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Theory of Photon Quanta

Chaos–Imaginary Ostensibility

Highlights

Extending General Relativity

Laws of Classical Electrodynamic

Discovering Thoughts, Inventing Future

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Rectifications of Einstein's Errors Such as E = Mc^2 and Necessity of Extending General Relativity

By C. Y. Lo

Abstract- Due to inadequacy in mathematics, physicists failed to see Einstein's errors. For instance, the Einstein equation has no bounded dynamic solution due to missing the gravitational wave energy-stress tensor with an antigravity coupling, his calculation of the perihelion of Mercury cannot be justified with perturbation, and he did not see that the photonic energy must include gravitational wave energy. To derive the photonic energy, general relativity must be used. Following Einstein faithfully, Hawking never produced any verifiable predictions. This is due to that E = mc^2 is incon-sistent with the Einstein equation and is a major error. In fact, their space-time singularity theorems are based on invalid assumptions in physics, and thus the results are irrelevant. Einstein wrongly rejected the repulsive gravitation due to the charge-mass interaction. Experiments confirmed such errors, and the current-mass interaction implies that the weight of a magnet is directional. The repulsive gravitation implies to measure mass through gravity is invalid. He also failed to extend general relativity to a five-dimensional theory because of the need of unification between gravitation and electromagnetism. The hovering of a charged capacitor on earth is due to the repulsive gravitational force which cannot be screened.

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RECTIFICATIONSOFEINSTEINSERRORSSUCHASEMC2ANDNECESSITYOFEXTENDINGGENERALRELATIVITY

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C. Y. Lo

Abstract- Due to inadequacy in mathematics, physicists failed to see Einstein's errors. For instance, the Einstein equation has no bounded dynamic solution due to missing the gravitational wave energy-stress tensor with an antigravity coupling, his calculation of the perihelion of Mercury cannot be justified with perturbation, and he did not see that the photonic energy must include gravitational wave energy. To derive the photonic energy, general relativity must be used. Following Einstein faithfully, Hawking never produced any verifiable predictions. This is due to that $E = mc^2$ is incon-sistent with the Einstein equation and is a major error. In fact, their space-time singularity theorems are based on invalid assumptions in physics, and thus the results are irrelevant. Einstein wrongly rejected the repulsive gravitation due to the charge-mass interaction. Experiments confirmed such errors, and the current-mass interaction implies that the weight of a magnet is directional. The repulsive gravitation implies to measure mass through gravity is invalid. He also failed to extend general relativity to a five-dimensional theory because of the need of unification between gravitation and electromagnetism. The hovering of a charged capacitor on earth is due to the repulsive gravitational force which cannot be screened. His covariance principle is proven invalid by explicit examples, and the physical Riemannian space with a Euclidean-like structure is different from a mathematical Riemannian space embedded in a higher dimensional Euclidean space. This error has misinterpreted the Hubble's law as evidence for an expanding universe.

Keywords: anti-gravity coupling; principle of causality, repulsive gravitation.

A foolish faith in authority is the worst enemy of truth, -- A. Einstein.

I. Introduction

In the world, first we are aware of the distances between things and the time needed to travel the distance from one object to another. To measure these, we invent the rule and the clock. We are also aware that objects can be very light that we can easily carry or heavy that is difficult to move. Then we invent the scale to measure their different weights. The first natural force is gravity that we are against when we lift up things; otherwise an object will fall to earth with acceleration. At first we believed that a heavier object will drop with faster acceleration because a feather would fall very slowly. However, Galileo taught us that most objects drop with the same acceleration. A theory must be tested by observation. Thus, a science called physics was born.

It was based on the three basic laws on planets of Kepler from observing the stars [1], Newton discovered that the gravitational force F_g between two particles with masses m_1 and m_2 and a distance r as

$$F_g = G\frac{m_1 m_2}{r^2}, \tag{1}$$

where G is the Newtonian gravitational coupling constant. Moreover, Newton defined the mass of a object with

$$F = ma \tag{2}$$

where F is the force acting on an object, a is the acceleration of the object and m is the mass of the object. His theory was successful to explain mechanics and the orbit of the planets. The only exception was the perihelion of Mercury.

The deficiency of Newtonian mechanics started to show with electromagnetism when the velocity can be getting close to light speed. Then, the theory of special relativity was proposed. A problem is that according special relativity, influence of physics must be propagated with finite speed, but the Newtonian gravitational force is instantaneous. For solving this issue, Einstein proposed the general theory of relativity, in which gravity would be propagated with a finite speed. Einstein's theory was verified by his prediction on the bending of light and red shifts of light [2].

