he is able to observe that throughout the observation there are as many light waves passing through point A, as there are light waves passing through point B. If there would be more EM waves entering than exiting the space between the points A and B, a question would arise regarding the constant increase in the number of EM waves at the distance mentioned. An observer, based on all the time the same number of waves between the points A and B, detects the same frequency of EM waves in points A and B.

The speed of light or the speed of EM waves is determined by the equation $c = f \cdot \lambda$, where c is the speed of light, f its frequency and λ the wavelength. The findings in scientific literature indicate that a change in the gravitational field along the path of the light only changes the wavelength of the light, but not its frequency, therefore the change in gravity also changes the speed of light.

Impact of radial acceleration on the speed of light

Sagnac interferometer, shown in Figure 21, allows the measurement of the impact of the radial acceleration on the speed of light. In this measurement, the coil of the optical fiber is rotating. One of the beams is traveling in the

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[11] Wikipedia – Gravitational redshift

direction of rotation of the optical fiber, while the other beam is traveling in the direction opposite to the rotation. The optical fiber is the same and thus equally long for both beams.

The findings in the scientific literature state that the time delay between the two rays linearly increases with the length of the fiber, diameter of the coil of the optical fiber and the angular velocity of the disc rotation[12], $\Delta t = \mathbf{L} \cdot \mathbf{D} \cdot \boldsymbol{\omega} / \mathbf{c}^2$.

Measurement at a constant rotational speed of the interferometer reveals that the interference signal at the exit does not pulsate. This means that the beams arrive to the detector at the same frequency.

Mandatory paths of rays

The findings in the scientific literature[13] indicate that the optical paths of two beams have the same length only in the case where the interferometer is not rotating, as shown on the left side of Figure 25.

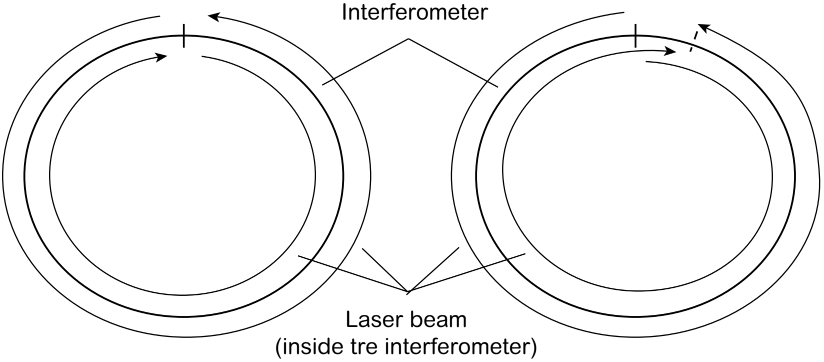

Figure 25 – When the interferometer is rotating the exit point should get nearer to one of the beams, but move away from the other, which is supposed to be the reason for the different of path times of the both beams.

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[12] Basac Secmen, simulation on interferometric fiber optic gyroscope with amplified optical feedback, September 2013, http://etd.lib.metu.edu.tr/upload/1253657/index.pdf

[13] Sagnac effect – Wikipedia, the free encyclopedia

The findings in scientific literature state that when the interferometer is rotating the exit point should get nearer to one of the beams, but move away from the other, which is supposed to be the reason for the different of path times of the both beams. The difference of both time values is attributed to the same speed of both beams to an outside observer and the different lengths of paths of each of the beams.

Speeds of rays

Expected time delay between the rays, at the same speed of the rays to an outside observer, due to the smaller speed of light in the glass equals[14] $\Delta t = LD\omega \cdot n^2/c^2$. In view of the geometry and the angular velocity, the measured time delay of beams within the fiber $\Delta t = L \cdot D \cdot \omega/c^2$, could be generated by the beam's speed of light, rather than the speed of rays in the optical fiber reduced by the refractive index of the glass. The measurements therefore show that to the outside observer light in one or the other direction of the interferometer is moving at different speeds. Consequently, this creates doubts about the speed of light which would be the same in all situations.

System of observation

The length of the beams' path and the time delay between the rays is better explained with a suitable system of observation, rather than with the

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[14] Peripheral speed of the interferometer is $r\cdot\omega$, and the added peripheral speeds of the two rays $D\cdot\omega$. The beam travels in the fiber for $L\cdot n/c$ seconds. The fiber is therefore presumably extended by the peripheral speed of the interferometer times the travel time of the beam in the fiber, which is $L\cdot D\cdot\omega\cdot n/c$ meters. If the extension of the fiber is divided by the speed of light in glass, we obtain the equation of the time delay $\Delta t = L\,D\cdot\omega/c^2$ (L – the length of the optical fiber, D – diameter of the optical disc, ω – angular velocity of rotation of the rotor, n – refractive index of the glass).

measurement described. With the correct understanding of a phenomenon any system of observation should give the same understanding of the phenomenon. The differences between systems of observation are that some systems describe the phenomenon in a more thorough and understandable way, while other systems are less transparent, thus even allowing for erroneous interpretation of the phenomenon.

The observer is therefore placed at the axis of the rotating interferometer, so that the observer rotates together with the interferometer. In this system of observation, the laser source, detector and optical fiber are still, even in the event of rotation of the interferometer. Consequently, the stationary laser, stationary detector and passive optical fiber do not show different lengths of ray paths between the laser source and detector. However, despite the standstill the observer detects a time delay between the beams.

Origin of time delay between the rays

Beams travel along a circumference. Radial accelerations are acting on the beams as a result of the speed of light in a curved conductor. Radial acceleration acts in one direction on the first beam and in the opposite direction on the other beam, due to the opposite direction of the second beam. To this acceleration, we must add the acceleration on the beam due to rotation of the interferometer, which is the same for both beams.

