ON THE INTERACTION OF STABLE WAVES IN THE IDEAL CONTINUOUS MEDIUM

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INTRODUCTION

In our previous article [1] the waves in an ideal continuous medium were considered as both objects of examination and tools for measuring. Also was proved, that the effects representing essence of a special theory of relativity: the finiteness of velocity of light, its independence from frame of reference, the Lorentz's transformations, follow from identical undular nature of objects and tools, used for investigation. Moreover, guess that all that surround us represent waves in same medium, allows to transform into the theorem a postulate about the independence of traveling waves velocity (e.g. velocity of light) from reference frame. Thus, was shown, that there is, at least, one case, when all standings of a special theory of relativity do not contradict presence of the medium - carrier of electromagnetic waves. This is the case, when all surrounding us, represents waves in the same continuous medium. In article [2] we have shown that waves, including electromagnetic, can not exist without carrier medium.

The idea about that the all objects in the world, environmental us, represent waves, having the same nature, correlate with a hypothesis of elementary oscillators accepted in a quantum theory of a field [3]. However offered approach allows better understanding the mechanisms of physical phenomena, basing to a rational basis.

The marked successes, of proposed theory have induced us to make the following step, namely to explore whether the waves can to interreact among themselves. In this article we put a problem, to investigate, how the stationary waves can interreact among themselves and finding the law of this interactions. We shall prolong to use the same receptions and labels as in the previous articles.

Let's agree, that in a own frame of reference the object is marked by not stroked values. That is, if, for example, the object standing in laboratory system, for him not stroked is laboratory system. If the object goes concerning laboratory system, not stroked will be a frame of reference, which goes together with object.

1. BASIC CONCEPTS.

In the article [2] we viewed in quality both objects and tools the stationary and quasi-stationary waves. Thus we as though have spotted, that the particles represent a superposition of pairs of waves, spreading in an opposite direction. As in our proofs we did not superimpose any requirements on function of amplitude *A*, in particular for wave, which serve models of particles, it can represent any function of radius, which can be spherical, or ellipsoidal.

We shall consider standing waves, which interreact as objects.. Let waves - objects in a own frame of reference is described by functions having a view:

$$a = A(r)\sin kr \sin \omega t \,, \qquad (1)$$

Where *k*- a wave number;
ω - frequency;
A(*r*) - amplitude, as well as in previous paper, represents some function from *r*. It is possible to show, that under certain conditions, the wave (1) can be stable, it means it can exist without changing the shape indefinitely long time, and in case of exterior actions, it will change its state as a single entity. Really, the expression (1) can be conversed to the superposition of two waves running in opposite directions.

$$a = \frac{A}{2}\left[\cos(\omega t - kx) - \cos(\omega t + kx)\right]. \qquad (2)$$

Each of two components will transfer a motion in opposite directions, so the aggregate energy remain localized, that is, will not move.

Let's illustrate this idea with help of two examples. The first example - tuning fork, the extremities of which oscillating in opposite directions. The second example - is a system from two balls, bounded with spring, which beforehand was stretched. In both cases the oscillations can be prolonged indefinitely long time, if there is no dissipation, it means transmutation of oscillations energy into heat. The feature of these two examples consist in, that the oscillations symmetric concerning a medial point located on a line, pairing an oscillating body. If we shall translocate an oscillating tuning fork, or system from balls and springs, the oscillations of a tuning fork or balls will move together with these systems. Or else, such oscillations have a stability in relation to exterior actions. It is necessary to note, that not all waves are stable. The majority of traveling waves haven't stability.

The expressions (1) and (2) also describe centrally symmetric waves. As we already have noted, under certain conditions such waves too can be stable in free space. If in medium is absent a dissipation the oscillations determined by expressions (1) and (2) can exist indefinitely long time.

The central symmetric waves were considered many times in acoustics, for example, in connection with phenomena of a cavitation, or as a problem in the limited space [4]. In both cases there is an interaction of a continuous medium to some border therefore nature of a stability of oscillations is another. The mechanism of a stability in our case also differs from the mechanism of a stability of solitons and solitary waves, which nature was featured repeatedly in the literature [5-8]. The solitons and solitary waves have a restricted stability, in the sense that they basically can not exist unbounded time, and the medium, in which they exist, is not ideal, besides they it's practically do not interreact with each other.

