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Photon: physical aspects and interpretation at the metaphysical reality level

Abstract

The possibility of the interpretation of physical phenomena at the metaphysical reality (MR) level is used. At this level the Inorganic world is represented as the order of being of three layers – the Active Ether (AE), Micro-objects and Radiation. The characteristic of each layer is given. The force interaction is replaced with the informational one.

The problems of photon and optical radiation duality are overcome at the MR level. A light wave is shown to not exist in nature as a physical reality. A photon is a light quantum, radiation is a photon flux. All the photons in the world are governed by the AE. It is a carrier and executor of the algorithms of all optical phenomena.

The AE implements wave-corpuscle optical phenomena and interactions in two stages. First, it makes a plan. Meanwhile it describes the photon flux in the form of a mathematical light wave. At the MR level the light wave loses its physical status and acquire the status of mathematical light wave, which is used by the AE when making the plans of optical phenomena and interactions. Further it realizes these plans by means of the appropriate control of the photon flux. Typical examples are given.

Section 1. Introduction. In this section we give the concept of a photon established in physics first, following the latest release of "Physical Encyclopedia" [1]. Of course, a historical aspect is inevitably present in this concept. Here is an abridged principal article about the photon from the encyclopedia. “A photon is an elementary particle, the quantum of the electric field. The mass of the photon equals zero, and that’s why its speed equals the speed of light. The spin of the photon equals 1 (in units of $\hbar = h/2\pi$, where h is the Planck constant)”.

“The idea of a photon emerged during the development of quantum theory and relativity theory [the term "photon" was introduced by G. Lewis (G. Lewis) in 1929]. In 1990 M.Planck obtained a formula for the spectrum of thermal blackbody radiation by assuming that the electromagnetic waves are emitted in certain portions - "quanta", the energy of which can take only a discrete set of values that are multiples of an indivisible portion, the quantum $\hbar\omega$, where ω is the electromagnetic wave. Developing the Planck’s idea A. Einstein introduced the hypothesis of the light quanta, according to which the electromagnetic radiation itself consists of such quanta. On the basis of this hypothesis he explained a number of regularities of the photoelectric effect, luminescence, photochemical reactions. Special relativity worked out by Einstein (1905) set the stage for the electromagnetic radiation to be considered one of the forms of matter, and the light quanta - real elementary particles. In the A. Compton’s experiments on the scattering of X-rays it has been established that radiation quanta obey the same kinematic laws, as the corpuscles, in particular, the quantum of radiation with the frequency ω also possess momentum $\hbar\omega/c$, where c is the speed of light”.

“As a result of the development of quantum mechanics became clear that the photon is not singled out among other elementary particles neither by the presence of wave properties manifested in the wave properties of light, nor by the ability to annihilate or to be created in absorption and emission events. All the matter particles, for example, electrons, turned out to posses not only corpuscular but also wave properties”.

In the above-cited encyclopedia paper "Photon", it is actually stated that the photon has an electromagnetic nature and represents an electromagnetic wave packet. Such a packet is characterized by the following physical parameters: frequency (wave length), energy, polarization vector, speed and direction of propagation. The wave packet should also have finite longitudinal and transverse dimensions. Two parameters of the photon, its momentum and spin, manifest themselves in its interaction with micro-objects, the photon’s spin having no classical analog. If the photon is described only by the first group of parameters, we deal with the classical description. The description with taking into account the spin and the momentum is called semi-classical.

The further development of quantum concept in physics gave rise to the emergence of quantum optics, a branch of optics studying the statistical properties of light fields and quantum manifestations of these properties in the interaction of light with matter. Naturally, one of the key issues in optics is - what is a photon? The description of different approaches to the problem of the photon is given in the review [2]. Three basic models of the photon are described in this paper: “Q-photon (a Fock state with c $n=1$ or a superposition of such states), C-photon (a classical wave packet) and M-photon (a hypothetical elementary particle giving rise to individual pulses at the output of photodetectors and still having no definition in the framework of any consistent theory)”. In [2] the existence of other models of the photon is noted, it is claimed that still there is no answer to the main question – what is a photon?

In modern physics the corpuscular and wave manifestation of the photon (light) has been called "wave-particle duality”. This duality turned out to be inherent in all micro-objects. In the “Physical encyclopedia” it is written: “Wave-particle duality is the most important universal property of nature which consists in the fact that all micro-objects possess both corpuscular and wave properties at the same time. For example, electron, neutron, photon in the certain conditions manifest themselves as particles moving along classical trajectories and having a certain energy and momentum, while in other conditions they reveal their wave nature, characteristic of the phenomena of interference and diffraction of the particles. As a primary principle, wave-particle duality is at the heart of quantum mechanics and quantum field theory».

