The Speed of Light Postulate – Extended Concept

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Abstract

This paper concerns the history of the speed of light postulate and explains all unexpected and inexplicable results of the notable experiments related to the measurement of the speed of light, such as the "Michelson-Morley experiment", the "Sagnac experiment", the "Michelson-Gale-Pearson experiment", the "Miller's experiments", the "One way speed of light measurements", as well as the "Shapiro time delay effect" and the anomaly in the acceleration of the space-probes "Pioneer 10", "Pioneer 11", "Galileo", "Ulysses". As a conclusion, "Thesis about the behavior of the electromagnetic radiation in gravitational field" is formulated. The properties of atoms depend on the intensity of the gravitational field in the time-spatial domain, where the atoms are located. Another conclusion is that all so-called "fundamental constants of physics" are only "local constants". As a general conclusion, "Thesis about the global physical reality of the Universe" is formulated. This is a new model of uncertainty of the Universe, which gives the answer of the question about "the origin of the energy" and includes decisions of a lot of problems in the physics today (such as: "the accelerated expansion of the Universe"; "the dark matter and the dark energy in the Universe", etc.), which have been under research for a long time.

Keywords: speed of light postulate, Special Relativity, fundamental constants, properties of atoms, Michelson-Morley experiment, Sagnac experiment.

PACS:
04.20.Cv - "Fundamental problems and general formalism";
06.20.Jr - "Determination of fundamental constants";
06.30.Ft - "Time and frequency".

1. Introduction

Historically, the questions about the velocity of light and what medium supports the transmission of the electromagnetic waves arose after the development of Maxwell's theory of electromagnetism. For James Clerk Maxwell and other scientists of the time, the answer was that the light traveled in a hypothetical medium called luminiferous ether. Albert Michelson (the master of light) made his first experiment in 1881 in order to determine the rate of the motion of the Earth around the Sun through the stationary luminiferous ether. The result that the hypothesis of stationary ether is incorrect was confirmed in 1887 with the Michelson-Morley experiment. FitzGerald, as well as Lorentz, attributed the "null result" of the experiments to a hypothetical length contraction affecting the path. The complete explanation theory "The Special Theory of Relativity" (STR) was proposed by Albert Einstein in the paper "On the Electrodynamics of Moving Bodies" (1905). As a matter of fact, the special theory of relativity was based on two postulates: (1) "the principle of relativity" and (2) "the constancy of the speed of light". They were formulated in the following way:

„The same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good. We will raise this conjecture (the purport of which will hereafter be called the "Principle of Relativity") to the status of a postulate, and also introduce another postulate, which is only apparently irreconcilable with the former, namely, that light is always propagated in empty space with a definite velocity c which is independent of the state of motion of the emitting body."

This formulation does not point directly that the speed of light is constant for all frames of reference. In fact, the postulate of the speed of light is based on the known till that time "Michelson–Morley experiment", i.e. on the fact that no change of the speed of light in vacuum (in the empty space) can be registered as a result of the motion of the Earth around the Sun. However this fact is not enough to make the conclusion that the speed of light is constant for all frames of reference. In the history of theory of Physics there are three experiments which disprove this claim, but the physical society systematically avoids explaining. These experiments are „the Sagnac's experiment" in 1913, the „Michelson-Gale-Pearson experiment" in 1925 and "the Miller D.C. experiments".

That is why, this paper starts with the awareness of the results of all notable experiments related to the measurement of the speed of light, such as the "Michelson-Morley experiment", the "Sagnac experiment", the "Michelson-Gale-Pearson", the "Miller's experiment", the "One way speed of light measurements", as well as the "Shapiro time delay effect" and the anomaly in the acceleration of the space-probes "Pioneer 10", "Pioneer 11", "Galileo", "Ulysses". As a result of the analyses of aforementioned experiments, "Thesis about the behavior of the electromagnetic radiation in gravitational field" is formulated, which actually is an "Extended Speed of Light Postulate".

2. The notable experiments related to the speed of light determination – results and explanations

2.1. The first Michelson's experiment

Actually, the history of the "Speed of Light Postulate" started in 1881. Albert Michelson designed experimental apparatus (later known as a Michelson interferometer) and made experiments in order to determine the rate of the motion of the Earth around the Sun through the stationary luminiferous ether. The designed experimental apparatus, illustrated in Figure 1, uses two-way path of light propagation and consists of a light source, detector, "SSM" (Semi-silvered mirror) and two mirrors (A and B), which are horizontally located (at the same gravitational potential). The change of the speed between the two light beams would cause different shift of the interference fringes.