Let's mark, that in our case the mechanism of waves stability in vacuo is relativistic. The more detailed exposition, will become as a subject of one of the following article. There will be clear, why they till now did not become a subject of examination of the theory of waves, and why such waves are not observed in acoustics.

Thus, in this article, we shall assume, that in vacuo there can be inconvertible waves, described by expressions (1) and (2). Due to the stability, in processes of interaction among themselves these waves remain invariant in the own frame of reference.

If the results, which we shall receive, will correspond to reality, it will give us reliance that the chosen model is correct. And it in turn will allow to apply the found model to the further construction of the theory.

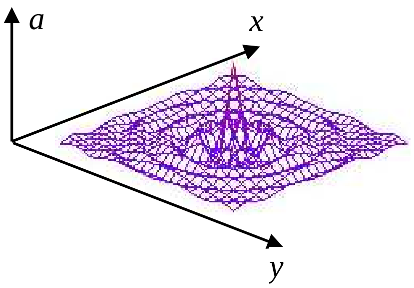


Figure 1. Wave described by expression (1) in bidimensional representation

The two-dimensional representation of the wave (1) is given in a fig. 1.

In other system, moving concerning laboratory system with velocity *v*, the traveling waves-components: frequencies and wave numbers will be others and will be determined by the Doppler formulas for longitudinal effect.

$$\omega_1 = \omega\sqrt{\frac{1-\beta}{1+\beta}} \qquad \omega_2 = \omega\sqrt{\frac{1+\beta}{1-\beta}} \tag{3}$$

$$k_1 = k\sqrt{\frac{1-\beta}{1+\beta}} \qquad k_2 = k\sqrt{\frac{1+\beta}{1-\beta}} \tag{4}$$

where $\beta = \frac{v}{c}$ - normalized velocity.

Thus, in the stroked system, wave (1) will be conversed in

$$a' = A'\sin\left(\frac{k_1+k_2}{2}r' - \frac{\omega_1-\omega_2}{2}t'\right)\times \times\sin\left(\frac{\omega_1+\omega_2}{2}t' + \frac{k_1-k_2}{2}r'\right) .(5)$$

Here amplitude, and the rates of time and length will be already others (stroked), because has changed a scales of time and lengths. Let's remind that the both scales time and lengths are defined by frequency and wave number accordingly. These two values have a role of rulers and clocks distributed in space.

If to compare (5) with (1), it is visible, that in (5) the value $\frac{k_1+k_2}{2}$, have the same role as *k* in (1). Really both expressions, **cos**(kr) and $\cos\left(\frac{k_1+k_2}{2}r'\right)$ describe sinusoidal functions fixed in space. Corresponding wave-lengths serve as units of length.

Similarly, $\cos(\omega t)$ and $\cos\left(\frac{\omega_1+\omega_2}{2}t'\right)$ describe the change of amplitude in a fixed point in dependence from the time in laboratory frame of reference and in the proper frames accordingly. And corresponding periods serve as units of time. Hence

$$\omega' = \frac{\omega_1+\omega_2}{2} . \tag{6}$$

in proper frame of reference have the same role as ω in laboratory system

Testimony on that these values play the same role in various systems, and that it is real the etalons, is that fact, that their ratio is always constantly and does not depend on a frame of reference. Really, by direct substitution with help of expressions (3) and (4) it is easy to test, that

$$\frac{\omega}{k} = \frac{\omega_1}{k_1} = \frac{\omega_2}{k_2} = \frac{\omega_1+\omega_2}{k_1+k_2} = c . \tag{7}$$

The ratio of wave-object displacement to period represents the velocity of wave movement, i.e.:

$$v = \frac{\omega_1 - \omega_2}{k_1 + k_2}. \quad (8)$$

The substitution of expressions (3) and (4) in (6), permit to receive a relation between the wave-object frequency in proper system ω and wave-object frequency ω', measured in stroked system

$$\omega' = \frac{\omega}{2}\left(\sqrt{\frac{1-\beta}{1+\beta}} + \sqrt{\frac{1+\beta}{1-\beta}}\right) = \frac{\omega}{\sqrt{1-\beta^2}}. \quad (9)$$

2. PRINCIPLE OF IDENTICAL CHANGE OF FREQUENCIES OF INTERACTING WAVES

Let's demonstrate, that as a result of waves interaction, their frequencies vary on the same value.