This completes our description of modern ideas about the photon. The foregoing allows to state distinctly the problem of the photon. It consists in attributing to it two incompatible principles – the corpuscular one and the wave one. Having analyzed this situation we arrived at the question: is it possible to solve the problem of the photon in the framework of physics and its research methods? Most likely, no. That is why we came to the conclusion that the solution of the problem of the photon is apparently “beyond physics”, “after physics” and “over physics”. In other words this problem should be regarded at the metaphysical level of physics. This is the primary problem of the present paper. Its solution, in turn, will determine in general the range of problems on the subject of a photon at the metaphysical level of physics. Note, that physics and metaphysics of physics represent two levels of the cognition of nature, the latter following the former and being based on the knowledge system developed in it, in other words, on the modern physical picture of the world.

Section 2. In this section we present the basic principles of the transition from the physical level of the cognition of nature to the metaphysical level of physics. It is recognized in natural philosophy that every science has its own metaphysics. The basis of metaphysics of physics was laid by Aristotle. Turning from physics to the metaphysical level of physics, we proceed from the assertion, that analyzing nature at this level will allow a deeper understanding of fundamental principles of physical phenomena. Hereafter we will use the term "metaphysical reality", abbreviated as MR, instead of the term “metaphysics of physics", what is associated with our recognition of the existence of the veridical metaphysical reality together with the physical reality. We presented our metaphysical view on the Inorganic world in the book [3]. There the gravitational and electromagnetic interactions, including optical phenomena were discussed at the MR level.

At the MR level space and time are recognized, like in physics, to be the fundamental structures of the world. In natural philosophy there is a doctrine of the layers, the understanding of reality as the order of the layers of being. In this context both in the framework of physics and at the metaphysical reality level the Inorganic world, abbreviated the N-world, can be imagined as the order of three layers correspondingly:

- micro-particles (matter),	- micro-objects,
- physical fields and	- the active ether and
- radiation;	- radiation.

Functioning of the N-world includes the being of each layer separately and the interactions between them. The representation of the N-world as the order of three layers in physics is quite logical. The physical fields are the gravitational, electromagnetic, electrostatic and magnetostatic fields. The Layer of radiation includes all types of radiations with the propagation speed equal to the speed of light.

Both in the framework of physics and at the MR level the first layers consist of the same quantum particles – electrons, protons and other atomic nuclei. A distinctive feature of them is that they possess mass, are stable and are considered to be long-living (billions of years). They make up atoms, atoms make up molecules, and so on for all matters and bodies, including the celestial ones.

At the MR level the micro-objects are considered to be active objects of nature. Every object has a Universal system of algorithms, according to which they interact with each other as well as with the layers of the Active Ether (AE) and Radiation. Their activity consists in the ability to estimate the external physical situation they appear in and to determine the corresponding algorithm of their behavior, and then to realize it. They possess informatics – the ability to produce, store, send, receive and process information. In addition, they possess the ability to self-motion and the ability to change their spatial orientation. Micro-objects interact with each other and with the layers of the AE and radiation. The force interaction is characteristic of the treatment at the physical level and is replaced by the informational interaction at the MR level.

The layer of physical fields was replaced with the AE layer at the MR level. The AE is immaterial and is present everywhere in the N-world. It can be understood, following Aristotle, as a specific entelechy of the N-world. «In modern natural philosophy entelechy means effective power, which is not so blind as the physical forces of nature, but is sensible, like human actions. Entelechy is something real, but this reality is not physical or mental, but metaphysical" (Encyclopedic Dictionary of Philosophy, Moscow, 1998). Here we are going not to try to define the essence of the AE, but to figure out and describe its various functions for insurance the functioning of the N-world, including the interaction with layers of Micro-objects and Radiation. Its function for insurance of the gravitational, electrostatic and magnetostatic interactions is considered in detail in another paper that is published together with this one.

Basically, those functions which are implemented be the AE appear to us as relevant aspects of the N-world. These aspects have been studied in physics and keep on being studied in the framework of physics. Our task is to analyze the existing aspects of the functioning of the N-world exactly as the functions of the AE. For the AE to be able to implement its functions, it must possess the Universal system of algorithms, as well as the Means and Methods to realize these algorithms. Let’s list here some of the potentials of the AE. It should have a basic reference grid, the same for the whole N-world. In addition it may also have local coordinate systems which are usually called inertial systems in physics. Further, it should have the potential to control the position and kinetics of all micro-objects in their own coordinate systems and to exercise, if necessary, such a control. The AE possesses informatics - the ability to produce, store, send, receive and process information. Its interaction with the layers Micro-objects and Radiation has an informational character.