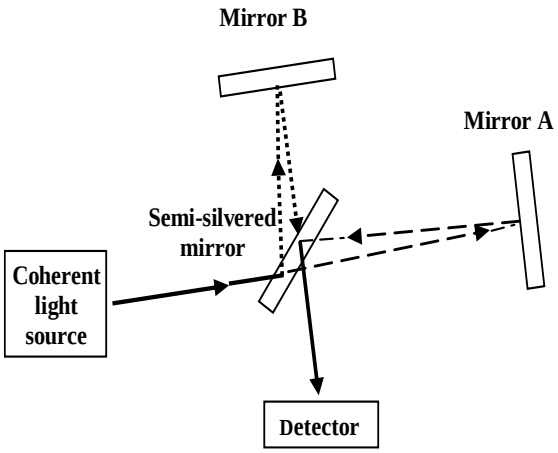

Figure 1. The scheme of the Michelson interferometer

If the luminiferous ether is stationary in relation to the Sun and Earth's orbit, the drift of the ether related to the Earth's motion will be in different direction in any two opposite locations of the Earth's orbit, as shown in Figure 2. This difference will correspond to the Earth's motion of approximately 30km/s on its trajectory around the Sun. Using a wavelength of about 600 nm, Michelson expected that there would have been a shift of about 0.04 interference fringes.

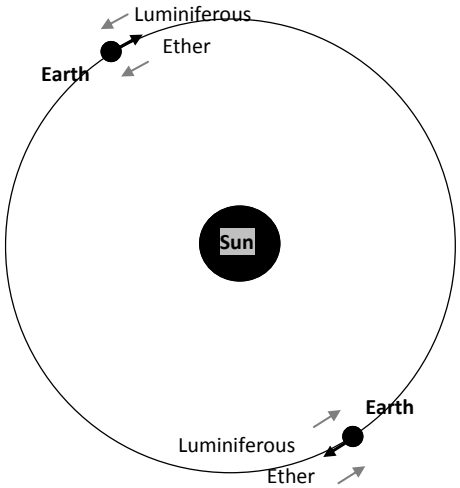

Figure 2. The expected effect of the luminiferous ether on the speed of light

However, the expected shift of the interference fringes was not observed. The results were reported by Michelson (1881):

"The small displacements -0.004 and -0.015 are simply errors of experiment."

The Michelson's conclusion in the paper "The Relative Motion of the Earth and the Luminiferous Ether" was:

"The interpretation of these results is that there is no displacement of the interference bands… The result of the hypothesis of a stationary ether is thus shown to be incorrect, and the necessary conclusion follows that the hypothesis is erroneous."

2.2. Michelson-Morley experiment

The famous Michelson–Morley experiment was performed in 1887. Albert Michelson, with the collaboration of Edward Morley, constructed a new improved interferometer. As in the first experiment, the improved interferometer had two-way path of light propagation and equal arm lengths. But by using multiple mirrors, the light pathlength was about 10 times longer. The light was repeatedly reflected back and forth along the arms of the interferometer, increasing the light pathlength to 11m. In that way, there is more than enough accuracy to detect the ether-hypothetical effect of the Earth's motion around the Sun. At the pathlength of 11m, the expected shift should have been about 0.4 fringes. To eliminate thermal and vibration effects, the Michelson and Morley's interferometric apparatus was assembled on the top of a large block of sandstone, about a foot thick and five feet square, which was then floated in a pool of mercury. However, the result of the experiment was entirely unexpected and inexplicable - the apparent velocity of the Earth around the Sun through the hypothetical ether was practically zero at all times of the year, in different points of the Earth's orbit. The reported results were given by Michelson (1887):

"It seems fair to conclude that if there is any displacement due to the relative motion of the earth and the luminiferous ether, this cannot be much greater than 0.01 of the distance between the fringes."

Although repeated over the next 40 years with even greater precision, this experiment proved the same negative result and earned Michelson the Nobel Prize in 1907.