For each period both waves-objects interact during the same interval of time Δt from the point of view of laboratory system, so:

$$\Delta t_1 = -\Delta t_2 = \Delta t$$

Numbers of elementary interactions of both waves is the same, $n_1 = n_2$. If partial Δt is identical, and their number n are identical, then $\Delta T = n\Delta t$ for both waves should be identical, that is

$$\Delta T_1 = -\Delta T_2.$$

Where ΔT_1 - is change of a period of the first wave-object, and - ΔT_2 change of a period of the second wave. If for the first wave period increasing, for second wave period decreasing, because waves, which interact, moving in opposite directions and from the point of view of laboratory system for one waves the velocity increasing, and for other - decreasing

From here follows that

$$\frac{1}{\Delta T_1} = -\frac{1}{\Delta T_2}.$$

Hence,

$$\Delta f_1 = -\Delta f_2$$

or

$$\Delta\omega_1 = -\Delta\omega_2. \quad (10)$$

Thus, at interaction of two waves of change of their frequencies will be identical.

Or else, during each partial act of interaction in time Δt period of a wave change on ΔT, and if for both waves Δt is identical, then ΔT will be identical too. We continue taking into account, that the wave-object is stable, that means the interaction happens between objects which not changes. As the number of the interactions n for both waves is identical, then product $n\Delta T$ for both waves will be identical too. But $n\Delta T$ is a change of a wave period as a result of interaction. So change of a period of both waves is identical. Hence, reciprocal values, it means the change of frequencies of both waves is identical too.

As $k = \frac{\omega}{c}$, therefore for wave numbers also can be noted

$$\Delta k_1 = -\Delta k_2. \quad (11)$$

However for wave numbers it is necessary to keep in mind, that it represents vectors. So, in a proper frame of reference of wave-object, the wave numbers vectors of traveling waves-components are directed to the opposite parties and have modules equal. Therefore result, the wave number of wave-object in quiescence is equal to zero. The propagating wave-object is described by expression (5), where the wave numbers of traveling waves-components haven't equal modulo. Therefore module of a resulting wave number of wave-object will be equal to half of difference of wave numbers of waves-components. Thus, subject to expressions (4), for a resulting wave number of shifting wave-object we can note:

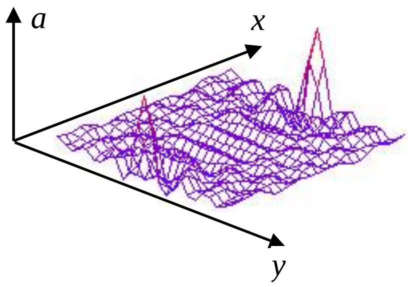
$$k_r = \frac{k}{2}\left(\sqrt{\frac{1+\beta}{1-\beta}} - \sqrt{\frac{1-\beta}{1+\beta}}\right) = \frac{\beta k}{\sqrt{1-\beta^2}}. \quad (12)$$

So, in case of waves-object the expression (11) should be noted for resulting wave numbers as:

$$\Delta k_{r1} = -\Delta k_{r2} \quad (13)$$

3. ELASTIC COLLISION OF TWO WAVES-PARTICLES

Process we shall examine in laboratory system. Let's assume, that two waves-objects, described by expressions such as (1) in proper frames of reference, are moving towards each other along the axis (fig. 2). It exist a big difference into interaction of waves studied here, and interaction of solitons or solitary waves studied for example in works [3-6]. The point is that our waves-objects don't penetrate one another. On contrary, the force of repulsion grows, with diminution of distance between them. The explanation consists in stability of waves-object, in the sense that there is a strong correlation between properties of medium and properties of wave-object. The presence near to another wave-object breaks the properties of medium, it means changes its parameters. As we already have noted, this mechanism will be described in more detail in one of the following articles. Thus, the degree of interaction between waves-objects grows with diminution of distance between them.



