Nature of the light

1. Photons as positively charged particles

Light is a stream of positively charged particles, namely photons. For now, let's take this as an axiom, which in the future will not contradict any of the facts and will be supported by evidence. As an example, the fact of acquisition of a positive charge by the Earth and some materials under the influence of sunlight can be given. Or take the case when the electron jumps to a lower orbit with the emission of a photon. This fact can be interpreted as an increase in the negative charge of an electron, which is more strongly attracted to a positively charged nucleus. Consequently, by virtue of the law of conservation of charge, the emitted photon must have a positive charge. The very definition of light as an electromagnetic wave speaks of the electrical nature of light. By the way, the charge of the photon in physics is equal to $q < 3 \cdot 10-33e$, but not zero! [1] All the facts presented in this article confirm this concept. Let us now turn to some light phenomena that were previously inexplicable by the corpuscular theory of light: refraction, dispersion, diffraction, polarization.

2. Refraction and dispersion

Dielectrics have an electric double layer with the positive electric charge on their surface. This is caused by displacement of surface electrons deep into the object. Between the surface charge and the negative charge of displaced electrons, a potential difference is formed. This is a kind of capacitor.

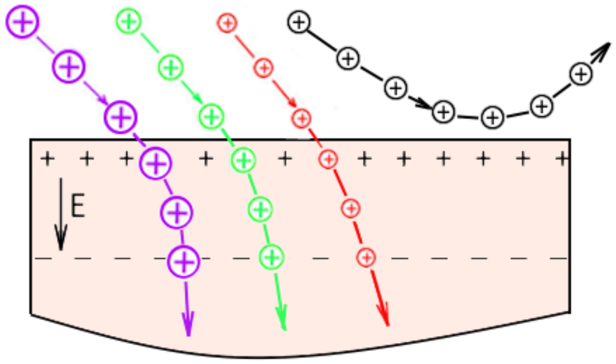

Fig.1

The «violet» photons have a charge (or q/m) greater than «red» ones, and therefore they refract more strongly from the electric field. There is dispersion of light. With a sliding angle of incidence (black color in the Fig.1), the photons do not have time to penetrate deep into the object and are reflected from the surface by the action of electric repulsive force. With a sliding angle of incidence (black in Fig.1), the photons of all colors do not have time to penetrate deeply into the object and are reflected from the surface by the action of an electric repulsion force.

3. Single - slit diffraction

The beam of light fall to the single slit. The forces of mutual electrical repulsion act on photons in a beam of light. These forces tend to expand the beam, but the force of mutual magnetic attraction (the Ampere force) act on the photons, keeping them in a beam.

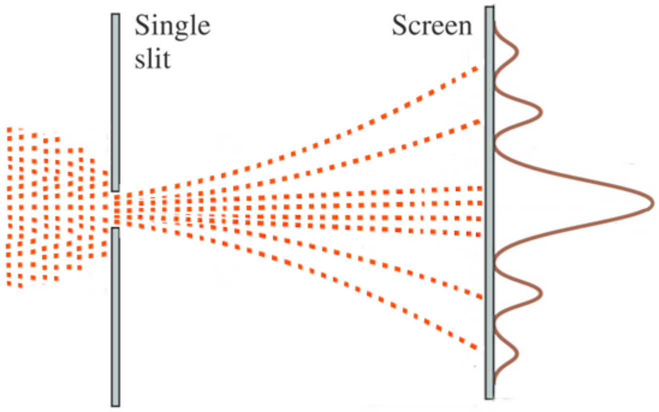

Fig.2

Having passed a narrow slit, the beam of light becomes so thin that the forces of magnetic attraction lose their dominance, and external photons begin to move away from the beam. Then the following internal photons become external and move away from the beam, and so on.

But now the forces of repulsion are already acting on these photons both from the side of the beam and from the side of the previously divorced photons. As a result, they are somewhere in between them. The same thing happens with subsequent photons separated from the beam. They appear on the screen at equal distances between them. At the same time, most photons fall into the center of the screen, not having time to disperse on the way to the screen. The greater the photon charge, the longer it is held by magnetic forces in the beam and is scattered to a smaller angle. Since violet photons have greater charge, they form a denser diffraction pattern with smaller distances between intensity maxima.

4. Diffraction of a single photon

It would seem that the phenomenon of diffraction of a single photon should represent an insurmountable difficulty for the corpuscular theory. How can a photon interact with itself? After all, even the wave theory of light here gives up and resorts to using a statistical interpretation of the position of the photon! Now it turns out that a particle (photon, electron ...) can be anywhere with any probability!

To put it mildly, this assumption is not very convincing. On this occasion, Einstein said: «God does not play dice!». Let’s try to explain this phenomenon.

The fact is that the charged particles get on the screen and stay there. Then they begin to interact with new arriving particles. Namely, they repel them from themselves in checkerboard order: up and down,up and down…(see the Fig.3).