Here it could be mentioned again that the efforts of this experiment were meant to register the relative motion of the Earth on its trajectory at its orbit around the Sun through the luminiferous ether. After the right conclusion that *"the hypothesis of a stationary ether is thus shown to be incorrect"*, Michelson realized that the registered little shifts of the interference fringes could have been only a result of the rotation of the Earth on its axis, as a result of the choice of reference system (the Earth's surface). In fact, the registered little change between the interference fringes corresponds to the linear speed of the Earth's surface at the local latitude, which is no more than 0.46 km/s (as it is on the Equator). That is why, Michelson directed his efforts to the "Effect of the Earth's rotation on the velocity of light", accurately registered with the Michelson-Gale-Pearson experiment (1925).

2.3. Sagnac's experiment

George Sagnac, French physicist, constructed apparatus (ring interferometer), also called a Sagnac interferometer. The light source, collimator, beam-splitter, light pencils and mirrors of the interferometer were all mounted on a spinning disc, which are actually rotating in the reference system associated to the space itself (in the empty space). A monochromatic light beam is split and the two beams are designed to follow the same path but in opposite directions around a polygonal mirror course. The two recombined beams are then focused on a photographic plate, permitting measurement of fringe shifts with a high accuracy, as was described by Sagnac (1913). The result of experiment is that the fringe shifts are changing with the change of the velocity of the disk rotation.

The explanation can be given using the substantiated conclusion of Michelson that *"the hypothesis of stationary ether is thus shown to be incorrect"* and the reality that the speed of light is not the same for all frames of reference. It is a subject of Newtonian mechanics*:*

- Firstly, let us consider the reference system related to the space itself, where the speed of light is a constant (in the empty space). The two light beams travel in opposite directions. In this reference system, the pathlengths travelled by the two light beams in the space are different. It is due to the moving of the target's point (mirrors) in the space during the travel time of the light between them. Thus, the pathlength of one of the light beams is shortening and the pathlength of the other light beam is extending. The change of this difference depends on the velocity of the rotation of the spinning disc with the apparatus. As result of the change of the light beams pathlengths in this reference system, different phases between the two beams are created, depending on the velocity of the disk rotation
- Secondly, let us consider the reference system related to the spinning disk with the interferometer (the rotating reference system). In this reference system, the mirrors, light source and photographic plate are stationary; the pathlenghts (the distances among the mirrors, light source and photographic plate) are not changing. Therefore,

if we measure the speed of light of the two light beams in the reference system related to the spinning disk, we will register for them different speed of light. In this case it can be concluded that the fringe shifts are changing due to the change of the speed of light of the two light beams, which in turn is dependent on the velocity of the disk rotation.

The conclusion is that the experiment unambiguously shows that the speed of light is not the same for all reference systems. Nowadays, the result of this experiment has very significant implications in practice. It is used for various purposes in practice, such as the fibre optic gyroscope in the aviation, the space navigation, the everyday needs for positioning purposes on the Earth what is well described by Ashby (2003), etc.

2.4. Michelson-Gale-Pearson experiment

The Michelson-Gale-Pearson experiment uses a very large rectangular ring interferometer (a perimeter of 1.9 kilometer), as was described by Michelson (1925): *"Air was exhausted from a twelve-inch pipe line laid on the surface of the ground in the form of a rectangle 2010X1113 feet. Light from a carbon arc was divided at one corner by a thinly coated mirror into direct and reflected beams, which were reflected around the rectangle by mirrors and corners. The two beams returning to the original mirror produced interference fringes"*.

In this experiment, the moving plate with the interferometer and the detector (the observer) is the Earth's surface itself, which moves with the linear velocity at the local latitude. The explanation is the same - the speed of light is constant in empty space (in the reference system related to the space itself), but the target's points (the mirrors) are moving during the travel time of the light beams between them, with the linear velocity of the Earth's surface. The effect of extending or shortening of the pathlenghts in the space is opposite for the two light beams that travel in opposite directions. Therefore, the shift of the interference fringes is due to the Earth's rotation, and the "Effect of the Earth's Rotation on the Velocity of Light" is registered.

The conclusions are two:

- On the base of this experiment, we can measure the linear velocity of the Earth's surface at any local latitude. The measured exact linear velocity of the Earth's surface at different latitudes is a proof that the **speed of light is constant in vacuum** (in the reference system, connected to the space itself).
- The second conclusion is that Michelson-Gale-Pearson experiment proves the same reality as the Sagnac's experiment - that **the speed of light is not the same for all reference systems**.