In physics, there are repulsive forces related to attractive forces. In electromagnetism there is a repulsive force between two particles of the same charges, and there is an attractive force between different charges. In nuclear physics, there are strong nuclear attractive force and also the weak force that lead to the nuclear decay. However, since there was no repulsive gravitational force, Einstein claimed that the inertial mass and the gravitational mass were equivalent. Moreover, there is no bounded dynamic solution for the Einstein equation [3, 4]. Thus, his theory is actually incomplete.

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In fact, general relativity has never reached a verifiable prediction on dynamic problems with the non-linear Einstein equation [4]. Hawking's theory was in the central development of general relativity, but his theories have never been verified [5]. There were questions on Einstein's theory, but none had a clear experimental support [4]. Now, the formula $E = mc^2$ has been proven invalid theoretically as well as experimentally [6], it is the time to review the whole theory of general relativity. In particular, the necessity of extending general relativity must be addressed [7].

Because of mathematical inadequacy, the deficiency of the Einstein equation was not aware that [4] Einstein incorrectly assumed that the bounded solution from the linearized equation assures the existence of a bounded dynamic solution for the non-linear equation [4]. Moreover, based on the defective Einstein equation, the singularity theorems of Penrose and Hawking were derived and accepted although it is well-known in physics, a singularity would mean a deficiency of the assumptions. Because gravity seems to be always attractive and the deficiency of Einstein equation was not aware, based on simulation, the notion of black holes was proposed [8].

However, Einstein's claim of $E = mc^2$ actually has never been proven [9] and now it is proven wrong in theory and experiments [6]. A problem is that Einstein relies too much on his physical intuition, and thought experiments. He did not check his claims with explicit examples [4]. He also failed to see the need to do the real experiments to support $E = mc^2$ [10]. As we shall show that $E = mc^2$ is a major source of errors in Einstein's theory. It is also responsible for Einstein's failure in showing that the unification of gravitation and electromagnetism is valid since he did not accept the charge-mass interaction [7]. We shall show the existence of the repulsive gravitational force, and explain related issues.

Einstein also did not check the consistency of his theory [4]. In physics, even a proposal is confirmed by an experiment, there could still be imperfections that can be discovered only from later developments. For example, although his notion of photons was verified and Einstein won a Nobel Prize, no experiments had shown that the photons consist of only electromagnetic energy. These deficiencies are responsible for the failures of Einstein's unification.

In summary, there are six kinds of errors in Einstein's general relativity: 1) the implicit invalid physical assumptions such as the photons include only electromagnetic energy and the gravitation is independent of temperature; 2) the mathematical errors such as the linearization being as always valid and the existence of bounded dynamic solutions; 3) Acceptance of singularities as valid physical soluions; 4) the invalid unverified beliefs such as the covariance principle and the embedded Reimannian geometry; 5) the inappropriate applications of theories such as the special relatvity and Riemannian geometry; 6) the erroneous choice of $E = mc^2$ instead of the existence of repulsive gravitation. 1) Moreover, Einstein has the habit of using thought experiments. This would lead to implicit usage of invalid assumptions. Nevertheless, Einstein is still an outstanding physicist since he started the difficult but successful pioneer works.

Currently, many theories are based on speculations. However, we base on facts and logic in this paper.

II. The Inconsistency of the Einstein Equation and the Formula E = mc²

To see the inconsistency of Einstein's theory, we need to do only some simple algebra. From the Einstein equation,

$$G_{\mu\nu} = R_{\mu\nu} - (1/2)g_{\mu\nu}R = -KT_{\mu\nu} \qquad (3)$$

where $R_{\mu\nu}$ is the Rici curvature tensor, $g_{\mu\nu}$ is the space time metric, and $R = g^{\mu\nu}R_{\mu\nu}$, we have

$$R = Kg^{\mu\nu}T_{\mu\nu}. \text{ because } g^{\mu\nu}g_{\mu\nu} = 4. \qquad (4)$$

Since the electromagnetic energy-momentum tensor $T(E)_{\mu\nu}$ is traceless ($g^{\mu\nu}T(E)_{\mu\nu} = 0$), it cannot affect the Rici curvature R. Thus the electromagnetic energy cannot be equivalent to mass since the mass can affect R. Note that the validity of eq. (4) depends only on the static Einstein equation, which has produced many impressive and accurate predictions. Naturally, the problem would only be the inadequately verified formula [9].