At the MR level, as well as in the framework of physics, the layer of radiation includes all the types of radiations, the propagation speed of which is equal to the speed of light. At the MR level the electromagnetic interaction is divided into two types – optical and radio radiation. Their nature and essence are different. In this paper we will regard at the MR level only the problem of a photon and optical radiation. The radiation frequency of cold hydrogen $1.42 \cdot 10^9 Hz$ $(\lambda = 21{,}1 cm)$ may be taken as the lower boundary of the frequency range of optical radiation. Naturally, there is no sharp boundary between the frequency ranges of optical and radio radiation. Their frequency ranges overlap in vicinity of the above frequency $1.42 \cdot 10^9 Hz$. The main role of the layer Radiation is to ensure the information transfer, including the transfer of information about energy. Note the global character of the radiation phenomenon. It exists everywhere in the Universe. This completes the general description of layer Radiation.

To conclude this section we note that the basic elements of the transition from the physical level to the MR level are, firstly, the introduction of the AE into the structure of the N-world, or rather the recognition of the AE level existence in the structure of the N-world, and, secondly, the replacement of the force interaction with the informational one. As has been already mentioned above, the analysis of nature at the MR level is described in more detail in book [3].

Section 3. In this section we first consider the question about the duration of the period of cyclic activity of micro-objects, and then discuss the problem of a photon at the MR level. The being of all micro-objects – electrons, protons and other atomic nuclei – possess activity, which is periodic and consists in monitoring the external surrounding, processing received information and making decision, realizing this. Then the cycle repeats. Let us denote ΔT the duration of these cycles. The status of this parameter is a fundamental constant.

We need to determine the value of ΔT. In our view, an appropriate algorithm, by means of which the value of ΔT can be determined, is contained in the Planck's formula for the photon energy:

$$W = h\nu = h/T, \quad (1)$$

where h is the Planck constant, ν is the photon frequency, T is the period. The needed algorithm has the following form:

$$W = 1\,erg = h/\Delta T, \quad (2)$$

hence

$$\Delta T = 6{,}6262 \cdot 10^{-27} s. \quad (3)$$

This fundamental time constant corresponds to the following length constant:

$$\Delta L_0 = c\Delta T = 1{,}9865 \cdot 10^{-16} cm, \quad (4)$$

where c is the speed of light. Note, that these values of ΔT and ΔL_0 were given in the section “Conclusion” of book [3].

Now let us turn to the phenomenon of a photon, which was considered in detail at the MR level in [3]. Here we are going to give a brief general description, but with some comments. First of all let us answer the question, what is a photon, a corpuscle or a wave? This question can be answered by analyzing the notion of a light wave which obeys the superposition principle. When two light waves arrive at the observation point opposite in phase, we have a zero result: there is no illumination. Arguing that "two light waves arrive at the observation point" we allow their real separate existence at the observation point. In this case we should allow the energy transfer by these light waves as well. Here we have a contradiction between the assertion that two light waves actually arrive at the observation point and the assertion that both the waves themselves and their energy disappear as a result of antiphase superposition. Let us call this contradiction the paradox of light waves. The solution of this paradox consists in the recognition of the impossibility of the existence of a light wave as a physical reality. From here it follows, that the very possibility of formation of such waves by micro-objects is excluded. There remains one variant: micro-objects form corpuscles of light, hence, the photon is a corpuscle of light, which does not possess any wave properties.

Further we have to solve two following problems. Firstly, to give a description of a photon as the corpuscles of light. Secondly, it is necessary to explain the manifestation of the wave nature of light. Note again that we are dealing with the problem of a photon at the MR level. The photon is created by micro-objects, but it does not have the autonomy that is inherent in micro-objects. The micro-objects send the photon to the AE using a certain procedure [3]. Then it is governed by the AE up to its absorption by the micro-object, after what it ceases to exist. The AE controls all the photons in the Universe since their formation by micro-objects up to their absorption after that they cease to exist.