2.5. Dayton Miller's Ether drift experiments

Dayton Miller constructed a light-beam interferometer, at 4.3 meters across. As it was described by Miller (1933), the apparatus was the largest and most sensitive of this type ever constructed, with light beam pathlength of 64 meters (almost six times longer than the light beam pathlength of the Michelson-Morley interferometer). It was used in a definitive set of ether-drift experiments on Mt. Wilson (1734m above sea level), 1925-1926. According to the results of the experiments, Miller claimed that the absolute motion of the solar system towards the head of the constellation Dragon is about 200 km/s (registered relative to the ether).

In "My theory and Miller's experiments" Einstein (1926) wrote: *"If the results of the Miller experiments were to be confirmed, then relativity theory could not be maintained, since the experiments would then prove that, relative to the coordinate systems of the appropriate state of motion (the Earth), the velocity of light in a vacuum would depend upon the direction of motion. With this, the principle of the constancy of the velocity of light, which forms one of the two foundation pillars on which the theory is based, would be refuted"*. As a matter of fact, change of the speed of light, depending on the direction of the light transmission, which would correspond to the velocity of motion of the solar system of about 200 km/s, was not registered. However, we have to be aware, that in his work *"The Ether-Drift Experiment and the Determination of the Absolute Motion the Earth"*, Dayton Miller (1933) actually reported again that the speed of light is not the same for all reference systems.

2.6. One-Way Light Speed Determination

The measured speed of light in the reference system connected to the Earth's surface depends on the eastwards or westwards direction of the light propagation, which is influenced by the Earth's rotation. The experiments using "one-way" measurement of the speed of light (for example made by means of GPS system, as discussed by Gift (2010)), prove this reality. They show that the measured speed of light in the directions "East-to-West" and "West-to East" is different in the reference system related to the Earth's surface, where the target points are stationary. However, in the reference system related to the space itself, the speed of light is constant (actually proved by Michelson-Gale-Pearson experiment), but the light-beam-path is different, because the target points are moving with the Earth's surface during the light-beam-travel-time. We refer the reader to Sharlanov (2011), where it is

shown that in case of *"Westward Transmission",* the light-beam-path is shorter with the distance that the target western point is moved to East during the beam-travel-time. The shorter distance covered for the light-beam-travel-time is the reason a higher speed of light to be measured in the reference system connected to the Earth's surface. In case of *"Eastward Transmission",* a lower speed of light is registered due to the same reason: the light-beam-path is longer, because the target eastern point is moved to East during the beam-travel-time. The registered differences of the speed of light in the two directions are in conformity with the linear velocity of the Earth's surface at the local latitude. This conformity proves again that the speed of light is constant in the reference system related to the space itself (in the empty space). We can add that this conclusion is true, but in areas with the equal intensity of gravitational field (in areas with the same gravitational potential). The cases with different intensity of gravitational field will be discussed below. The other unambiguous conclusion is the same as in the previous experiments - that the speed of light is not the same for all reference systems.

3. The speed of light constancy – a brief analysis and conclusions

A different view, proving that the speed of light is not "a fundamental constant", but only "a local constant" was shown by Sharlanov (2012a) in the paper "The Speed of Light and Uncertainty Principle of the Macro-world". The next subsections concern the two aspects of the delusion about the invariance of the speed of light – in a time-spatial area with equal intensity of the gravitational field, and in time-spatial areas with different intensity of the gravitational field.

3.1. Survey about "the constancy of the speed of light for all reference systems. Conclusions

The first delusion concerns the areas with equal intensity of the gravitational field (areas with the same gravitational potential). This is the delusion that "the speed of light" is constant for all frames of reference, which was illustrated in the aforementioned experiments more than 100 years ago. These experiments prove that Galilean transformations are valid, when "the speed of light" is measured in a moving reference system in relation to the space itself.

All of the aforementioned experiments carried out on the Earth's surface can be explained on the base of the following assumptions that:

1) The speed of light is constant in vacuum (in reference system related to the space itself) in areas with equal intensity of gravitational field (in our case on the Earth's surface).
2) The speed of light in vacuum (in the reference system related to the space itself) does not depend neither on the velocity of the source of the electromagnetic radiation, nor on the velocity of the Observer. The explanation of this reality is outlined below in *"4.1. Thesis about global physical reality in the Universe".*
3) The measured speed of light on the Earth's surface is not the same for all reference systems. Mathematically, the relationship between the readings in the different reference systems is expressed through Galilean transformations – it is subject to Newtonian mechanics.