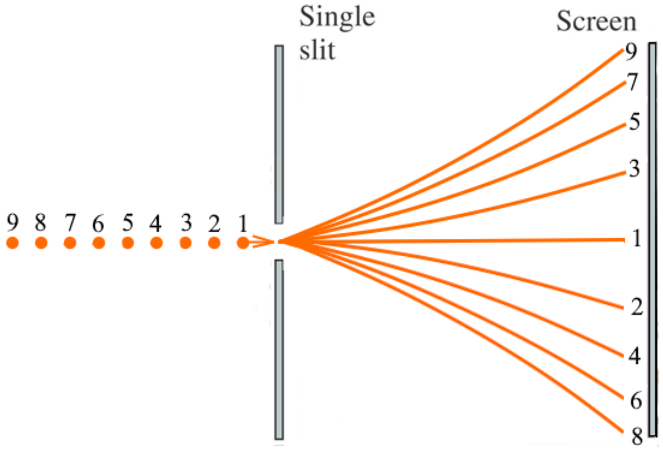

Fig.3

Mathematical modeling of this process has shown that the particles will be located at multiple distances from the center of the screen. In Fig.3, these particles are numbered in the order they hit the screen.

The distance between the maxima in the screen depends on the charge, mass and speed of the particles. Physically, this happens as follows.

The first particle hits the center of the screen. The second particle, having an insignificantly small initial downward (or upward - does not matter) deflection upon departure from the liht source, will begin to increase this deviation under the action of the repulsive force from the first particle. The third particle will be repelled from the first pair of particle in the screen, and since their common electical center is below the center, the third particle uniquely deflects upward. The fourth particle can deviate both upward and downward, since in front of it in the screen there will be a symmetry of the particles with respect to the center.

This does not change the essence of the matter. For simplicity and clarity, Fig.5.3 shows its deviation downward as for all even particles.

Now the preponderance of repulsive forces will be at the bottom side, and the fifth particle will uniquely deflect upwards. And so on.

It’s simplified. Now consider a few details. Initially, a certain critical mass of the particles accumulates in the center of the screen, like a cluster. Subsequently, it will play the main role in the repulsive force module for new particles, but the direction of their motion («railroad switch») will be determined by the alternating asymmetry of the charges in the screen.

It will be necessary to do similar experiments, but only with the grounded for removing static charges off the screen. Or it will require a single fixation of the particles with their subsequent erasure from the screen.

Most likely diffraction pattern will not be observed.

5. Speed of light in different media

The classical theory does not say anything inteligible about this apart from the fact that the speed of light in a given medium depends of refraction index of a given medium and the retractive index depends on the speed of light in this medium!

Einstein’s «crowbar» explanation of the refraction of the light looks very clumsy.

If, they say, to imagine the wavefront in the form of a crowbar, then approaching a denser medium (sand) at an angle the crowbar will first touch at the sand with its near-end, as a result will be braked, and the far crowbars end will start to rotate around this point of the contact. This will change the direction of the wavefront (crowbar) in the sand. Famously! And how will crowbar again increase its speed when leaving sand?

But all this is explained quite simply. Light (photon) does not change its speed at all, it just needs to overcome a longer and tortuous path between the atoms of a denser medium. Therefore, leaving this medium, he does not need to increase his speed, which has not changed at all. Outwardly, it looks like a change in speed during the passage of this medium.

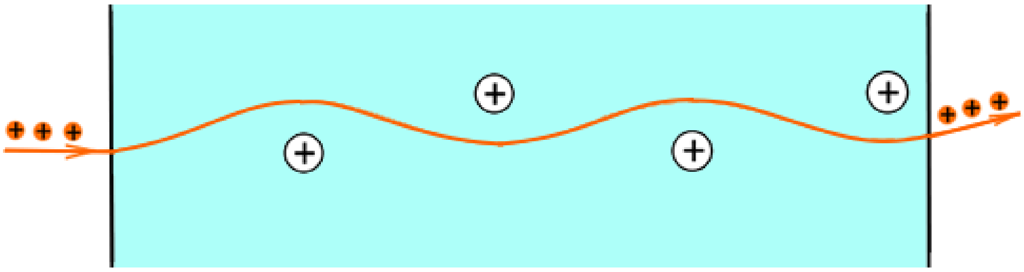

Fig.4

Such a winding trajectory of photon motion also explains their scattering. The angle of photon exit from the medium depends on the direction of its movement at the moment of exit from the medium (in Fig.4 this is slightly up). And since each photon has its own trajectory, the exit angles will be different.

Let’s look at the propagation of light in the water. Strange as it may seem, the structure of the water is still not precisely defined! For the sake of simplisity, we take the tetrahedral form of the water, that is not too far from the truth. The trajectory of photons in the water will,of course, differ from its simplified representation in the Fig.4, and mainly because it is not a plane (2D) curve but a three-dimensional (3D) cylindrical spiral (Fig.5).

Fig.5

The Fig.6 shows the 2D-trajectory of the photon in the water.