Moreover, eq. (4) was first derived by Einstein himself [11]. Thus the failure of seeing this inconsistency is clearly his oversight. This also illustrates that a major problem of Einstein is his inadequate checking for the internal consistency of his theory. This is why he did not discover that there is no bounded dynamic solution for the Einstein equation. Nevertheless, theorists such as Will [12] incorrectly claim that $E = mc^2$ had been proven.

III. The Problem of the Photons and the Anti-Gravity Coupling

The fact is that the equivalence of energy and mass has never been generally verified [9]. However, the equivalence between the photonic energy and mass has been verified theoretically by Einstein [13] and this is supported by the experimental fact that a π_0 meson can decay into two photons. 2)

This paradox can be solved only if the photons contain energy other than the electromagnetic energy. This would mean that Einstein's proposal on the notion of photon [14] is only partially correct.3) Experimentally, the photoelectric effect has verified that the photons contain mainly electromagnetic energy. However, it has not been verified that the photons contain only electromagnetic energy.

According to Einstein, the gravity generated by an electromagnetic wave can be derived from the Einstein equation with the electromagnetic wave energy-stress tensor as the source. In the calculation of the bending of light, it is implicitly required that such gravity generated by an electromagnetic wave is negligible.

However, for a plane electromagnetic wave, the metric obtained by Penrose [15] is the following:

$$ds^2 = du\,dv + Hdu^2 - dx_i dx_i \text{, where } u = ct - z,\ v = ct + z. \quad (5)$$

$$H = h_{ij}(u)x_i x_j,$$

where $h_{ij}(u)$ is the energy-momentum tensor.

Since the solution (5) is not bounded and has unphysical parameters, it violates the principle of causality (see Appendix A). This also exposed a deficiency because this violates the requirement for the calculation of the bending of light [2].

However, according to the old standard of the Physical Review [16] the solution of Penrose was perfectly valid. This shows that the editors of APS had a deficiency in physics. This deficiency was exposed because they are facing a choice of accepting the solution of Penrose or rejecting Einstein's theory. Moreover since such gravity is very weak in physics, journals such as the Chinese Physics B, in agreement with Einstein, believed that such gravity can be calculated with the perturbation approach, but they did not do it.[4)]

Note, however, that mathematically for a perturbation approach to be valid, a necessary condition is that this problem has a bounded solution. This compatibility between mathematics and physics is crucial for the validity of a theory in physics.[5)] However, explicit calculation shows that it is impossible to have a bounded solution for the gravity of an electromagnetic wave [17]. This shows that Einstein does not understand general relativity adequately.

Fortunately, general relativity shows that the photon contains also gravitational energy. This is actually very natural because any charged particle is always massive and the electromagnetic wave is generated from the motion of charged particles. A gravitational wave component was not included in because general relativity had not been invented.

In order for Einstein's theory to make sense, the related Einstein equation with an electromagnetic wave as the source, must include the photonic energy-stress tensor with the anti-gravity coupling [17, 18].

For this case, the related modified Einstein equation is the following:[6)]

$$G_{ab} \equiv R_{ab} - \frac{1}{2} g_{ab}R = - K[T(E)_{ab} - T(p)_{ab}], \quad (6)$$

and

$$T_{ab} = - T(g)_{ab} = T(E)_{ab} - T(P)_{ab},$$

where $T(E)_{ab}$ and $T(P)_{ab}$ are respectively the energy-stress tensors for the electromagnetic wave and the related photons. *Thus the photonic energy must include also the energy of its gravitational wave component as previous analysis shows.* Note that it is natural to include the gravitational wave energy in a photon since a charged particle is always massive.

There is a conflict if the photons consist of only electromagnetic energy. *Thus, the need and existence of a gravitational wave was discovered as early as 2006* [17, 18].[7)] Now, this conflict is resolved since the photonic energy is the sum of electromagnetic energy and gravitational energy, and thus it is established that $E = mc^2$ can be invalid.

In Einstein's 1905 proof [13] for the equivalence of mass and photonic energy, he implicitly assumed that the photonic energy is the energy of the massless particles. *Apparently he was not aware that the energy of massless particles is inconsistent with the energy-stress tensor of an electromagnetic wave. Moreover, to establish this, a modified Einstein equation must be used* [6]. Ohanian [19] incorrectly credited von Laue for a complete proof of the equivalence of mass and photonic energy. However, the fact is that both von Laue and Einstein failed [6].