The acceleration due to rotation of the interferometer is consequently added to the acceleration of the first beam and subtracted from the acceleration of the second beam. The light beams consequently experience different radial acceleration.

Different radial acceleration could therefore represent an answer to the question of origin of the time delay between the beams. The measurement thus shows that the radial acceleration, which acts on the light beams in the optical fiber, also affects the speed of light in the optical fiber.

The speed of the reflected light from the transversely moving base

The design of the Sagnac interferometer based on rotating mirrors is shown in Figure 26. Interferometer consists of a laser lamp (L), a semi-permeable mirror (B), which splits the beam in two directions toward the mirrors (M), and the detector (P), ultimately intercepting the beam.

The interferometer is rotating. The beams are successively deflected from the mirrors (M), one after the other, so that one light beam is traveling between the mirrors in the direction of the interferometer‘s rotation, and the other beam in the direction opposite to the rotation of the interferometer. In the end, the semi-permeable mirror combines both beams and focuses the joint beam onto the detector (P).

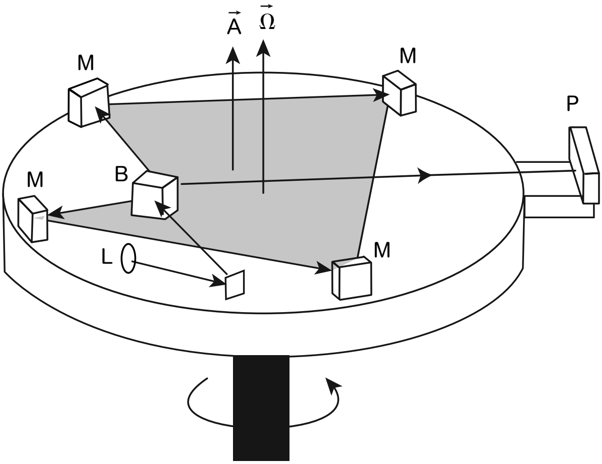

Figure 26 – The design of the Sagnac interferometer based on rotating mirrors. Interferometer consists of a laser lamp (L), a semi-permeable mirror (B), which splits the beam in two directions toward the mirrors (M), and the detector (P), ultimately intercepting the beam.

Measurements in the case of a stationary interferometer show that the beams reach the detector at the same time. However, upon rotation of the interferometer beams reach the detector with a time delay. The article *Sagnac effect* in Wikipedia[15] discloses that beams of the interferometer shown in Figure 26 reach the detector with a time delay of $\boldsymbol{\Delta t = 4S\omega/c^2}$. S is the surface area between the mirrors, while ω is the angular speed of rotation of the interferometer.

To measure the time delay between light beams we can use the measuring method described in the article THE POLARIZATION SAGNAC INTERFEROMETER FOR GRAVITATIONAL WAVE DETECTION[16] Laser emits a signal in the form of pulses. The time in which each pulse reaches the detector through the first and through the second beam is measured at the detector. The difference in time is measured directly in units of time.

Hypotheses about the origin of the time delay between the rays

Professional literature wrongly states that the time delay between the rays is caused by the convergence of the first mirror toward the first beam and distancing of the second mirror from the second beam.

First, that interpretation is contrary to the STR. Converging the beam toward the mirror could namely be understood as if the speeds of rays leading toward the mirrors are not identical to the speed of light. According to the STR, light always has the same speed with respect to the mirror, namely the speed of light, which excludes the converging of mirror toward the beam.

Secondly, from the geometric point of view the mirrors are moving transversely with respect to the beam. Converging of the mirror toward the beam should result in the different frequencies of the two beams at the

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[15] **Sagnac effect** – Wikipedia, the free encyclopedia – https://en.wikipedia.org/wiki/Sagnac_effect

[16] Peter T. Beyersdorf, THE POLARIZATION SAGNAC INTERFEROMETER FOR GRAVITATIONAL WAVE DETECTION January 2001 http://nlo.stanford.edu/system/files/dissertations/peter_beyersdorf_thesis_january_2001.pdf

detector, which was not the case as far as measurements with this Sagnac interferometer are concerned. Equality of frequencies is indicated by the interference ray at the detector, which is not flashing at a constant angular velocity of the interferometer. Interference of beams therefore does not show the convergence of the beam toward the mirror

Time of travel of each individual beam

In case of the Canon speedometer of the base presented in Figure 17 the impact of transverse speed is measured and its impact is shown for the wavelength of the reflected light, but not for the frequency. Theoretical background of this phenomenon is explained in the next section entitled "Model of the movement of light". In the case of the described Sagnac interferometer we have the same example of reflection of light from transversely moving mirrors, as in the case of the Canon speedometer of the base.

Various wavelengths of reflected light and thus its different speeds are also shown by the design of the interferometer itself. The detector (P) of the interferometer presented in Figure 26 is located at the greatest possible distance from the semi-permeable mirror (B). Thus, the authors of the measurement increased the sensitivity of the interferometer. Greater time interval between light beams at a greater distance of the detector from the semi-permeable mirror implies a different speed of beams at the exit from the semi-permeable mirror of the interferometer to the detector, as shown in Figure 27.

In Figure 27 the time delay between the rays at point A is smaller than the time delay at the more distant point B. The time delay between the rays is even greater at point C. However, this can only happen at different wavelengths and speed of rays that exit the interferometer.