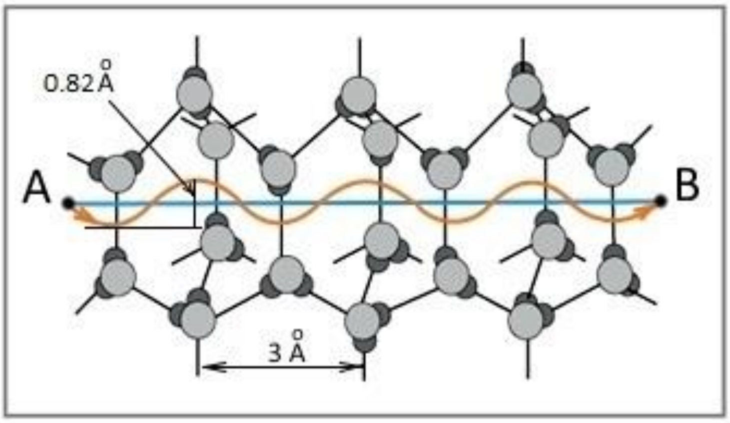

Fig.6

The length of the spiral trajectory of the photon must be **1.33** times larger than the blue straight line AB, since it is considered that the velocity of the light in the water is **1.33** times less than in the vacuum. Knowing the average distance between the water molecules (**H = 3 angstrom**) and the length of one turn of the spiral **L = 1.33H**, we easily find the diameter of the spiral **D = 0.82** angstrom by the formula:

$$L = \sqrt{H^2 + \pi^2 D^2} \qquad (1)$$

It is under such conditions that the photon overcomes the distance from p.A to p.B by **1.33** times slower than in a straight line, and it seems to us that its speed in the water is **1.33** times less than in the vacuum!
The light speed in any media is a constant value **$C = 3 \cdot 10^{8}$ m/s**!

Take for example a glass with the refractive index **n = 1.6**. It also has the same tetrahedral structure with the distance between the atoms **Si** and **O** equal to **1.6 angstrom** (an interesting coincidence!). The diameter of the photon’s spiral trajectory in glass will be equal to **0.64 angstrom**.

This is understandable because the denser the atoms are, the less time there is for photon to deviate to each of them. The range of its oscillations will decrease from **0.82** in water to **0.64** in glass. If we knew the electric charge density between the atoms, then we could determine from these data the charge of the photon, or rather the ratio of the charge to mass (**q/m**)!

6. The Fizeau experiment

In his famous experiment, Fizeau wanted to discover the entrainment of the luminiferous ether by the flow of water. For To do this, he fed water under pressure into the pipe and passed two rays of light through this flow: one the flow of water, the other against. These two beams were then combined in an interferometer. It was assumed that flowing water will carry with it the ether and, consequently, the speed of the light beam in the same direction will be greater by the amount of water flow velocity, and against the current - less. It turned out that the beam of light is carried away by the ether, but only partially. Explanations for this phenomenon are quite complex.

Everything is explained much more simply.

Fig.7 shows the paths of the photon: in still water - **S1**, against the flow – **S2**, with the flow – **S3**.

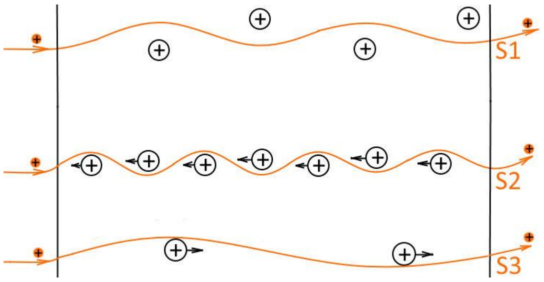

Fig.7

The speed of light is constant in all media. Due to the difference in their density, expressed by the refractive index n of the medium, the photon has to travel a more or less tortuous path, that is, a greater or lesser distance.

When a photon moves towards the flow of water, it encounters more atoms of the medium on its way, which seem to run into it. In this case, the photon travels a greater distance, going around each of the atoms (**S2>S1**). This is perceived as an increase in the density of the environment.

And when it moves in the same direction as the water, it encounters fewer atoms, which, so to speak, float away from it, as if reducing the density of the water. The distance covered is less (**S3<S1**).

Now a little more specific. Let's return to the parameters of the trajectory of photons in water and glass, given in the previous paragraph (Fig.6).

When a photon propagates in water moving along with it at a speed of **U = 10 m/s**, the period of the spiral **H** increases from **3** to **3.000000133 angstroms**, the diameter of the spiral does not change, and the “increase in speed” of photons (formula 1) will be ***Δ*V = 4.39 m /s**. Theory, but, in fact, an empirical selection by physicists of the formula (because the theory failed here):

$$\boldsymbol{\Delta} \mathbf{V} = (\mathbf{1} - \mathbf{1}/\boldsymbol{n}^{\mathbf{2}})\mathbf{U}, \tag{2}$$

gives us an increase in the speed equal to **4.35m/s**.

As you can see everything fits perfectly!

When a photon moves in a moving, denser (say, glass) medium, there will be an increase the spiral period from **1.6** to **1.600000085 angstroms**. In this case, the speed of passage of a photon through a section of water (not the photon speed itself!) according to our calculations (formula 1) will increase by **6.09 m/s**. Physical theory gives exactly the same result – **6.09**!