Fugure 2. A picture of interaction of two stable waves described by expression (2) in bidimensional representation.

Let frequencies of two interreacting waves in proper systems are equal accordingly to ω_{01} and ω_{02}. And normalized velocities of waves-objects concerning laboratory system before interaction is β_1 and β_2, and after it's interaction is β_1' and β_2'.

Then, according to the formula (9), the frequencies of waves-objects, measured in laboratory system up to interaction of waves, will be.

$$\omega_1 = \omega_{01}\frac{1}{\sqrt{1-\beta_1^2}} \quad \text{and,} \quad \omega_2 = \omega_{02}\frac{1}{\sqrt{1-\beta_2^2}}, \qquad (14)$$

and after interaction

$$\omega_1' = \omega_{01}\frac{1}{\sqrt{1-(\beta_1')^2}} \quad \text{and,}$$

$$\omega_2' = \omega_{02}\frac{1}{\sqrt{1-(\beta_2')^2}}. \qquad (15)$$

Expression (10) is possible to write as

$$\omega_1 - \omega_1' = \omega_2' - \omega_2. \qquad (16)$$

By substitution (14) and (15) in (16), we shall receive the equation for frequencies:

$$\frac{\omega_{01}}{\sqrt{1-\beta_1^2}} - \frac{\omega_{01}}{\sqrt{1-(\beta_1')^2}} = \frac{\omega_{02}}{\sqrt{1-(\beta_2')^2}} - \frac{\omega_{02}}{\sqrt{1-\beta_2^2}} \qquad (17)$$

Similarly, following the expression (12), for resulting wave numbers of waves - objects before interaction, it is possible to note:

$$k_{r1} = \frac{\beta_1^2 k_{01}}{\sqrt{1-\beta_1^2}} \quad \text{and,} \quad k_{r2} = \frac{\beta_2^2 k_{02}}{\sqrt{1-\beta_2^2}}, \qquad (18)$$

and after interaction

$$k_{r1}' = \frac{\beta_1' k_{01}}{\sqrt{1-(\beta_1')^2}} \quad \text{and,} \quad k_{r2}' = \frac{\beta_2' k_{02}}{\sqrt{1-(\beta_2')^2}}, \qquad (19)$$

as the equation (13) for wave numbers is

$$k_1 - k_1' = k_2' - k_2. \qquad (20)$$

with help of (18) and (19) will keep:

$$\frac{\beta_1^2 k_{01}}{\sqrt{1-\beta_1^2}} - \frac{\beta_1' k_{01}}{\sqrt{1-(\beta_1')^2}} = \frac{\beta_2' k_{02}}{\sqrt{1-(\beta_2')^2}} - \frac{\beta_2^2 k_{02}}{\sqrt{1-\beta_2^2}} \qquad (21)$$

Thus, we obtained a system of two equations (17) and (21), which describe process of interaction between two quasi-stationary waves-objects like represented on the picture 2. Taking into account $k = \frac{\omega}{c}$, the system can be copied:

$$\frac{\omega_{01}}{\sqrt{1-\beta_1^2}} + \frac{\omega_{02}}{\sqrt{1-\beta_2^2}} = \frac{\omega_{01}}{\sqrt{1-(\beta_1')^2}} + \frac{\omega_{02}}{\sqrt{1-(\beta_2')^2}} \qquad (22)$$

$$\frac{\omega_{01}\beta_1}{\sqrt{1-\beta_1^2}} + \frac{\omega_{02}\beta_2}{\sqrt{1-\beta_2^2}} = \frac{\omega_{01}\beta_1'}{\sqrt{1-(\beta_1')^2}} + \frac{\omega_{02}\beta_2'}{\sqrt{1-(\beta_2')^2}} \qquad (23)$$

In this system, we shall assume as unknowns the normalized velocities of waves-objects after interaction. Then the solutions will be expressions.