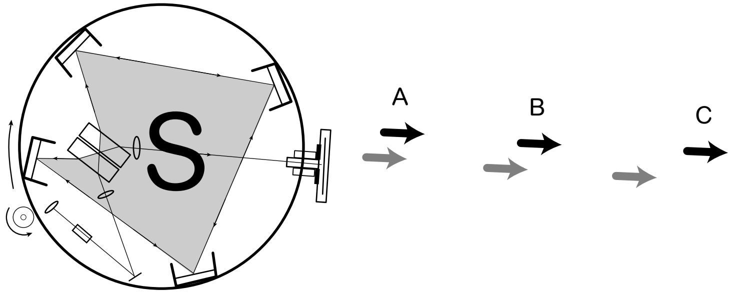

Figure 27 – The detector (P) of the interferometer presented in Figure 26 is located at the greatest possible distance from the semi-permeable mirror (B). Thus, the authors of the measurement increased the sensitivity of the interferometer. Greater time interval between light beams at a greater distance of the detector from the semi-permeable mirror implies a different speed of beams at the exit from the semi-permeable mirror of the interferometer to the detector.

> ***Measurement 2:*** *The time delay between the rays from the interferometer is first measured close to the semi-permeable mirror, and in the second case at a greater distance from the mirror. Comparison of the results of measurements of the time delay between the light beams, in regard to Figure 27, shows if the speed of light at the exit of the interferometer is the same in both cases or not.*

Model of the movement of light

The observer should be alone in the room. He has no point of reference according to which he could identify his speed. His speed is indefinable, random, trivial.

The observer accelerates for a short period and he is subjected to a certain force. He infers that his speed changed during acceleration. The change of his speed is also trivial. He does not know his initial speed, neither can he assess whether his speed increased or decreased during acceleration. Both options could be true at the same time because he does not have anything to compare his speed with.

Even when the observer finds himself within EM waves, according to the theory of relativity his speed is still trivial. According to the theory of relativity, the speed of EM waves is always the same in regard to the observer, that is the speed of light, independently from the acceleration of the observer.

Trivial speed of the observer means that all transformations of time and space are also indefinable. According to the theory of relativity space in this case can shrink itself or not at the same time. The same applies for the transformation of time. In the case of an isolated observer within the EM waves the theory of relativity therefore proves to be of little use.

Notwithstanding the trivial velocity of the observer, we notice a measurable change in the frequency of EM waves felt by the observer as a result of acceleration according to the Doppler effect.

Here we come across a discrepancy. Trivial speed of the observer can not create a measurable and clearly defined change of frequency of the EM waves, as detected by an observer. Measurable frequency change can only be created by a definite measurable change in velocity between the light and the observer.

The continuation of the essay is devoted both to theoretical reflection on the speed between the light and the observer, as well as to measurements of the speed of light with respect to the observer.

The wavelength of light

In what way does the speed of the observer impact the wavelength of light? The dashed vertical lines in Figure 28 represent EM waves, for example the nodes of EM waves. EM waves extend from left to right and are observed by three observers: A, B and C. All three measure the distance with an equal scale. The length of the scale is represented by the length of the arrows.

Observer A is moving from left to right. Observer B is moving from right to left at the same speed, as indicated by the arrows.

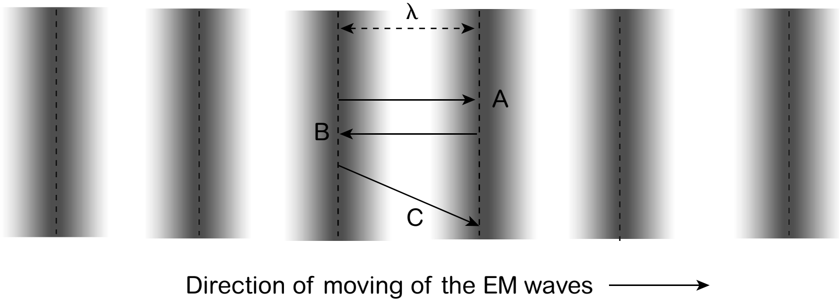

Figure 28 – Observer A is moving from left to right. Observer B is moving from right to left at the same speed. Observer A and B perceive the same wavelength, irrespective of their speeds.

The observer will measure the same wavelength, both according to the theory of relativity, as well as the Newton's laws. Nevertheless, according to the theory of relativity a variation in the distance due to the transformation of space can be detected. As the two observers travel in different directions with the same speed, this change in distance is identical for both observers. Observer A and B perceive the same wavelength, irrespective of their speeds.

The observer C does not move in the direction of the light. Due to the movement at an angle, he perceives a greater distance between the two nods of EM waves.

His arrow is too short, due to the oblique direction, and does not extend from one node to the other, although the scale (the length of the arrow) is of the same length, as the scales of the observers A and B. The observer C perceives a greater wavelength of EM waves in case of a cross-motion, than the observers A and B.

The change in the wavelength in the case of transverse movement of the observer C is confirmed by the measurement shown in Figure 17. The wavelength independent from the speed, in the case of the observer moving in the direction of the movement of light, is shown by the measurement described later in Figure 32.

Frequency of light

Observers A and B perceive different frequencies according to the Doppler effect. The observer who travels toward the EM waves, hits the EM waves more often, which increases the frequency of light. The observer who is moving in the direction of EM waves, hits the EM waves less often.

Observers A and B perceive the same wavelength and different frequencies of light. This means that the observers A and B perceive different speeds of light.

When the observer C moves perpendicular to the movement of the EM wave, he does not detect a change in frequency of the EM wave, but detects a change in its wavelength, which is confirmed by the measurement in Figure 17.

In general, the observer may perceive both the changes in wavelength, as well as the frequency of light, depending on the direction of movement of the observer through the EM wave.