The substantial cores of all the photons are of the same type, irrespective of their energy. They are localized in the volume with unidimensional characteristic (4) – $\Delta L_0 = 1{,}9865 \cdot 10^{-16} cm$. The photon is at rest during the period of time (3) $\Delta T = 6{,}6262 \cdot 10^{-27} s$. Then the AE annihilates it and creates in an adjacent region of space. In this region the photon is at rest again during the period of time ΔT. Then the cycle repeats. One can also assume that the instant of creation of the photon by the AE is separated from the instant of its annihilation by a certain period of time: $\Delta t_0 \leq 0{,}5\Delta T$. In other words, information about the photon can stay in the AE memory for the time Δt_0 in each period ΔT. Thus, the AE moves all photons in space step by step, with the step size ΔL_0. This is kinematics of the photon motion in space. The mean velocity of the photon motion is $2{,}9979 \cdot 10^{10} cm / s$.

As has been mentioned, the substantial cores of all the photons are of the same type, irrespective of their energy. It also means that information about its energy is not contained in its substantial core. This information is contained in the AE memory. Energy is the first basic parameter of the photon, the second one is the direction of its spatial orientation. Looking ahead, we note that the wavelength of the photon is a parameter derived from its energy and is located in the AE algorithms.

Photon is at rest in each cycle of motion. In this state it exhibits itself to external observers, which in the N-world are the micro-objects. They recognize the photon, if it is within the scope of their external view with the radius of the order $10^{-7} cm$. In the state of rest the photon also exhibits its spatial orientation, which is detected by micro-objects. The spatial orientation of the photon forms the basis for the notion of its spin and polarization of light. Meanwhile, the quantum theoretical concept about the spin and the quantization of its projections on the preferred direction goes back the corresponding AE algorithms.

The geometric model of the photon can be represented in two forms (Fig. 1). In both models, the substantial core of the photon has a spherical shape with the diameter ΔL_0. In the first variant the metaphysical feature of the vector $\vec{p}$ showing the spatial orientation of the photon is contained in the substantial core (Fig. 1a). In the second variant the substantial core of the photon is accompanied by a metaphysical point 2 (Fig.1b), which exhibits itself and, accordingly, is recognized by micro-objects.

a) b)

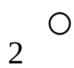

Fig. 1. Geometric model of a photon:
1 – the substantial core of the photon,
$\vec{p}$ – the vector of the spatial orientation of the photon,
2 – metaphysical point.

The distance from the substantial core center of the photon to the metaphysical point 2 is ΔL_0. In this variant, considered in book [3], the metaphysical point 2 indicates the direction of the spatial orientation of the photon. In both cases the vector $\vec{p}$ is located in the plane perpendicular to the direction of the photon motion. The AE controls the metaphysical point 2 as well as the core of the photon. In our view the second variant is preferable.

It is well known that energy is not a substance. The micro-object creating a photon also gives the AE information about the amount of its energy. This information is stored in the AE memory and transferred to the micro-object by absorption of the photon. As has been mentioned, the photon is characterized by two basic parameters – by the energy W and the direction of spatial orientation, shortly by the vector $\vec{p}$. The lower boundary of the photon energy range W corresponds to the energy of cold hydrogen $9{,}41 \cdot 10^{-18} erg$ $(\lambda = 21{,}1cm)$, the upper one corresponds to the energy of the photon γ of $6{,}63 \cdot 10^{-4} erg$ ($\nu = 10^{23} Hz$). The orientation of the vector $\vec{p}$ varies from 0 to 360° in the plane, perpendicular to the trajectory of their motion. It is important to note that the scale of the range of these two parameters of photons characterizes their informational potential. To this point we shall return later.

We have mentioned above, that the micro-object creates a photon and sends it to the AE using a certain procedure [3]. Further the AE governs the photon up to its absorption by another micro-object. The main types of the control are the insurance of the photon motion in space along a linear trajectory, the change of the direction of motion, the insurance of reflection and refraction at the boundary of two media, the motion in a material medium. The annihilation of the photon by the AE in one place and its creation elsewhere plays an extremely important role. The AE can move the photon both explicitly and implicitly. In the latter case it moves the photon in its memory as an information packet, the photon being not able to exhibit itself to external observers. Most likely, such a transfer of the photon can take place in a rarefied cosmic space.

So far we have considered the motion of the photon in space at the speed of light. In a material medium the speed of the photon is less than that of light:

$$V = c/n, \tag{5}$$

where n is the refractive index. Such a speed is ensured by the AE by means of a periodic delay of the photon in one place.

The AE ability to annihilate and create photons suggests that it may be a source of them itself. It is a separate issue, in what cases and for what purpose it can create photons and hence be the author of illusory visions of objects. This topic requires further study taking into account optical phenomena of nature having random character. It may be also noted here that one of the important consequences of such possible AE activity can be the assumption about the similarity of a remote part of the Universe sphere to the demonstration planetarium. This aspect of the issue was discussed in [3].