Therefore, as was written by Einstein (1926): "*then relativity theory could not be maintained, since … the principle of the constancy of the velocity of light, which forms one of the two foundation pillars on which the theory is based, would be refuted".*

Actually, the delusion that "the speed of light" is constant for all frames of reference has resulted in the wrong use by Einstein of the Lorentz transformations in the Special Theory of Relativity (STR). The Lorentz transformations are the mathematical solution of the task, formulated as: "the speed of light to be the same, measured in the co-ordinates of all frames of reference". However, this task does not correspond to our local physical reality and the claim that the speed of light is constant for all reference systems is refuted by much more than the above mentioned experiments. Further details about consistency of STR with the physical reality can be read in the paper "*Awareness of Special and General Relativity and Local and General Physical Reality*" by Sharlanov (2012b), which includes a thorough analysis of the discrepancy between our local physical reality and the logical and mathematical models that are used in the STR. One of the conclusions in this paper is:
"It is time to close the phenomenal page in physics – the "Special Theory of Relativity". The special relativity is a great attempt for its time to explain our local physical reality. In spite of its unconformity with our local physical reality, the Special Relativity broke the scientific thinking about the "absoluteness" of the time and space, about the perception and understanding of the physical reality."

3.2. Survey about "the constancy of the speed of light in the reference system related to the empty space" – or "the speed of light in vacuum". Experiments, proving facts and explanations

The second delusion is that the speed of light is not "fundamental constant". It is only "local constant" in the reference system related to the space itself (to the empty space). The following facts shown that the speed of light is different in areas with different intensity of the gravitational field.

Note 1: In this paper it is accepted that "higher gravitational potential" corresponds to the "lower intensity of gravitational field", as well as the "weaker gravitational field" and the "higher level of expansion of space and acceleration of time (shortening of the second)". Conversely, "lower gravitational potential" corresponds to "higher intensity of gravitational field", as well as "stronger gravitational field", "higher level of contraction of space/ time delay" and "higher level of GRULW (Global Relative Universe Level of Warping)".

Note 2: Any local area of the Universe is characterized by its GRULW, by its relative local space-time expansion/contraction. For example, in any time-spatial domain in the Solar system, GRULW depends on (GL_P+GL_S+GL_G+GL_U). GL_P is the level depending on the gravitational potential related to the nearest planet. GL_S is the level depending on the gravitational potential related to the Sun (the nearest star). GL_G is the level depending on the gravitational potential related to the current location of the Solar system in our Galaxy (the Milky Way). GL_U is the level depending on the gravitational potential related to the current location of the Milky Way in the Universe in relation to all galaxies.

In the paper *"On the Influence of Gravitation on the Propagation of Light"* (1911), Albert Einstein considers the change of the frequency (one of the characteristics of the electromagnetic radiation), in places with different gravitational potential (different intensity of the gravitational field):

$$\nu = \nu_0\left(1+\frac{\Phi}{c^2}\right) \tag{1}$$

In this equation **ν** is the frequency of certain electromagnetic radiation in a location with a gravitational potential **Φ**, relative to the origin of the co-ordinates; ν_0 is the frequency of the same electromagnetic radiation in the origin of the co-ordinates; and **c** is the constant "speed of light".

The most common assumption is that the frequency of electromagnetic radiation decreases while moving away from a massive body. This is inconsistent with the formula (1), which clearly shows that with the increase of **Φ** (away from the surface), the frequency is increased. Perhaps this assumption is a consequence of not specifying the location of defining the units that we use to make conclusions. The different cases of measurement in time-spatial domains with different intensity of the gravitational field are discussed in detail by Sharlanov (2012a), where the used units for measuring the speed of light in a specific time-spatial domain are defined in other time-spatial domain with different intensity of gravitational field.

Further in the same paper, Einstein states:
*"If we call the speed of light at the origin of co-ordinates c_0, then the speed of light **c** at a place with the gravitation potential **Φ** will be given by the relation:*

$$c = c_0\left(1+\frac{\Phi}{c^2}\right) \tag{2}$$

The principle of the constancy of the speed of light holds good according to this theory in a different form from the one that usually underlies the ordinary theory of relativity."

However, the change of the wavelength (which means the change of the unit "meter") is not taken under consideration in this equation. If the change of the wavelength (which means the change of the unit "meter") was set into the expressions of "**Φ**" and "**c**" - the result would have been uncertainty of the equation itself.