Measurements show that a cognitive model of movement of the boat upon the undulating water can be used to illustrate the movement of light. When the boat is moving towards the waves or away from the waves, the length of the wave may be comparable to the length of the boat. It does not matter whether the boat is moving towards the waves or away from the waves. The only thing different is the frequency of hitting the waves when the boat is moving against the waves compared to the boat moving in the opposite direction than the waves.

Unsuccessful attempts at measuring the speed of light

Light provides high-quality observing of the surrounding area on account of the fact that it conceals its features from us. There were certain unsuccessful attempts at measuring the speed of light in the circumstances of a moving source of light, gravity or magnetic field.

Michelson interferometer

The answer to the question whether ether exists and affects the speed of light can be determined with the Michelson interferometer. Measurements were carried out in 1877 by Michelson and Morley[17]. They showed that the ether does not exist and consequently could not affect the speed of light.

Due to the initial enthusiasm a century ago, the scientific papers carelessly and euphorically stated that based on the Michelson interferometer the speed of light was measured, which was identical under every circumstance.

The speed of light, which comes from a moving source of illumination, has never been measured on the basis of the Michelson interferometer. Physicists even doubt that this interferometer would detect a change in the incident speed of light. Modern articles (in Wikipedia[18] and elsewhere), do not mention that Michelson-Morley interferometer could detect hypothetically different speeds of light from a moving source.

Unfounded findings from a hundred years ago, stating that the Michelson interferometer had demonstrated the speed of light which is identical under all circumstances, has even distracted physics from efforts to objectively measure the speed of light from a moving source.

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[17] Jose A. Fretre: ‚'Experiment Of Michelson-Morley And The Original Formula"

[18] "Michelson–Morley Experiment"; http://en.wikipedia.org/wiki/Michelson-Morley_experiment.

Measurement of light from an accelerator

In November 2011, the measurements of the speed of light from a cyclotron were carried out in Moscow[19], as shown in Figure 29. The literature referees to it as a measurement of the speed of light from a moving source. In conclusion, the article states that the measurement was not necessary, since it is already completely clear that the speed of light is the same under all conditions. Thus, the conclusion itself above all points to the discomfort regarding the measurement.

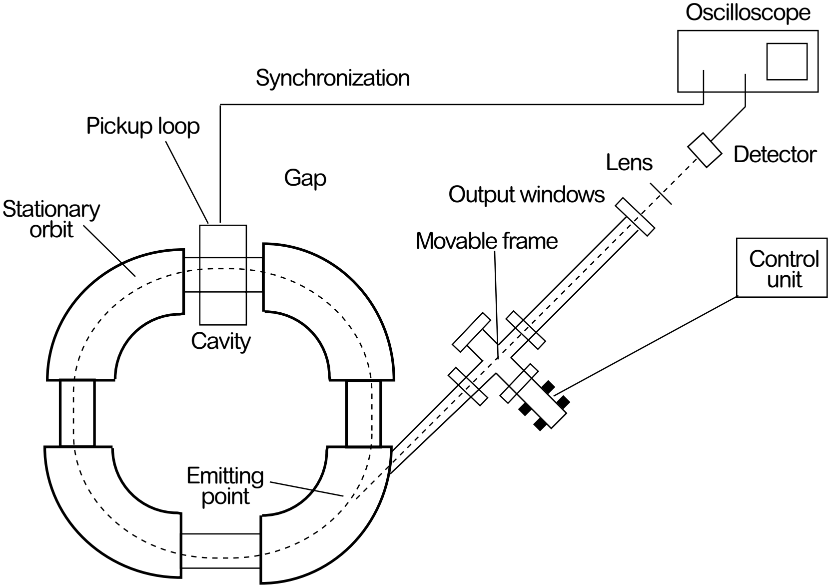

Figure 29 – Moving electron creates turbulence in a magnetic field, however the speed of the electron does not affect the speed of the created EM light wave. The speed of the EM wave is determined by the properties of the magnetic field.

The results of the measurement showed that light exits the accelerator with the speed of light. Cyclotron includes rapidly moving electrons, which

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[19] Measuring speed of the light emitted by an ultrarelativistic source – E. B. Aleksandrov, P. A. Aleksandrov, V. S. Zapasskii, V. N. Korchuganov, A. I. Stirin

do not themselves generate light. There are also, in regard to the light sink, static magnets with their static magnetic field.

When an electron passes through the magnetic field, it creates turbulences within the latter. After the passing of an electron, the turbulent magnetic field is generally leveled and settled. In some cases, however, the magnetic turbulence generates an EM wave, depending on the magnetic field excitation method.

Moving electron creates turbulence in a magnetic field, however the speed of the electron does not affect the speed of the created EM light wave. The speed of the EM wave is determined by the properties of the magnetic field and *Maxwell's equations* which determine it. Thus, the speed of the light from a stationary magnetic field of the cyclotron does not depend on the speed of the electrons. This particular measurement, therefore, does not represent the measurement of speed of light from a moving source.

Measurement of the speed of light in an accelerator

The methodological error described above is corrected in the measurement of the speed of light, carried out in 2007, and is described in the article »S. REINHARDT; *Test of relativistic time dilation with fast optical atomic clocks at different velocities*«.

A lithium ion passes the accelerator tube in Figure 30, in the first case at a rate of 0.03 c, and in the second case at a rate of 0.064 c. On the basis of fluorescence, ion emits light in the direction of its movement, and in the direction opposite to its movement.

In parallel with the ion in the accelerator tube laser beams are radiated.