Q.E.D. It's all about the winding slalom of photons between the atoms of the medium.

It should be repeated again. The photon speed in any media is a constant value **C = 3 · $\mathbf{10^8}$ m/s**!

7. Polarization

A photon is not just a charged particle, it is also an unevenly charged particle - a kind of dipole. This, generally speaking, is a minimal assumption compared with the characteristics that physics imparts to a photon: mass, electric charge, spin, parity, C-parity, condensed, wavelength, circular polarization, energy, angular frequency, helicity. In principle, any charged particle: whether it is a dielectric or a conductor, or a plazma, - it will be an unevenly charged particle, exept perhaps evenly charged dielectric sphere, which is not so easy to get! Imagine a photon in the form of a drop. The form doesn’t matter. Then at the narrow end of the photon the electric charge density will be greater and this end can be considered a positive pole of the dipole.

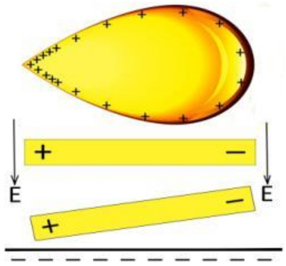

Fig.8

This does not mean that the photon is a full-fledget dipole, but simply means that the photon in the external electric field will not remain stationary, but will be oriented in accordance with the electric field lines. It will be attracted to the negatively charged surface on the left side more than on the right side (see Fig.8). In other words, it will turn.

Let's try to explane the phenomenon of polarization of reflected light. The orientation of photons in space is chaotic. There is no priority direction. In other words, the photon orientation is not two-dimensional 2D (X-Y), but three-dimensional 3D (X-Y-Z). Chaotically oriented photons fall to the glass plate. The vector of each of them can be decomposed into 6 spatial components: +X,+Y,+Z (orange colour in the Fig.9) and –X,-Y,-Z (blue). Let us consider the process of reflection of each of these components.

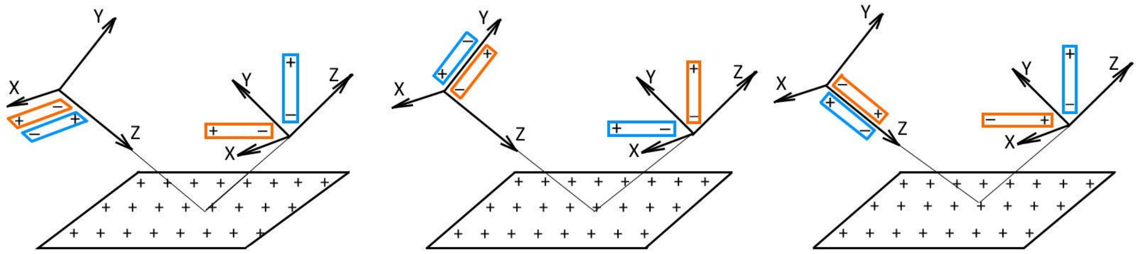

Fig.9 a) b) c)

Recall that the dielectric glass has the positive charged surface.

1. Reflection of the X-component (Fig.9a).

When approaching the glass, the positive end of the dipole will begin to repulse from it, thereby rotating the dipole in the X-Y plane. As a result, after reflection, the dipole will occupy some intermediate position between the X and Y axes.

Thus, dipole lose part of its X component and instead obtained a +Ycomponent.

2. Reflection of the Y component (Fig.9b).

When approaching the glass,the positive end of the dipole will begin to repulse from it thereby turning the «orange» dipole to the vertical position and the «blue» dipole to the horizontal position. After reflection both dipoles will occupy some intermediate position between the axes Y and Z, losing, at the same time, part of their Y-component. It is interesting that both dipoles will have a positive +Y component! As a result, the «orange» dipole will gain +Z component and the «blue» dipole will gain -Z component.

3. Reflection of the Z-component (Fig.9c).

After reflection the «orange» dipole will lose some of its Z-component by Y-component in return and the «blue» dipole will change its Z-component from minus to plus and will gain +Y component in return.

Now let's imagine all these metamorphoses in numerical form. Until the moment of falling to the glass surface, the dipoles did not have any priority orientation in space. In Figures 9 we can see that the polatity of the dipoles is compensated for all axes. Let's take the magnitude of their initial dipole moment along the axes X,Y,Z, respectively, per **1**.

Then initially along the axis X we had two dipoles: **+1.0** and **-1.0**. Similarly with axes Y and Z.

After reflection, the summary dipole moments along the axes will be distributed approximately like this:

- along the X-axis: **+0.5** and **-0.5**;
- along the Y-axis: **+3.5** and **-0.5**;
- along the Z-axis: **+2.0** and **-0.5**.

This means that when reflected from the glass, the dipoles will mainly reorient in the +Ydirection, and also (two times less) – in the +Z direction, due to the X-oriented dipoles in the main.

Thus, a partial polarization of the light occurs.