For the further discussion we need to determine the description of a light beam at the MR level. A beam of light is always and everywhere, including inside any optical device, a flux of photons distributed randomly. Estimates show that the probability to find even two photons in one place is small under normal lighting conditions. In principle, if two or more photons meet in one place, it would not result in any physical consequence, as photons do not interact with each other. In most cases, the direction of the spatial orientation of different photons in the light beam is arbitrary (the radiation of the Sun, stars, the majority of artificial light sources). Only in a limited number of cases, the light beam is polarized, for example, laser beams, the light at the output of the polarization devices.

Section 4. In this section we discuss at the MR level the manifestation of the wave nature of the photon and light. The photon is a corpuscle of light, it does not possess any wave properties. Therefore, in the remainder of the paper we will speak of the wave manifestations of light, of a ray of light, which is a flux of photons. The AE governs all the photons in the Universe, it is the author of all optical phenomena whose plans are stored in its Universal algorithm system. Accordingly, the AE ensures the manifestations of the wave nature of light. The above allows us to solve the wave-particle duality paradox of the photon and light, the corpuscular and wave manifestations of light being kept as primary principles. Corpuscular manifestations of light are clearer, as light consists of particles - photons. Wave manifestations of light are ensured by the AE through the appropriate control of the photon flux, what leads to the increase of the number and variety of optical interactions, as well as to the great increase of the information capacity of the photon flux. To these aspects of optics we return below. Historically, ray optics appeared first, then wave optics and at the beginning of the XX century – quantum optics.

In the universal AE algorithm system there are both standard plans of optical interaction and principles of their routine planning. The AE implements the routine planning of optical interactions and their realization everywhere and continuously throughout the Universe. Note, that the planning is realized only where there are micro-objects and matter with which photons interact. The planning is realized in the form of both quantum and wave interactions. In the latter case the corresponding AE algorithms contain the secondary parameter of the photon, its wavelength which is connected with the energy of the photon W by the Planck's formula:

$$\lambda = ch/W = 1{,}9865 \cdot 10^{-16}\, эрг \cdot см / W \,, \qquad (6)$$

Note, that this form of the Planck's formula is basic at the MR level, because it relates the primary parameter of the photon (W) to the secondary one (λ). In addition, in its plans of optical interactions the AE uses the representation of the photon flux in the form of a harmonic function

$$\vec{a} = \vec{a}_0 \cos[2\pi(ct - x)/\lambda], \qquad (7)$$

where $\vec{a}_0$ is the maximal amplitude, t is time, x is distance. The representation of the photon flux in form (7) corresponds to the notion of a light wave in optics. Thus, at the MR level we have necessarily to replace the light wave which does not exist as a physical reality with a mathematical light wave in form (7). As we see, the status of the notion of a light wave is changed at the MR level.

It is commonly thought in wave optics that the description of light by harmonic function (7) corresponds to its nature. At the MR level the optical interaction, in which wave manifestations of light are observed, should be considered to take place in two stages. At the first stage the AE determines the plan for the optical interaction. Either it uses a standard plan contained in its memory or it makes a plan of the optical interaction taking into account the specific physical situation. All the classical results of the theoretical description of optical interactions in the framework of wave optics are interpreted at the MR level as AE plans. Moreover, the former ones go back in the latter. At the second stage the AE realizes the plan of the optical interaction. It governs all the photons in the

Universe, respectively. It is it who realizes the optical interactions using various methods of the photon flux control. Here again let us repeat the main types of the AE control over the photons. It ensures the motion of a photon along a linear trajectory and the change of the direction of its motion, ensures the reflection, refraction at the boundary of two media, motion in a material medium, change of the polarization of a photon, regulates the intensity of the photon flux. In the process of the realization of the optical interactions the AE ability to annihilate photons in one places and create them elsewhere plays an important role.

Here we can note the following. In optics the term “wave properties of light” is used. It follows from the above that at the MR level this term should be replaced with the term “wave properties of light ensured by the AE”.

From the methodical point of view, at the MR level it is expedient to analyze every optical phenomenon individually. In [3] a number of optical phenomena were analyzed. The most typical of them is two-beam interference of light as in the Young’s double-slit experiment [1], [4]. In this experiment superimposing of the light beams from two cophased point sources of light occurs. Interference is observed at the point of overlapping of two light beams in the far-field region in the form of a series of light and dark bands. In the classical theory of this phenomenon light rays are described as mathematical light waves (7). Here we shall not present this theory, it can be found, for example, in [1] and [4]. However, note the following. In optics there is the law of the independence of light beams. In the phenomenon of two-beam interference the violation of this law takes place. In classical theory, this issue is not commented. In addition this theory cannot answer the question: at what distance from light sources does the law of the independence of light beams cease to be valid and interference takes place? The question about the mechanism of redistribution of the initial light fluxes - a mechanism of forming the interference beams seems essential.