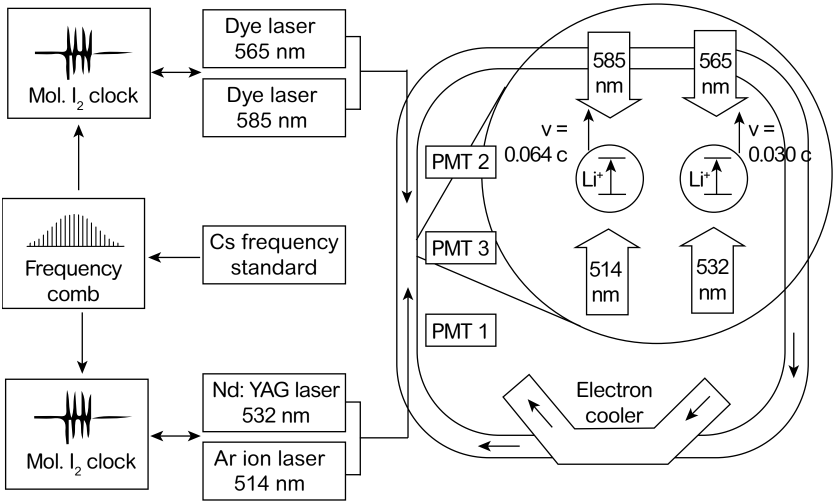

Figure 30 – The meter allows the measurement of the wavelength of light from the Li-ion by the spectrum analyzer. The light emitted by the moving light source only alters the frequency, but not the wavelength. The spectrum analyzer, do not detect changes in the wavelength of the light from the Li-ion, regardless of the speed of the ion and of the direction in which the light was emitted.

We measure the interference of the laser beam with the light radiated by the Li ion. The measurement did not consider the measuring of which of the beams‘ frequencies (from the laser or the Li-ion) is higher and which is lower. They only measured their difference. Which beam has a higher frequency and which a lower frequency was determined on a subjective basis of the expected result of the measurement. The measurement therefore does not contain an objective method for measuring the frequency. The article does not even individually mention the measured frequencies. Inconsistent measurement method and the lack of specification of the key results of the measurement does not allow us to regard this measurement as scientific and substantiated.

Wavelength measurement

The meter in Figure 30 allows in a rather simple way for the measurement of the wavelength of light from the Li-ion by means of the spectrum analyzer. In the article presented, there is no mentioning of the measuring of the wavelength of the light from the Li-ion, although the wavelength measurement is technologically rather simple, easier than the measurement of frequency.

The light emitted by the moving light source only alters the frequency, but not the wavelength, as is explained in more detail in Figure 28. The spectrum analyzer, as expected, did not detect changes in the wavelength of the light from the Li-ion, regardless of the speed of the ion and of the direction in which the light was emitted. The authors possibly gave up the measurement of wavelength exactly because they expected different results.

> ***Measurement 3:*** *Measurement of the wavelength of light from the Li-ion on the basis of the spectrum analyzer based on the meter shown in Figure 30. We measured and compared the wavelength of the light, which was emitted by the Li-ion, once in the direction of the ion's movement and the second time in the opposite direction.*

GPS

Measurements of the speed of light according to professional criteria therefore do not give the basis for the inference about the speed of light which would be the same under every situation. Proponents of the STR, therefore, also cling to methods which are less methodological in order to prove that the speed of light is identical under all circumstances.

An extended example of such a general proving of the speed of light as being identical under all circumstances is the functioning of GPS system, which is meant for navigation. In the literature we can find interpretations that the GPS system would not work without the use of the STR laws.

Satellites of the GPS transmitters are orbiting above the GPS receivers. Between the satellites and numerous GPS receivers there is a multiplicity of speeds regarding their approaching and distancing, and in addition, the speeds of the receivers and satellites are constantly changing.

Even if the satellite knew its speed toward a single, selected GPS receiver, it would be unable to adjust its clock frequency according to that of the GPS receiver as it has a different speed toward every GPS receiver. Furthermore, the satellite transmits the same signal for all receivers. Diversity of mutual speeds do not enable to reconcile the frequency of a signal at the satellite in accordance with the STR for specific GPS receivers.

Speeds of satellites, according to the Doppler effect, are affecting the frequency of the radio signal between the Earth and the satellite. In the case of interplanetary rockets the speeds reach up to 50 km/s. According to Doppler, in the GHz area of radio waves changes in the frequency of radio waves due to the speed of the rocket fall within the MHz class and the same should apply for the frequency width of the receiver in order to receive radio signals for communication between the Earth and the rocket.

Nevertheless, expanding the frequency bandwidth of the receiver to the MHz frequency bandwidth increases the reception of interfering signals caused by the radio pollution of space.

Radio communications between the Earth and distant satellites, therefore, should be designed to enable tuning according to the wavelength of a radio signal, not the frequency. Since the wavelength of the radio signal at the reception does not change with the speed of the satellite, according to Doppler only the frequency is changed, the antennas could be configured to receive a very narrow section of wavelengths, which would extensively eliminate the interference from perturbing radio signals.

Muon decay time

The proponents of the STR refer to the half-life of muons as a general proof of its validity. On Earth muons are created by the degradation of the charged pions in the atmosphere under the influence of cosmic rays. Life span of still muons is 2.2 ms.

Frisch and Smith have measured the number of muons at two heights (at the top of the mountain and at the sea), with 1,900 m of altitudinal difference. It has been shown that they measured more muons by the sea than was expected on the basis of their life span. When muons move at a speed that is close to the speed of light, they only travel 660 m at the time of degradation period. Frisch and Smith assumed that more muons are detected at the seaside due to their longer life span, resulting from STR and high speeds of muons.