Let's consider two more interesting aspects.

If the angle of incidence is greater than the Brewster's angle, then the degree of polarization will increase as this is shown by experience:

- along the X-axis: **+0.2** and **-0.2**;
- along the Y-axis: +**4.0** and **-0.2**;
- along the Z-axis: +**1.2** and **-0.8**.

If the angle of incidence is close to vertical angle.

- along the X-axis: **+0.9** and **-0.9**;
- along the Y-axis: **+1.0** and **-0.8**;
- along the Z-axis: **+3.0** and **-0.9**.

In the latter case, polarization does not occur in the planes X, Y we are familiar with, but the summary dipole moment along the +Z-axis increases!

Thus,as a polarizator, two mirror surfaces reflecting a light with an incidence angle close to a vertical can be used.

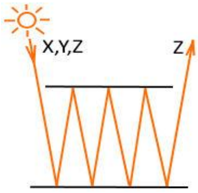

Fig.10

It should be noted the approximate-schematic, notional nature of these calculations, since the magnitude of the dipole electric moment of the photons, the angle of their rotation during reflection and many other factors are not exactly known.

And let’s talk about another way of polarization.

After passing through the tourmaline crystal, the light beam is divided into two beams,one of which turns out to be polarized.

Let’s try to explain this phenomenon by the corpuscular theory of light.

Whithout going into the subtleties of crystallography, let’s imagine schematically the passage of photons through the tourmaline crystal having a rhombohedral lattice system with complex interrelations between the lattice ions. In such a crystal, more than enough of all the kind of electric field heterogeneities.

Let’s this heterogeneity is expressed in the predominance of positive ions (charges) on the sharp angles of the rhombuses. See the Fig.11.

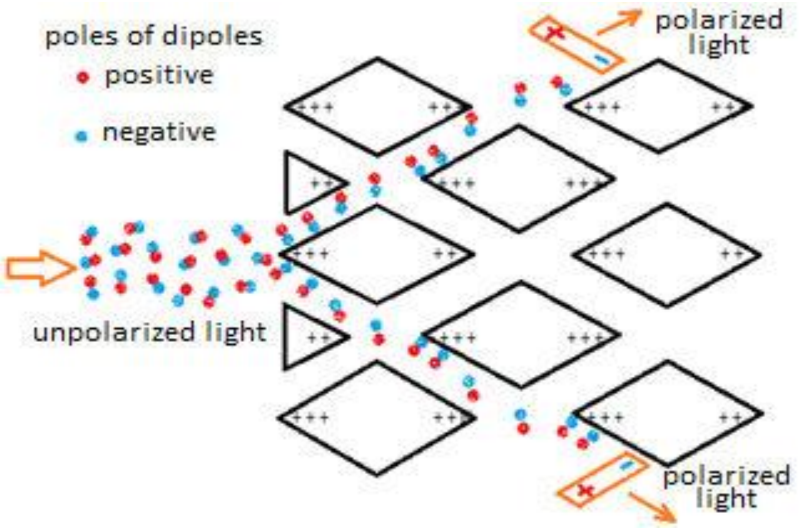

Fig.11

When unpolarized photons fall on these angles, they change its spatial orientation and begin to move along one of the two channels with opposite sign of their polarization vectors. Thus, polarization occurs.

As such a polarizer can be a thin sharp edge of glass or metal. If you direct the light ray to the edge, then this ray will be divided into two polarized rays.

To enhance the effect, it is possible to give the edge an electric charge, changing the sign of which we can change (switch) the orientation of polarization vector.

A little bit about the circular polarization. During polarization, the photons are rotated, taking a new position. If you interrupt this process during the rotation phase, choosing the appropriate thickness of the crystal, the photons will continue to rotate by inertia even after exiting the crystal. Circular polarization occurs.

8. Photoelectric effect

A small lyrical digression. The phenomenon of the photoelectric effect is a balm for the soul of supporters of the corpuscular theory of light. This is their territory. You don't need to add anything here. But let's add. I don’t like his explanation at all, or rather the lack thereof. After all, don’t take a turn from the same Einsteinian vocabulary as an explanation: light quanta KNOCK electrons out from the surface! Why don’t they drive them deep, which would be more logical?!

And everything is very simple. Violet photons have a larger charge (see 5.2), and therefore, when they hit the metal surface, they simply reduce the surface potential difference with their positive charge, facilitating the work function of electrons and increasing their speed.

The number (1, 2, or 3 violet) photons incident on the surface also determines the number (1, 2, or 3) of electrons released by each of them. And the speed of the electrons released by them depends on the “color” of photons (charge). Violet photons impart more speed to electrons than green and, especially, red ones. A very simple explanation of the laws of the photoelectric effect.