This phenomenon was discussed at the MR level in detail in [3]. Below we give the summary of this discussion. The classical theory of two-beam interference represents a corresponding AE plan of this phenomenon. More precisely, the classical theory goes back to the corresponding AE algorithms. It realizes the plan of this phenomenon in the following way. The angle of impact of two light rays decreases with increasing distance from the light sources and at a certain distance it takes a value of γ_0. This parameter does not depend on the wavelength, and according to our estimates, amounts to about 20 seconds of arc. The locus where the angle of impact of two light beams is γ_0, we shall call the critical surface (K-surfaces). In the space limited by the K-surface the law of the independence of light beams holds valid. At this surface The AE implements the corresponding redistribution of the photon flux from two sources. Firstly, it outlines base areas and angular domains on the K- surface for each future interference beam. Then it annihilates in each base area half of the total number of all photons and further creates them in other places, but within each area. This way it ensures the corresponding distribution of the photon flux in each interference beam. To provide the change of angular parameters of the photon motion in the interference beams, the AE implements the appropriate change of the initial direction of all the photons on the K-surface. This concludes our brief description of the treatment of the two-beam interference of light at the MR level. Note, that in book [3] diffraction by the border of a semiplane is discussed in detail at this level.

As the light wave does not exist as a physical reality, a standing light wave cannot exist as a physical reality as well. However, the AE uses the idea of it in its activity, for example, under the conditions of the Wien’s experiment [4]. The questions about the interpretation of a standing light wave were discussed at the MR level in detail in [3].

To conclude this section, note the following. In classical physics the optical interactions are divided into two categories. Those interactions, where only corpuscular properties of light manifest themselves, belong to the first category. The most typical examples are the photoelectric effect and the Compton effect. The second category includes those in which the wave properties of light manifest themselves. The most typical examples are interference and diffraction of light.

At the MR level the first category of phenomena is supplemented with emission and absorption of photons by micro-objects. This category of phenomena can be grouped under the name "quantum optical effects or interactions". Respectively, the second category of phenomena can be grouped under the name "wave-particle optical effects or interactions".

Section 5. Micro-objects create photons and send them to the AE. It receives the photons and then governs them till the instant of their absorption by micro-objects. It ensures the interaction of photons and matter throughout the Universe, with everything on the Earth and with artificial optical devices. In [3] some examples of the interaction of the photon with optical devices were examined at the MR level, including the Fabry–Pérot and Mach–Zehnder interferometers. In this section we revisit these interferometers in order to demonstrate how exactly the AE ensures the interaction of the photon flux with them. Let us give additional explanations of relevance. Note that in the Fabry–Pérot and Mach–Zehnder interferometers the most typical cases of the wave-particle optical interaction of the photon flux take place.

First let us consider the Fabry–Pérot interferometer consisting of two glass or quartz plates separated by some distance (Fig. 2). The facing surfaces are treated with an accuracy of about 0.01 of the visible light wavelength and are coated with reflective coating. Reflective surfaces of optical mirrors are set strictly parallel to each other. The possibility of adjusting the separation of the reflecting surfaces d is provided for.

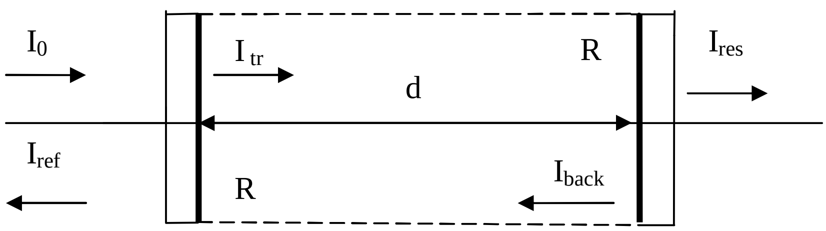

Fig. 2. Fabry–Pérot interferometer

In optics the interaction of the ray of light with the interferometer is considered in the following way. The ray of light is described by a mathematical light wave in form (7). Next, multiple transmission of this wave through the interferometer is taken into account resulting in a system of partial waves with decreasing amplitudes which form a geometric progression both at the output and at the input. Naturally, at the input these partial waves propagate in the opposite direction relative to the initial wave. Next, the sum of the partial waves is calculated both at the output and at the input, and then one turns to the intensity of the light beam. As a result, the following formulae are obtained:

$$I_{res} = I_0 \frac{(1-R)^2}{(1-R)^2 + 4R\sin^2\varphi} \ , \tag{8}$$

$$I_{ref} = I_0 \frac{4R\sin^2\varphi}{(1-R)^2 + 4R\sin^2\varphi} \ , \tag{9}$$

$$I_{tr} = I_{res} / (1-R) \ , \ I_{back} = RI_{tr} \ , \tag{10}$$

where I_0 in the initial intensity of light, R is the energy reflection coefficient of the optical mirrors. In (8) and (9) the phase φ depends on the ratio of the interferometer length to half the wavelength and varies from 0 to π, if we ignore integer multiples of π. Note, that the derivation of formulae (8) and (9) can be found, e.g., in [4].

Now let us turn to the analysis of the wave-particle optical interaction of the photon flux with a Fabry-Perot interferometer at the MR level. Note, that under I_0 in formulae (8) and (9) the intensity of the photon flux at the input of the interferometer should be meant. The AE performs the optical phenomenon under study in two stages. At the first stage it makes a plan of the interaction, at the second stage it realizes this plan. The AE activity for making the plan of the optical interaction may be regarded as analogous to the classical analyses of the interaction of mathematical light wave (7) with the interferometer. Relations (7) and (8) are in a good agreement with experimental data. This suggests that, as a result of planning the optical interaction, the AE arrives at the same algorithms (8) (9) and (10). However, here we should keep in mind the following. In principle, we do not know in advance the algorithms used by the AE. Nevertheless, we are sure that the results of our analysis of physical phenomena go back to the respective AE algorithms, particularly, formulae (8), (9), (10) go back to them.

Now let us turn to the second stage of the AE insurance of the optical interaction under study – the realization of algorithms (8), (9) and (10). Here, first of all the following should be noted. The mathematical light wave reflected off the interferometer consists of two components. The first component is a fraction of the incident wave reflected off the input mirror. The second component is a fraction of the backward wave in the interferometer, which came out through the input mirror. By analogy, one can assume that I_{ref} – (9) will consist of two components. However, this is not the case. As was shown in [3], I_{ref} – (9) represents just a fraction of I_0, 'reflected' off the input mirror. Respectively, in the interferometer I_{back} is completely 'reflected' off the input mirror and becomes a part of I_{tr}.

This conclusion derived in [3] may be confirmed as follows. The main balance equation has the form

$$I_0 = I_{ref} + I_{res} \quad . \tag{11}$$

The balance equation at the output mirror is

$$I_{tr} = I_{back} + I_{res} \quad . \tag{12}$$

At the MR level under these parameters the intensities of photon fluxes are meant. From (11) and (12) it follows that

$$I_{tr} = (I_0 - I_{ref}) + I_{back} \quad . \tag{13}$$

The difference $(I_0 - I_{ref})$ is a fraction of I_0 transmitted into the interferometer through the input mirror. The second term in (13) is I_{back} completely reflected by the input mirror inside the interferometer. Thus, when realizing algorithms (8), (9) and (10) the AE performs a complete reflection of I_{back} by the input mirror and forms I_{ref} – (9) as the difference $(I_0 - I_{res})$ by means of its reflection by the input mirror of the interferometer.

Note that when the length of the interferometer d is a multiple of half the wavelength λ, respectively in (8) and (9) $\varphi = 0$ or π, then I_{ref} becomes zero. Then it becomes obvious that the AE completely reflects I_{back} off the input mirror inside the interferometer. In this case simple relations are fulfilled: $I_{res} = I_0$, $I_{tr} = I_0 + I_{back}$.

Here we can note the following. The attempt to regard the intensity of the photon fluxes I_{back} and I_{ref} as a sum of two components fails. The corresponding equations for these hypothesized components have no solutions.

Now let us turn to the consideration of the wave-particle optical interaction of the photon flux with the Mach–Zehnder interferometer (Fig. 3). The incident light beam is divided into two beams at the reflective layer of the semitransparent mirror P_1. Completely reflected by the plane mirrors M_1 and M_2, they recombine, precisely put, they are superimposed on each other at the reflective layer of the second semitransparent mirror P_2. The four reflective surfaces are set parallel to each other. Usually such an interferometer is used to obtain fringes of equal inclination by means of smooth rotation of the mirrors at a slight angle, e.g., rotation of the mirror M_1 around the axis perpendicular to the plane (Fig.3).