The most important fact in this article is that Einstein got to the idea that the frequency of any electromagnetic radiation and the speed of light change when the electromagnetic radiation is passing through areas with different intensity of the gravitational field.

Here we can mention one important fact concerning certain local time-spatial domain. If the units of the length and time, *"the meter"* and *"the second",* are defined by means of the characteristics of certain electromagnetic radiation and if they are changing in full synchrony with the change of the intensity of the gravitational field, then we cannot register neither the change of the units, nor the change of the speed of light. This subject is discussed by Sharlanov (2012a):
"We cannot measure or calculate in our local time-spatial domain (where the units are defined), neither the change of the defined by us units, nor the change of all our local constants, because they all change in perfect synchrony with the change of the entire physical reality. Also, we cannot measure or calculate any change in

another remote time-spatial domain with different level of contraction/expansion of the space-time, because the units in the remote domain are uncertainly different."

Actually, the velocity change of electromagnetic radiation is changing with the change of the intensity of the gravitational field. One example that proves this reality is "the Shapiro time delay effect". The time-delay effect is caused by the lower speed of radar signals passing near a massive object (the Sun), through a stronger gravitational field. It was proven by Shapiro (1964): "*The experiment was designed to verify the prediction that the speed of propagation of light ray decreases*."

On the other hand, the fact that the velocity of electromagnetic signals increases in the areas with weaker gravitational field (lower GRULW) toward the border of the Solar system is proven by the registered anomaly in the acceleration of the space-probes "Pioneer 10", "Pioneer 11", "Galileo", "Ulysses". We refer the reader to Sharlanov (2011):

"The expected travel time of the communicational electromagnetic signals (calculated on the base of fundamental constancy of the speed of electromagnetic radiation) between the spacecraft and Earth turns out to be much more than the real travel time. As a result, we "register" backward attraction of the space ship/probe to the Sun."

The conclusion of that survey is that the speed of light is changing with the change of the intensity of the gravitational field, but it can be registered only with experiments that use units defined in different time-spatial domain with different intensity of the gravitational field. The two aforementioned cases prove this reality in the global sense of the Universe.

4. The theses related to the global physical reality in the Universe and to "the speed of light postulate"

4.1. The thesis about global physical reality in the Universe

Space-time itself is often called "vacuum" or "empty space" and it exists on many levels. It lays among the elementary particles of matter, among all planets, stars and galaxies. All of these levels are mutually interconnected, depending on each other, and changing in perfect synchrony. Space-time is altered at a micro-level and macro-level. It is curved, bended, and warped by the smallest particles of matter (such as nucleus of the atom), as well as warped by the planets, stars and galaxies in all areas of the Universe. Any local area of the Universe is characterized by its GRULW (Global Relative Universe Level of Warping), by its relative local space-time level of expansion/contraction. The intensity of the gravitational field in any local time-spatial domain fixes the local physical reality, fixes the properties of atoms, fixes the characteristics of the electromagnetic radiation.

The electromagnetic field exists on the gravitational field. It means that:

- the electromagnetic radiation generates itself locally in the space itself as a photon generated by the transition of electrons from one level of space and energy to another, in energy conformity with the local level of space-time warping (level of space-time contraction/expansion). It is absorbed (at the transition of electrons from one level of space and energy to another, giving energy to electrons) again in full energy conformity with the different local level of space-time contraction/expansion. Therefore, the **properties of atoms** are changing with the change of the intensity of the gravitational field;
- the electromagnetic radiation spreads in the space-time, oscillating and changing its own characteristics again in synchrony with the local level of space-time warping. On one hand, this synchrony means that the electromagnetic radiations are oppressed (overwhelmed) in a strong gravitational field (at a high level of contraction of the space). They transform into oscillations with shorter wavelengths and lower frequencies, which means lower speed of diffusion ($c=\lambda\nu$). On the other hand, when the electromagnetic radiation frees itself from gravity upon entering into a weaker gravitational field (higher level of expansion of space), the wavelengths of electromagnetic oscillations become longer and their frequencies become higher, which means higher speed of diffusion ($c=\lambda\nu$).