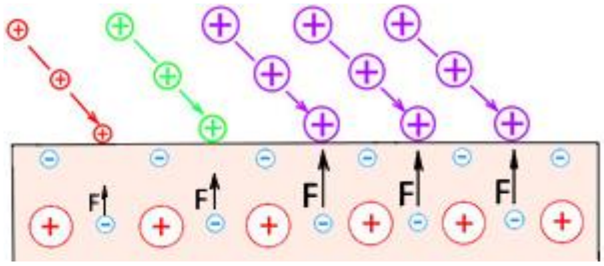

Fig.12

This corresponds to the laws of photoelectric effect. There is no knocking out of electrons - but there is an understandable electrical interaction of particles!

9. Compton scattering

A little bit of criticism. The electron size is $\mathbf{10^{-20}\ m}$. The wavelength of the γ- photon is $\mathbf{10^{-11}\ m}$. Tell me, please, how it is possible to repulse a huge photon by a small electron, the size of which is a billion times smaller than the photon?

And even at a big angle! It’s like talking about the repulse of the Earth by a cherry! This is not so much about the energy as about the area of interaction of cherry with the Earth. The size of the photon must be at least commensurable with the size of the electron. But most likely it is much smaller.

Let’s try to explain this effect in another way. At Compton’s experiment, the photon in the collision with the electron changes not only the trajectory, but also its wavelength. See the Fig 13.

Concerning the trajectory, everything is clear, reflection occurs. But why the wavelength increases? Recall that the larger the photon’s wavelength the smaller the it’s positive electric charge (see paragraph 2).

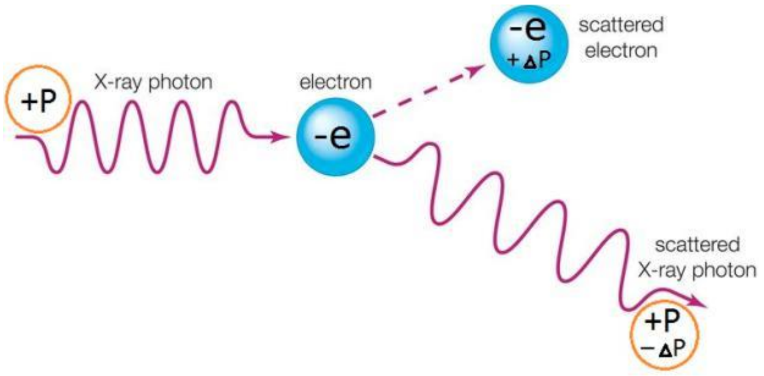

Fig.13

The photon falling on the electron, as it were, stics to it for some time, transferring to it some of its positive charge. Therefor, after contact, the positive charge of the photon will decrease by – *Δ*P and the charge of the electron will increase by + *Δ*P.

As already mentioned, a decrease in the photon's charge corresponds to an increase in its wavelength in the classical physics sense. And the denser and longer their contact, the greater part of the photon's charge will remain with the electron. This happens better with a direct, rather than a tangent, impact, that is, when the interaction time is longer. In this case, large angles of deflection of the body will be observed. All as in the experience.

But charge quantization is the principle that the charge of any object is an integer multiply of the elementary charge. In our case, it will be clear that after the contact the charge of the electrons will not be equal to zero. In this case, three options are possible.

1. The charge of the electron itself will decrease by *Δ*P. Nothing wrong with that. For example, the quarks charge is quantized into multiples of **1/3 e**. It will require a very accurate experiment to determine the magnitude of the electron charge.
2. The charge of the electron will remain unchanged and the particle of the photon with a charge of + *Δ*P join it.
3. This small particle will be a separate positively charged particle with a frequency that is dozen times larger than the frequency of the falling photon. This corresponds to the X-ray spectrum. After this collision, it would be good to look for the small positively charged photon!

10. The Faraday Effect

The Faraday effect is the rotation of linear polarization of light induced by a magnetic field.

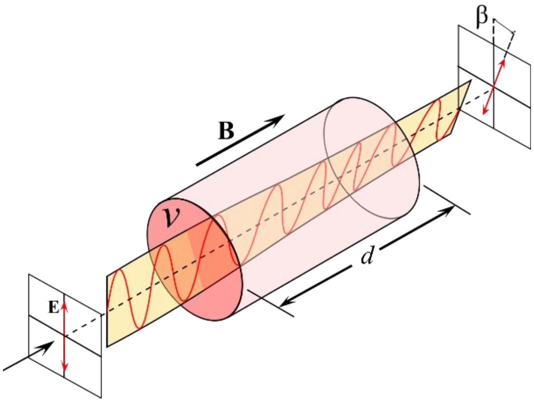

Fig.14

This effect is also very simple. When moving along magnetic field lines, the photon will move along the spiral, since there is always an infinitesimal component of the photon vector, which is perpendicular to the movement of the photon. This component can be caused by anything. Take, for example, the mutual repulsion of photons. Any beam is scattered.