$$\beta_1' = \frac{A}{BD} \quad (24) \qquad \beta_2' = \frac{E}{FD} \qquad (25)$$

Here we have designated:

$$\begin{aligned} A = {} & \left\lfloor \beta_2\omega_{02}\left(1-\beta_1^2\right)\sqrt{1-\beta_2^2}\right\rfloor \times \\ & \times\left[3\beta_1\omega_{01}^2\left(1-\beta_2^2\right) - \omega_{02}^2\left(\beta_1+\beta_1\beta_2^2-2\beta_2\right)\right] + \\ & + 2\beta_2\omega_{01}\omega_{02}^2\sqrt{1-\beta_1^2}\left(\beta_1+\beta_2-\beta_1\beta_2^2-\beta_1^2\beta_2-\beta_2^3\right) + \\ & + \beta_1^2\omega_{01}\sqrt{1-\beta_1^2}\left[\omega_{01}^2\left(1-2\beta_2^2+\beta_2^4\right)+\omega_{02}^2\left(3\beta_2^4-1\right)\right] \end{aligned} \qquad (26)$$

$$\begin{aligned} B = {} & 2\beta_1\beta_2\omega_{02}^2 + \beta_2^2\left(\omega_{01}^2-\omega_{02}^2\right) - \\ & - 2\omega_{01}\omega_{02}\sqrt{1-\beta_1^2}\sqrt{1-\beta_2^2} - \omega_{01}^2 - \omega_{02}^2 \end{aligned} \qquad (27)$$

$$\begin{aligned} D = {} & \beta_1\omega_{01}\sqrt{1-\beta_1^2}\left(\beta_2^2-1\right) + \\ & + \beta_2\omega_{02}\sqrt{1-\beta_2^2}\left(\beta_1^2-1\right) \end{aligned} \qquad (23)$$

$$\begin{aligned} E = {} & \left\lfloor \beta_1\omega_{01}\left(1-\beta_2^2\right)\sqrt{1-\beta_1^2}\right\rfloor \times \\ & \times\left[3\beta_2\omega_{01}^2\left(1-\beta_1^2\right) - \omega_{01}^2\left(\beta_2+\beta_1^2\beta_2-2\beta_1\right)\right] + \\ & + \left(2\beta_1\omega_{01}^2\omega_{02}\sqrt{1-\beta_2^2}\right) \times \\ & \times\left(\beta_1+\beta_2-\beta_1^2\beta_2-\beta_1\beta_2^2-\beta_1^3\right) + \\ & + \left(\beta_2^2\omega_{02}\sqrt{1-\beta_2^2}\right) \times \\ & \times\left[\omega_{02}^2\left(1-2\beta_1^2+\beta_1^4\right)+\omega_{01}^2\left(3\beta_1^4-1\right)\right] \end{aligned} \qquad (24)$$

$$\begin{aligned} F = {} & 2\beta_1\beta_2\omega_{01}^2 - \beta_1^2\left(\omega_{01}^2-\omega_{02}^2\right) - \\ & - 2\omega_{01}\omega_{02}\sqrt{1-\beta_1^2}\sqrt{1-\beta_2^2} - \omega_{01}^2 - \omega_{02}^2 \end{aligned} \qquad (25)$$

Besides there are two trivial solutions,

$\beta_1 = \beta_1'$; $\beta_2 = \beta_2'$

We shall show, that if

$$\beta = \frac{v}{c} << 1 \qquad (26)$$

then from these solutions the formulas follows, which describe a collision of two bodies in a mechanics:

For this purpose in the formulas (24) - (30) we neglect β in comparison with unit, and everywhere in these expressions we shall take into account only terms having the least degree of β in comparison with higher degrees. In this case, the expression (24) will be conversed in

$$\beta_1' = \frac{\beta_2\omega_{02}\left[3\beta_1\omega_{01}^2 - \omega_{02}^2(\beta_1 - 2\beta_2)\right]}{\left(-2\omega_{01}\omega_{02} - \omega_{01}^2 - \omega_{02}^2\right)\left(-\beta_1\omega_{01} - \beta_2\omega_{02}\right)} + \frac{2\beta_2\omega_{01}\omega_{02}^2(\beta_1 + \beta_2) + \beta_1^2\omega_{01}\left(\omega_{01}^2 - \omega_{02}^2\right)}{\left(-2\omega_{01}\omega_{02} - \omega_{01}^2 - \omega_{02}^2\right)\left(-\beta_1\omega_{01} - \beta_2\omega_{02}\right)} \tag{27}$$

Thus, in numerator there were terms containing only the second degree β, and in a denominator - first degree.