This assumption is unreliable, because we do not have estimates on how often muons are formed at different altitudes. It would be possible to formulate many speculative stories about the formation and degradation of muons, due to the vague starting point. However, such platforms that offer a multitude of possible interpretations are not suitable to prove the STR and consequently the speed of light which is identical under all circumstances.

Methods for measuring the speed of light

Worldwide, hundreds of forums defend the speed of light, which is identical under all circumstances. No other scientific discipline is under attack and repeatedly questioned to such an extent. The profession itself is to blame for this situation, as the speed of light coming from space is not credibly measured, although such measurements are technologically possible.

The speed of light can be measured, for example, on the basis of a separate and independent measurement of the frequency and wavelength of light.

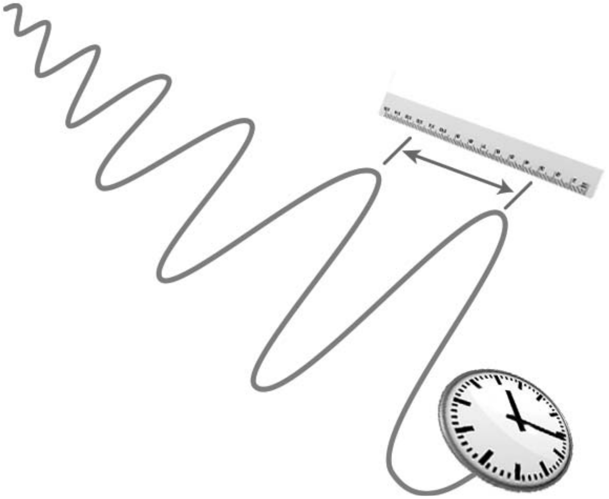

Figure 31 – The speed of light can be measured on the basis of a separate and independent measurement of the frequency and wavelength of light.

Frequency and wavelength of the light coming from the same source can be measured separately with two measurement instruments, one of which is sensitive to the frequency of light and the other to the wavelength of light.

Fabry-Pérot interferometer

Fabry-Pérot interferometer operates on the principle of multiple reflection between two semi-permeable plates. At the exit several parallel rays are radiated. When these rays are in the phase, they are interferentially amplified. The interference is dependent on the spacing between the plates and on the wavelength of light, however it is not dependent on the frequency of light. Measured deviation at the FPI interferometer is a function of the wavelength of light f(λ). The FPI interferometer may therefore be used to autonomously measure the wavelength of light.

Diffraction grating

The diffraction grating is sensitive to both the frequency and the wavelength of light, as explained in Figure 20, and as confirmed by Measurement 1. Parallel measurement of the observed light with both the FPI interferometer and the diffraction grating consequently allows for a separate measurement of the frequency and wavelength of light, as explained in greater detail below.

The measurement of the speed of light from the Comet Hale-Bopp

The authors of the measurement of light, which can be found in literature, were often close to the determining of the speed of light from a moving source of light. They only needed to describe and publish the results of the measurements, however they chose not to. Thus, to this day we do not have a credible article on measurement of the speed of light from a moving source.

One such example is the measurement of speed of the Comet Hale-Bopp, which was carried out in March 1997 at the University of Wisconsin[20]. With the help of the FPI interferometer they measured the spectral line of the wavelength 6300,304A of the head of the comet. The measurement results are shown in Figure 32

The horizontal axis above the diagram in Figure 32 shows the wavelength. The vertical axis represents the measured brightness of the light at the selected wavelength.

The measurement result (the right peak of the curve) shows that only a small fraction of the speed of light changes its wavelength due to the speed of the comet. The University cited the Rayleigh scattering as the cause. The light from the comet is supposed to hit material particles as it travels through the atmosphere, only to be absorbed and immediately afterward

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[20] Department of astronomy – WHAM http://www.wisc.edu

emitted again, but with a different wavelength[21]. This absorbing and re-emitting of light in the atmosphere is supposed to return the light's shift of the spectral line, from the state expected according to Doppler to the level emitted by stationary light source.

If the same spectral line from the comet is measured by a meter based on a diffraction grating, the meter shows the expected shift of the spectral line without Rayleigh scattering. The measurement result is added and displayed in the left curve in Figure 32.

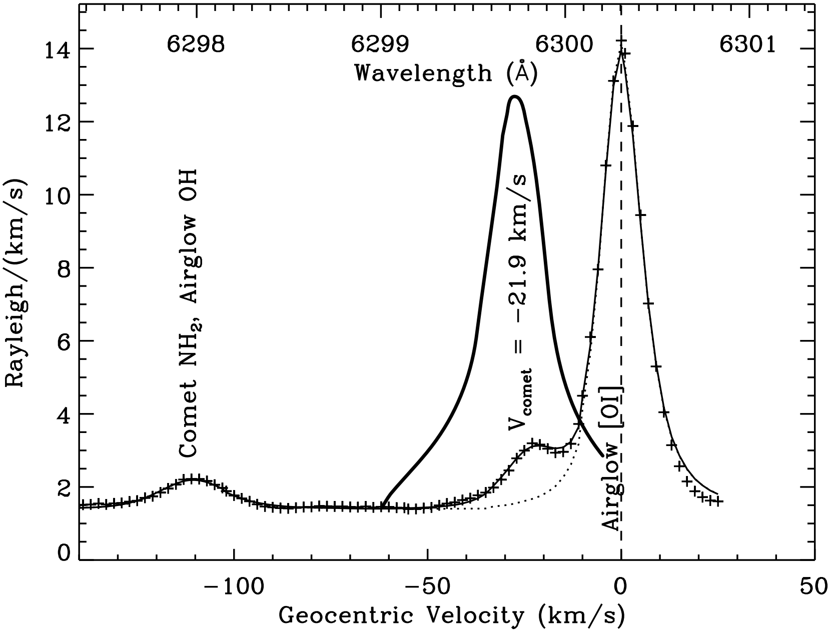

Figure 32 – The spectrometer based on a diffraction grating shows the speed of the comet in the class of a few tens of km/s. When the same light is measured by the FPI interferometer it does not show the expected shift of the spectral line. The differences between the measurement results can only be the result of different sensitivities of the meters for the frequency and wavelength of the light.