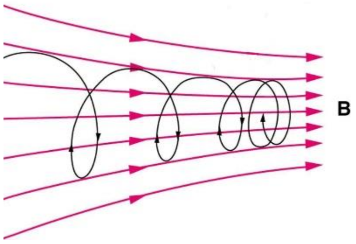

Fig.15

The positively charged photon twists around the magnetic field line in a clockwise direction, which corresponds to the rotation of the vector of the polarization in the Faraday effect. The speed of rotation of the more positive pole of the photon's dipole (see paragraph 7) will be greater than that of the less positive pole, according to formula: $\boldsymbol{\omega} = \frac{\boldsymbol{q \cdot B}}{\boldsymbol{m}}$. Therefore, in general, the photon will rotate clockwise, that is, it will change its vector of polarization.

And there is nothing surprising in that when the photon moves backwards, the direction of rotation of the vector of polarization does not change, since now the photon will rotate counter-clockwise, that is, in the same direction as in direct movement.

11. Zeeman effect

11.1 Transverse magnetic (tm) mode

When moving along magnetic field lines, the unpolarized monochromatic light ray with a frequency of $\boldsymbol{\omega}$ splits into 3 harmonics:

1. A linearly polarized harmonic with frequency $\boldsymbol{\omega}$;
2. A linearly polarized ray with frequency $\boldsymbol{\omega} - \boldsymbol{\Omega}$ and with the polarization vector perpendicular to the harmonic 1.
3. A linearly polarized ray with frequency $\boldsymbol{\omega} + \boldsymbol{\Omega}$ and with the polarization vector perpendicular to the harmonic 1.

In the Fig.16 the velocity vector **V** of the photons is directed from the observer and the vector of the magnetic field **B** is directed upward.

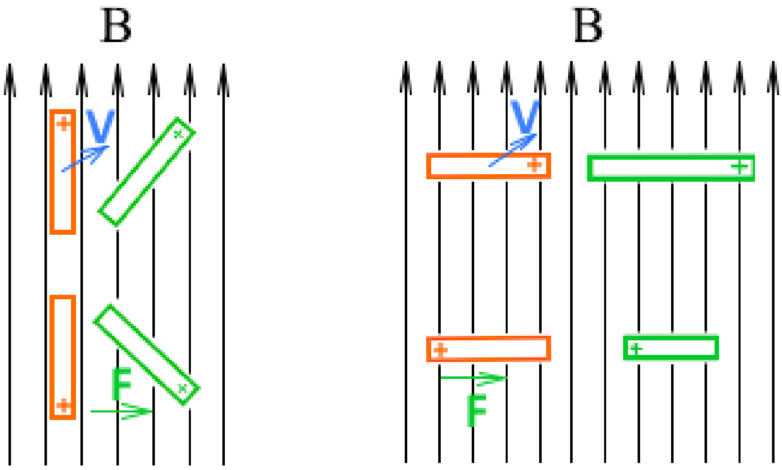

Fig.16 a) b)

The polarization vector of the photon can be decomposed into two components: vertical (a) and horizontal (b) component. The photon will be affected by the Lorentz force **F**, directed to the right.

Thus, vertically oriented dipoles will be rotated as shown in Fig.16a.

In this case, the dimensions that together with the charge of the dipoles determine the frequency do not change. These almost vertical dipoles form the harmonic 1. The horizontally oriented dipoles (Fig.16b) displaced to the right will be deformed: the upper dipole will be enlarged in length, and the lower dipole will be reduced as the more positive pole will be attracted more than the less positive one. The upper longer dipoles form the harmonic 3 and the lower dipoles form the harmonic 2.

Now let's explain how the dimensions of the photon affect its frequency.Recall that the larger the photon's wavelength the smaller the it's positive electric charge (see paragraphs 2, 8 and article «The nature of electrical forces»).

11.2. Longitudinal magnetic (lm) mode

It is known that in the longitudinal magnetic field the original light ray with frequency $\boldsymbol{\omega}$ disappears and instead of it two other rays appear:

1. The circularly polarized ray with clockwise rotation and a frequency $\boldsymbol{\omega - \Omega}$;
2. The circularly polarized ray with counter-clockwise rotation and a frequency $\boldsymbol{\omega + \Omega}$.

All this is explained simply. The photon in the longitudinal magnetic field moves along a spiral trajectory counter-clockwise.

Fig.17

In this case, it will periodically change the slope of its polarization vector clockwise or counter-clockwise. In the Fig.18 the velocity vector of the photons is directed from the observer and the vector of the magnetic field is also directed from the observer.