However, we always measure the same constant correlation between λ and ν, which we call "speed of light in vacuum", which is actually the speed of light in the reference system related to the space itself. The explanation consists in the fact that when we measure locally the speed of light, we use the units of length and time defined in the same time-spatial domain by means of the local changing characteristics of electromagnetic radiation (for example the local λ and ν). Moreover, we define these units by means of identical experiments. For example, we define "the second" by means of fixing *"the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the caesium 133 atom*", as was accepted by 13th meeting of the CGPM (1967/68), and the unit "meter" by fixing *"the length equal to 1650763.73 wavelengths in vacuum of the radiation corresponding to the transition between the levels 2p10 and 5d5 of the krypton 86 atom"* as was accepted by 11th meeting of the CGPM (1960). Therefore, the defined by us units of length and time change synchronously

with the change of the intensity of the gravitational field and we always get the same value (number) for the speed of light in vacuum. Hence, we incorrectly conclude that the speed of light is a "fundamental constant".
Conclusions:

- The "speed of light" is only a local constant (measured locally always the same, but actually different in any location of the Universe with different intensity of the gravitational field).
- As mentioned above, the wavelength and frequency of the emitted and the absorbed electromagnetic radiation depend only on the intensity of the gravitational field where the atom is located, if the atom is with the same energy status. Therefore, we can make and another conclusion that the speed of light in vacuum does not depend neither on the velocity of the body of the source of light, nor on the velocity of the body of the detector (the Observer).

The conclusion that the "speed of light" is not "a fundamental constant", but only "a local constant", concerns all of the so called "fundamental physical constants". They are only local constants in every time-spatial domain with equal intensity of the gravitational field. When the intensity of the gravitational field is changing - the characteristics of the electromagnetic field are changing, the properties of atoms and therefore the physical units are changing, the physical constants are changing - the whole physical reality is changing in full synchrony. It means that the **laws of physics** (the relationships between the different physical quantities) remain the same. That is why, we have a perception of certainty and permanency, what is actually a delusion. Moreover, it is a result of the perfect indisputable mathematical and experimental evidence about this certainty, which is a real fact in every local time-spatial domain, where the physical units are defined. This is the consequence of "the uncertainty principle of the macro-world", as defined by Sharlanov (2012a).

The general conclusion:

- Actually, this is a new model of uncertainty of the Universe. The change of the characteristics of the electromagnetic radiation shows one very important fact - that and the energy of electromagnetic radiation is changing with the change of the intensity of the gravitational field. The consequence is clear – the law of conservation of the energy is a local law in any time-spatial domain with equal intensity of the gravitational field. This is a new model of the Universe, which gives the answer of the question about "the origin of the energy" and includes decisions of a lot of problems in the physics today (such as: "the accelerated expansion of the Universe"; "the dark matter and the dark energy in the Universe", etc.), which have been under research for a long time.

4.2. The thesis about behavior of the electromagnetic radiation in gravitational field

As a result of the awareness of all of these experiments, we can make a conclusion about the behavior of the electromagnetic radiation in the Universe. All the "unexpected and inexplicable" results of the notable aforementioned experiments related to the determination of the change in velocity of light, can be explained on the base of the following statements:

1) In the local physical reality (in the areas with the same gravitational potential / areas with equal gravitational field intensity):
   - The velocity of the electromagnetic radiation is a local constant in the empty space (in the reference system related to the space itself).
   - The velocity of the electromagnetic radiation in empty space (in the reference system related to the space itself) depends only on the intensity of the gravitational field and does not depend neither on the velocity of the body of the source of electromagnetic radiation, nor on the velocity of the body of the detector (the Observer).
   - The measured velocity of the electromagnetic radiation in areas with equal gravitational field intensity is not the same for all reference systems. Mathematically, the relationship between the readings in the different reference systems is expressed through Galilean transformations - it is a subject of Newtonian mechanics.

These statements give explanation of the results of all aforementioned experiments carried out on the Earth's surface, where the intensity of the gravitational field is the same and where the units of time and length are defined.

2) In the global physical reality of the Universe (in the areas with different gravitational intensity):
   - The velocity of the electromagnetic radiation in vacuum, "in the empty space", (in the reference system related to the space itself) changes with the variation of the intensity of the gravitational field. In fact, the velocity of the electromagnetic radiation increases in areas with weaker gravitational field and decreases in areas with stronger gravitational field. This is due to the fact that the electromagnetic field exists on the gravitational field.

The examples proving the change of the velocity of the electromagnetic radiation with the change of intensity of the gravitational field are the aforementioned “Shapiro-time-delay effect” and the registered anomalies in the acceleration of the space probes “Pioneer 10”, “Pioneer 11”, “Galileo”, “Ulysses”.

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