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[21] *Rayleigh scattering, Wikipedia*: http://en.wikipedia.org/wiki/Rayleigh_scattering

The spectrometer based on a diffraction grating shows the speed of the comet in the class of a few tens of km/s[22] without the Rayleigh scattering. It shows speed, as it can also be estimated on the basis of the observation of the comet's path with a telescope. When the same light is measured by the FPI interferometer directed toward the comet, it does not show the expected shift of the spectral line[23]. The differences between the measurement results can only be the result of different sensitivities of the meters for the frequency and wavelength of the light.

The measurement of the spectral line with the FPI interferometer reveals the wavelength of light. If the spectral line is not detected, that would imply that the speed of illuminant does not affect the wavelength of the light.

The spectrometer based on a diffraction grating detects a shift of the spectral line according to Doppler effect. Consequently, the measurement results based on a diffraction grating can be attributed to a change in the frequency of light from the comet.

Characteristics of light from the head of Comet Hale-Bopp were therefore measured sufficiently to enable the authors of the measurement to present the results as: The measurement of light from the comet through the FPI interferometer shows that the speed of illuminant does not affect the wavelength of the light measured. However, measurements of the same light by using the diffraction grating indicate that the speed of illuminant does affect the frequency of light according to Doppler effect.

Changes in the frequency of light at the same wavelength and in accordance with the equation $c = f \cdot \lambda$ indicate that the speed of the light source impacts the speed of light at the sink.

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[22] Anita L. Cochran, Teksaška univerza: ''Atomic Oxygen in the Comae of Comets''; http://barolo.as.utexas.edu/anita/oxygen2.pdf

[23] 'Large Aperture 6300A Photometry of Comet Hale-Bopp";

> ***Measurement 4:*** *Comet is suitable for measuring light, knowing its speed as a source of light, and due to the fact that there is little turbulence. First, we measure the wavelength with the FPI interferometer, which should have minimal slits and edges, so as not to create the characteristics of a diffraction grating within the interferometer. Secondly, we measure the frequency of the same light on the basis of a diffraction grating. Different diffraction of light during both measurements implies different impact of the light source speed on the wavelength and the frequency of light.*

The importance of understanding the speed of light

Understanding the speed of light could greatly facilitate the industrial development of the measuring devices. However, the proper understanding of the speed of light has an even greater importance on the understanding of the Universe.

The speed of the Sun's corona

The measurements of the speed of celestial bodies in the past have brought about quite a few surprises, which stemmed from misconceptions about the speed of light. Examples of such surprises can be found in measurements of the speed of the Sun's corona[24], carried out in the previous century in India,

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[24] Delone, Makarova, Yakunina: ''Evidence for Moving Features in the Corona from Emission Line Profiles Observed During Eclipses'', Moskva, 1987.

- Raju, Singh, Muralishanker: ''Fabry-Parot Interfereometric Observation of the Solar Corona in the Green line'', Indijski inštitut za astrofiziko, Indija, 1997.

- Delone, Divlekeev, Smirova, Yakunina: ''Interferometric Investigations of the Solar Corona During Solar Eclipses and Problems for Future'', Inštitut za astronomijo Sternberg, Moskva, 1998

Russia, the USA, Japan, … Articles claim that the Sun's corona is very still, without turbulence, which is not true. Solar corona is the site of persistent plasma turbulences with speeds of up to a few tens of km/s, in the case of the solar flares even up to a 1,000 km/s.

The speeds of the Sun's corona were measured on the basis of measurement of spectral lines with the FPI interferometers, which measures the wavelength of the spectral line, unalterable with the speed of the corona. The measurement results did not detect the expected changes in the wavelength of the spectral line. This was mistakenly interpreted as a stationary solar corona.

Dark energy

The explosion of a supernova generates light, which disappears within a few weeks or months. The light from the supernova increases the redshift of the spectral line. Constant increasing of redshift of the spectral line of light from the supernova is explained in literature as a constant acceleration of the supernova away from Earth. There is supposed to be some unknown source which constantly accelerates the supernova. Physicists call it dark energy, although they do not know what that is supposed to be.

The literature states that all supernovae accelerate away from Earth; none of them accelerates toward Earth. Since the Earth is not privileged in the Universe, we can conclude that the same picture of accelerated distancing of a supernova is seen by all other observers at any location in the Universe.

Does supernova really accelerate, if every observer from any direction can see it accelerating away from them? When considering, we should allow for the possibility that the acceleration of a supernova could only be ostensible.

Due to the speed of the plasma, which is created by the supernova at the time of explosion, the light is moving at the speed of light with respect to particles in the plasma, from which it is emitted. According to an observer on Earth, it is moving faster or slower than the speed of light, depending on where and at what speed the plasma particle, which has emitted the observed light was moving. Seen from the sink, the light is moving with the speed of light, modified by the speed of the light source.