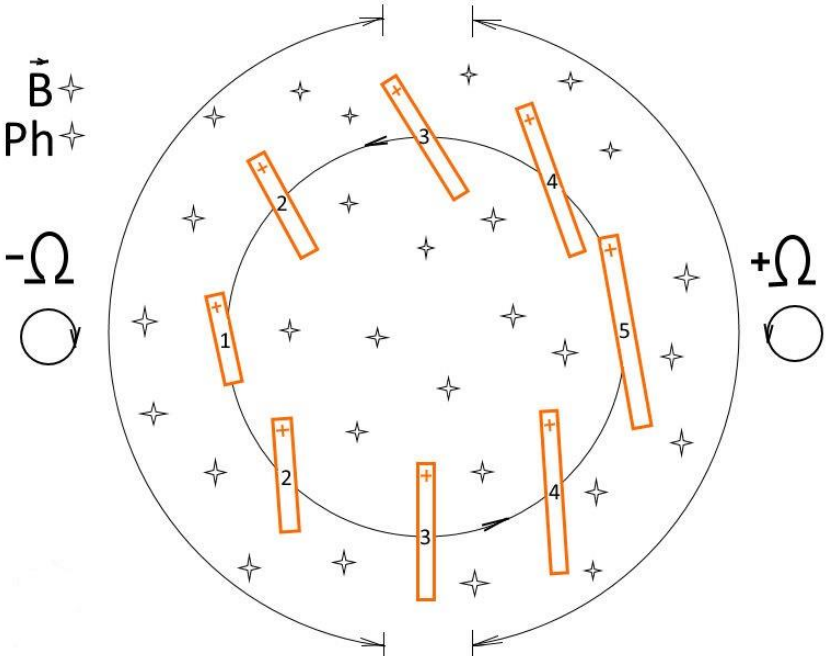

Fig.18

When moving from the bottom up, the photon stretches out in length and turns counterclockwise. When moving from top to bottom, it shrinks in length and turns clockwise. The relative length of the photons is indicated by the numbers inside them. When leaving the magnetic field, each photon will maintain its direction of rotation which it had at the time of exit. Thus, the number of photons with clockwise and counter-clockwise rotation will be the same. At the same time there will be no photons without rotation, as well as photons with initial average sizes.

This is how these two rays are formed with a circular rotation and with frequencies changed by a value equal to $\boldsymbol{\pm\Omega}$.

12. A bit of criticism of the wave-like nature of light

If the sunlight is a continuous spectrum of the EM waves from red to violet, then all these harmonics will interact with each other in such a way that as a result of their superposition will be only one harmonic with the wavelength corresponding to the middle of the spectrum, that is, to the green wave. In this case, its amplitude will be equal to the sum of the amplitudes of all harmonics. That is, as it absorbs all surrounding harmonics. Only one very bright green harmonic will remain. What we do not observe, of course!

The Fig.5.21 shows the result of the superposition of all (about 70) the harmonics of the visible spectrum.

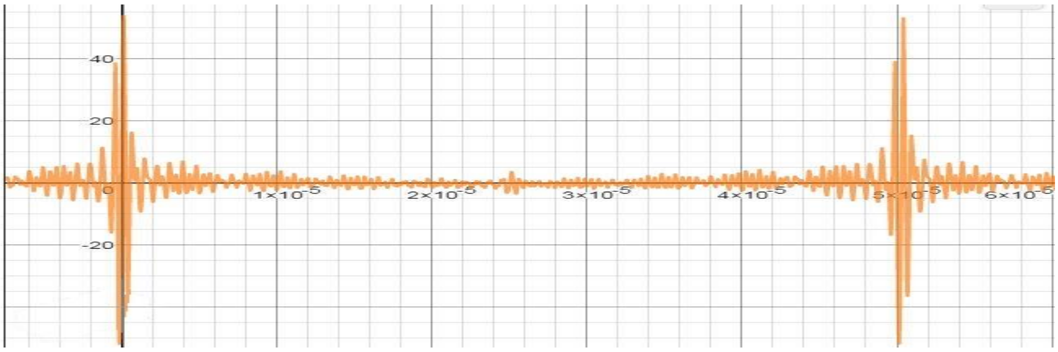

Fig.2

We can see the impulses with the middle spectrum wavelength.

In Fig.5.22 on an enlarged scale, the wavelength is clearly visible. $\mathbf{5,5 \cdot 10^{-7}}$м is the wavelength of the green light.

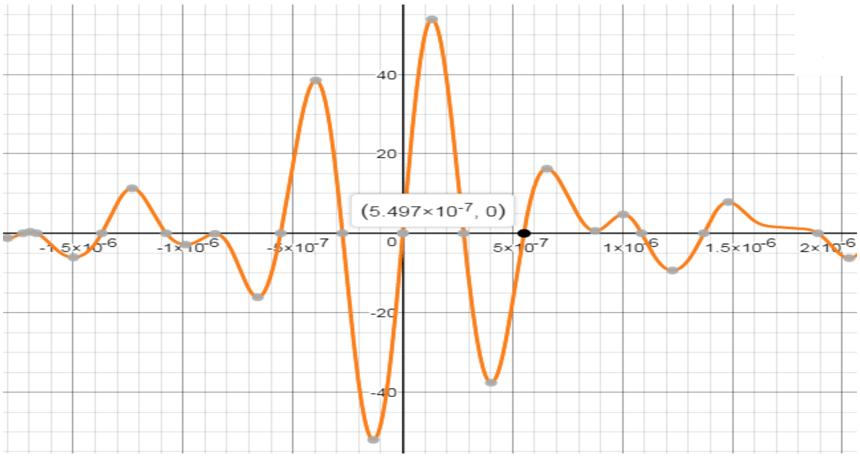

Fig.3

On the contrary, photons unlike the waves perfectly coexist with each other!