Sequentially we converse expression (32)

$$\beta_1' = \frac{\beta_2\omega_{02}\left(3\beta_1\omega_{01}^2 - \beta_1\omega_{02}^2 + 2\beta_2\omega_{02}^2\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{2\beta_2\omega_{01}\omega_{02}^2(\beta_1 + \beta_2) + \beta_1^2\omega_{01}\left(\omega_{01}^2 - \omega_{02}^2\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

As some transformations are not trivial, we give below sequential transformations of this formula.

$$\beta_1' = \frac{\beta_2\omega_{02}\left(\beta_1\omega_{01}^2 - \beta_1\omega_{02}^2 + 2\beta_1\omega_{01}^2 + 2\beta_2\omega_{02}^2\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{2\beta_2\omega_{01}\omega_{02}^2(\beta_1 + \beta_2) + \beta_1^2\omega_{01}\left(\omega_{01}^2 - \omega_{02}^2\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

$$\beta_1' = \frac{\beta_1\beta_2\omega_{02}\left(\omega_{01}^2 - \omega_{02}^2\right) + \beta_2\omega_{02}\left(2\beta_1\omega_{01}^2 + 2\beta_2\omega_{02}^2\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{2\beta_2\omega_{01}\omega_{02}^2(\beta_1 + \beta_2) + \beta_1^2\omega_{01}\left(\omega_{01}^2 - \omega_{02}^2\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

$$\beta_1' = \frac{2\beta_2\omega_{01}\omega_{02}^2(\beta_1 + \beta_2) + \beta_2\omega_{02}\left(2\beta_1\omega_{01}^2 + 2\beta_2\omega_{02}^2\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{+\beta_1\beta_2\omega_{02}\left(\omega_{01}^2 - \omega_{02}^2\right) + \beta_1^2\omega_{01}\left(\omega_{01}^2 - \omega_{02}^2\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

$$\beta_1' = \frac{+2\beta_1\beta_2\omega_{01}\omega_{02}\left(\omega_{01} + \omega_{02}\right) + 2{\beta_2}^2\omega_{02}^2\left(\omega_{01} + \omega_{02}\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{+\beta_1\beta_2\omega_{02}\left(\omega_{01}^2 - \omega_{02}^2\right) + \beta_1^2\omega_{01}\left(\omega_{01}^2 - \omega_{02}^2\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

$$\beta_1' = \frac{+2\beta_1\beta_2\omega_{01}\omega_{02} + 2{\beta_2}^2\omega_{02}^2}{\left(\omega_{01} + \omega_{02}\right)\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{+\beta_1\beta_2\omega_{02}\left(\omega_{01} - \omega_{02}\right) + \beta_1^2\omega_{01}\left(\omega_{01} - \omega_{02}\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

$$\beta_1' = \frac{+2\beta_1\beta_2\omega_{01}\omega_{02} + 2{\beta_2}^2\omega_{02}^2}{\left(\omega_{01} + \omega_{02}\right)\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{+\beta_1\beta_2\omega_{01}\omega_{02} - \beta_1\beta_2\omega_{02}^2 + \beta_1^2\omega_{01}^2 - \beta_1^2\omega_{01}\omega_{02}}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

$$\beta_1' = \frac{+2\beta_1\beta_2\omega_{01}\omega_{02} + 2{\beta_2}^2\omega_{02}^2}{\left(\omega_{01} + \omega_{02}\right)\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{+\left(\beta_1\beta_2\omega_{01}\omega_{02} + \beta_1^2\omega_{01}^2\right) - \omega_{02}\left(\beta_1\beta_2\omega_{02} + \beta_1^2\omega_{01}\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