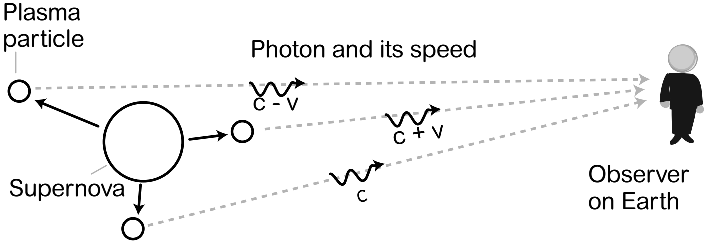

Figure 33 – It is possible to observe the duration of a supernova's explosion due to the different speeds of light rays on their way from the supernova to Earth, and not because of the actual duration of a single explosion. Although the supernova explosion occurs instantly, it will be observed for weeks, months or even years on Earth due to the different speeds of light.

The light coming from the supernova can have a speed of 1.01 c, when a fraction of the plasma, which emits the light, is propelled from the explosion toward an observer on Earth at a speed of 0.01 c. When a particle of the plasma is propelled away from Earth at a speed of 0.01 c, due to the explosion, the light towards the observer on Earth shall travel at a speed of 0.99 c.

The image of supernova is obtained gradually. Instantaneous explosion may occur on the supernova, millions of light-years from Earth, but it is not seen as a momentary phenomenon on Earth due to the different speeds of light. The more distant the supernova, the more the light phenomenon on its path towards the observer is extended through time by different speeds of light.

It is possible to observe the duration of a supernova‘s explosion due to the different speeds of light rays on their way from the supernova to Earth, and not because of the actual duration of a single explosion. Although the supernova explosion occurs instantly, it will be observed for weeks, months or even years on Earth due to the different speeds of light.

First the light with red frequency delay arrives to Earth, followed by the violet frequency delay of spectral lines. Changes in the frequency delay are thus not a consequence of the acceleration of a supernova, but of gradual coming of light to Earth from the particles of plasma with different speeds.

Thus, such understanding does not need the notion of dark energy. The concept of dark energy is the result of an erroneous understanding of the speed of light.

Comments and opinions

The essay is worthy of thorough consideration. Not only does it draw attention in an easy and understandable way to the contradictions that are embedded in the very foundations of modern science, but also gives an explanation and ideas that go beyond these contradictions. Thus, it is still possible to obtain important insights by only using pencil, paper and common sense, without the need for expensive research projects! One can not but agree with the text. Really exciting! Although I am not acquainted with all the details of modern physics, I increasingly realize that physics needs not only a superficial, but a complete renovation. I am convinced that physics shall develop in the direction indicated in this book, becoming simpler, deeper and more all-encompassing. With respect and envy,

Janez Berce, MSc

You really give yourself to the whole world. I have read the essay and remained almost breathless. Outstanding. There are some uncertainties, but overall this is one of the freshest winds in the last hundred years. If you will be able to trigger an avalanche, by procuring the first snowball, a lot of tension shall be released. Let fate be lenient on you.

Gregor Cuzak, MSc

I can not agree with many things in the text. Because EM waves (light) are propagated by the local EM field, the reciprocal wavelength is proportional to the frequency ($f = c/\lambda$) and can not be dictated by a distant moving light source independently of frequency. Wavelength and frequency are not independent, otherwise the world would be a completely different place. As a teacher, I am aware that many questions in the text need a more convincing answer, than is offered by the usual explanations in textbooks and journals. This booklet has warned me of many problems that seem obvious to an expert, but not to a layman. Neither can I quickly present reasons for the incongruity of some astronomical measurements!

Prof. Dr. Mitja Rosina

When reading the Essay I was attracted by certain new, original views on natural phenomena in the Universe, which are distinguished by simplicity and clarity. These views are generally derived from the existing measurements, but their interpretation is sometimes slightly unusual, often at odds with the applicable laws of physics. The booklet is especially interesting in those places where it offers a simple explanation for differences in the results of measurements of the same cosmic phenomenon. Such is the case, for example, with the measurement of the Doppler shift of the spectral lines of light, as a result of flares on the Sun's surface. The measurements vary in dependence on the principle which is used for the operating of the instrument for measuring the Doppler shift. The explanation offered by the author consequently entails the claim that the speed of light is no longer constant and is dependent on the speed of the illuminant. This would mean that the Einstein's theory of relativity does not apply in the form in which it was written.

Prof. Dr. Gorazd Kandus

Acknowledgements

The Essay on light emerged from a heated debate on the understanding of optical phenomena, and differences in understanding the results of measurements of light already performed at various scientific institutions in the world. The interlocutors have had and still have different views in many respects. Acknowledgement to the counterparts is primarily due to the constructive, diverse and tolerant dialogue despite the differences in views, which made it particularly interesting.

My first exchange of ideas about the theory of relativity was with the physicists Gregor Cuzak, Msc, more than ten years ago, for which I owe him a deep acknowledgement.

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I thank Prof. Dr. Marko Uršič and Prof. Dr. Janez Bešter for their guidance through the scientific literature on the speed of light, and occasional assistance in the studying of the mysterious properties of light.

My acknowledgement is also due to all the colleagues, among whom I should mention Janez Berce, Msc, Toni Berce, and many other counterparts.

Light
attracts painters,
photographers, architects,
and especially physicists and
astronomers. This is an essay on the
physical properties of light.
We believe that the speed of light in vacuum is the same in all situations, which is difficult to grasp by reason. We have the feeling that light is understood by only a few individuals, however, this is not the case. Thus, let us unveil measurements and knowledge that shall illuminate the physical properties of light. In the first part the author's view of the structure of light waves is described, while in the second part the methods of measuring the speed of light are analyzed by pointing out their strength and weakness. At the same time it puts forward suggestions for new measurements.

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