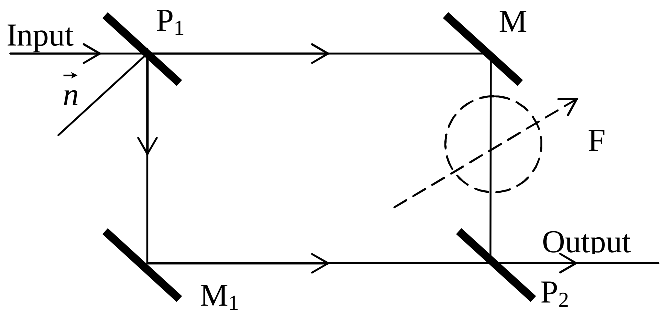

Fig. 3. Scheme of the **Mach–Zehnder interferometer**

Here we consider another mode of operation of the interferometer. A mathematical wave of form (7) arrives at its input. In one of the arms of the interferometer there is a device F which allows to adjust smoothly the optical length in the range from 0 to λ. In the framework of the classical approach the rate of the luminous flux at both outputs of the interferometer will be

$$I_{res} = 0{,}5 I_0 \cos^2 \varphi \quad , \qquad (14)$$

where I_0 is the rate of the luminous flux at the output, φ is the phase shift of the light wave which has transmitted through the device F relative to phase of the light wave transmitted through the second arm of the interferometer. Meanwhile, for the luminous conservation law to be fulfilled one needs to assume the existence of a reflected light wave at the output of the interferometer with the intensity

$$I_{ref} = I_0 \sin^2 \varphi \quad . \qquad (15)$$

We have had no opportunity to review all the publication on this subject. The scheme on Fig. 3 and the formulae are given in Ref. [2]. Judging by the text, the author of paper [2] has no doubt about the correctness of his analysis of the interaction of the light beam with this interferometer However, here we have questions. First of all, are relations (14) and (15) confirmed experimentally? We do not have reliable information on this subject. Perhaps there have been no experiments altogether performed according to the scheme on Fig. 3.

Now let us interpret at the MR level the wave-particle optical interaction of the photon flux with the Mach–Zehnder interferometer as shown on the scheme of Fig. 3. Let us assume that relations (14) and (15) are fulfilled in experiments. It means that these relations belong to the AE as a plan of the optical interaction. Further the AE realizes this plan by means of an appropriate control over the photon flux. Meanwhile, two variants are possible. In the first variant the direction of the reflected photon flux is opposite to that of the initial photon flux. In the second case the direction of the reflected photon flux coincides with the normal $\vec{n}$ to the surface of the input mirror. Respectively, the reflection angle is 45°.

However, here the variant of purely quantum optical interaction should be considered possible though unlikely. In this case at both outputs of the interferometer a constant rate of the photon flux would be observed independent of the optical length variation of one of the interferometer arms in the range from 0 to λ.

What a variant of the optical interaction does the AE use exactly? This question can be answered only in an experiment.

Section 6. To summarize let us briefly list the main results of the interpretation of the photon and optical radiation at the MR level.

1. The solution of the problem of the photon and wave-particle duality of optical radiation is assumed to be impossible in the framework of physics and its research methods.

2. A transition to the next level of cognition of nature, the level of metaphysical reality (MR), is assumed. At this level the Inorganic world is referred to as the order of being of three layers – the Active Ether (AE), Micro-objects and Radiation. The characteristic of each level is given. The force interaction is replaced with the informational one.

3. The problem of the photon and duality of optical interaction has been discussed at the MR level. A photon is a corpuscle and wave properties are not inherent in it. All the photons in the Universe are governed by the AE from the instant of their creation by micro-objects to the instant of the absorption by them. Accordingly, the AE is the carrier and executor of the algorithms of optical phenomena and interaction.

4. There is no light wave in nature as a physical reality.

5. The AE algorithms provide for two kinds of optical phenomena and interactions: (1) – quantum interaction, e.g., photoelectric effect, Compton effect; (2) – wave-particle interaction, e.g., interference and diffraction.

6. The AE implements the wave-particle optical interaction in two stages. First it makes a plan of the optical phenomenon or interaction using the description of optical radiation in the form of a mathematical light wave, and then it realizes this plan by means of an appropriate control over the photon flux. As an example the description of the procedure how the AE ensures the two-beam interference of light, as well as of the wave-particle interaction of the optical radiation with the Fabry–Pérot and Mach–Zehnder interferometers is given.

7. By governing the photons the AE can annihilate them in one place and create in other places, e.g., this takes place by the insurance of the phenomenon of the two-beam interference of light. Starting from that it is assumed that the AE is able to generate photons on its own, in accordance with its own purposes.

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