$$\beta_1' = \frac{+2\beta_2\omega_{02}\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}{\left(\omega_{01} + \omega_{02}\right)\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{+\beta_1\omega_{01}\left(\beta_2\omega_{02} + \beta_1\omega_{01}\right) - \beta_1\omega_{02}\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

$$\beta_1' = \frac{+2\beta_2\omega_{02}\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}{\left(\omega_{01} + \omega_{02}\right)\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)} + \frac{+\beta_1\omega_{01}\left(\beta_2\omega_{02} + \beta_1\omega_{01}\right) - \beta_1\omega_{02}\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}{\left(\omega_{01} + \omega_{02}\right)^2\left(\beta_1\omega_{01} + \beta_2\omega_{02}\right)}$$

$$\beta_1' = \frac{+2\beta_2\omega_{02} + \beta_1\omega_{01} - \beta_1\omega_{02}}{\left(\omega_{01} + \omega_{02}\right)}$$

$$\beta_1' = \frac{\beta_1\left(\omega_{01} - \omega_{02}\right) + 2\beta_2\omega_{02}}{\left(\omega_{01} + \omega_{02}\right)} \tag{28}$$

After similar transformations, from the solution (20) we shall receive expression

$$\beta_2' = \frac{\beta_2\left(\omega_{02} - \omega_{01}\right) + 2\beta_1\omega_{01}}{\left(\omega_{01} + \omega_{02}\right)} \tag{29}$$

The formulas (33) and (34) are equivalent to expressions

$$v_1' = \frac{v_1(\omega_{01} - \omega_{02}) + 2v_2\omega_{02}}{(\omega_{01} + \omega_{02})} \quad (30)$$

$$v_2' = \frac{v_2(\omega_{02} - \omega_{01}) + 2v_1\omega_{01}}{(\omega_{01} + \omega_{02})} \quad (31)$$

If multiply the numerator and denominator to constant factor $\hbar / c^2$, then we shall receive the known formulas describing collision of two bodies in a mechanics

$$v_1' = \frac{(m_1 - m_2)v_1 + 2m_2v_2}{m_1 + m_2}$$

$$v_2' = \frac{(m_2 - m_1)v_2 + 2m_1v_1}{m_1 + m_2}$$

Last two formulas represent the solutions of equations system, which describe the central impact of two elastic bodies with masses m_1, m_2 and initial velocities v_1 and v_2, i.e. solutions of equations describing the law of conservation of energy and of impulse.

$$m_1v_1 + m_2v_2 = m_1v_1' + m_2v_2'$$

$$\frac{m_1v_1^2}{2} + \frac{m_2v_2^2}{2} = \frac{m_1v_1^{2\prime}}{2} + \frac{m_2v_2^{2\prime}}{2}$$

Thus, we have proved, that the behavior of stationary stable waves is equivalent to interaction of mechanical bodies . Thus the law of conservation of energy follows from a principle of identical change of frequencies of interreacting waves, and law of conservation of momentum - from a principle of identical change of their wave numbers.

CONCLUSIONS

1. We have shown, that the waves described by expressions (1) and (5) interact among themselves as mechanical bodies. Hence, it is necessary to search the solutions describing particles in vacuum in this form. This idea is valid, at least, for a band, where there are interactions without change of properties of particles. It just corresponds to electromagnetic and gravitational interactions.

2. In the model, offered by us, for stable waves-objects, the conservation laws are similar to the laws of conservation of energy and of impulse, consequently in the further development of our theory we can apply these laws. Or else, we have shown, that the laws of conservation of energy and impulse, belong to the world constructed from waves in continuous medium, which is single entity, all the rest representing a states of this entity

3. And at last:

- the results of the previous work [2], namely that, the independence of velocity of light from a reference frame and consequently also Lorentz transformation are caused by undular nature of all objects;
- and results of this article, which prove, that the stable stationary waves interreact as mechanical particles, allow to state, that stationary objects, it means the objects, which can move with arbitrary velocity and which have mass not equal zero, or else, the particles, represent standing waves or quasi standing waves.

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