IV. Experimental Verification on the Invalidity of E = mc²

Theoretically it has been shown that the energy may not always be equivalent to mass. However, a theoretical conclusion may not be valid unless it is supported by experiments because in physics implicit assumptions could be used without knowing it. For examples, an implicit assumption in the space-time singularity theorems of Penrose and Hawking is that all the coupling constants have the same sign [20] and Einstein's claim of $E = mc^2$.

Einstein [10] explained that $E = mc^2$ means that a piece of heated-up metal would have an increment of weight since if an increment of energy for matter implies and increment of mass, this would result in the increment of weight. Therefore, if a piece of heated-up metal has a reduced weight, it has proven that the formula $E = mc^2$ is not valid. Note that it has been shown from eq. (6) that Einstein's understanding of general relativity is inadequate.

Moreover, Dmitriev, Nikushchenko, & Snegov [21] showed in 2003 that a piece of heated-up brass has reduced weight. This experiment is done inside a Dewar vessel that separates the influence of outside heat (see Appendix B). Fan Liangzao, Feng Jinsong, & Liu Wu Qing [22] also show in 2010 that six kinds of metal, after heating-up, have reduced weight. Thus, as shown by the Einstein equation, energy may not be equivalent to mass (see Section 2).

However, they have mistaken instead that these experiments [21, 22] show a reduction of mass. Note that, it has been firmly established that mass is equivalent to energy from the atomic bomb although energy may not be equivalent to mass. Therefore, their claim is inconsistent with established experiments. Moreover, they must explain where the lost mass has become. Understandably their results were incorrectly rejected by many as due to errors.

As Einstein pointed out, the acceleration mass is related to the resistance to acceleration and gravitational mass is related to the attraction to a mass. Thus, acceleration mass and gravitational mass should be distinguishable. Einstein was surprised since he can define the acceleration mass as equivalent to the gravitational mass. *This is due to that the existence of repulsive gravity has not been recognized*. However, it is possible that the mass and gravity can be distinguished with the first approximation of a formula for the period T of a pendulum as follows [23]:

$$T \approx 2\pi\sqrt{\frac{l}{g}}, \tag{7}$$

where l is the length of the pendulum and g is the gravity. Thus, the change of mass of the pendulum would not change the period of the pendulum, but the change of g, the period of the pendulum will be changed.

Since a piece metal is a solid, a reduction of its mass or gravity can be distinguished by using it as a pendulum. In fact, it has been verified by Liu [24] that the mass is essentially the same as Einstein [10] and Lo [25] predicted, but the period is extended after heating-up. Moreover, recently it has been verified by Lo [26] with a torsion balance scale that the lead balls have reduced gravitation after heated-up. *Thus, measuring mass through gravity is nolonger valid.*

Also, it has been verified by Tsipenyuk & Andreev [27] that a charged metal ball has reduced weight,[8)] and a charged capacitor also reduces weight [28].[9)] These experiments support the existence of a charge-mass repulsive force [29] that has been derived from the Reissner-Nordstrom metric of a particle with charge q and mass M [30],

$$ds^2 = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)dt^2 - \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)^{-1} dr^2 - r^2 d\Omega^2, \tag{8}$$

(with c = 1) where r is the radial distance (in terms of the Euclidean-like structure [31]) from the particle center.[10)] In this metric (8), the gravitational components generated by electricity have not only a very different radial coordinate dependence but also a different sign that makes it a new repulsive gravity [7]. This repulsion implies that the basic assumption for black holes of gravity being always attractive [8] is invalid, and general relativity must be extended.[11)]

For an elementary charged particle, the repulsive gravitational force would be very small. However, a similar metric can be derived for a charged ball. The only change is that r becomes R, the distance from the center of the ball and q becomes Q the total charge of the ball. Thus, for a charged ball with sufficient charges Q, the repulsive gravitational force can be macroscopically observed [32] [12)].

V. A Charged Capacitor and the Current-Mass Interaction

The study of charging capacitor was initiated by Thomas T. Brown and later was joined by Paul A. Biefeld [33, 34].

They are known as the B-B effects. A problem is that they cannot be explained with current theories. Thus, many regarded the B-B effects as just experimental errors. Note that physical laws are obtained from observations.

For instance, it is known that a charged capacitor has reduced weight. Moreover, after being charged with a high voltage (about 40 kilovolts), but without continuous supply of electric energy, the lifter (a light capacitor) is able to lift its own weight plus a payload hovering on earth. Also a lifter could get to work by charging the wire to either a positive or a negative potential. It has been determined that the lift is not due to ion wind effects [33]. Thus, the lift is generated by changing something inside the lifter with one high voltage charge.

In a charged capacitor, the only change is the state of motion of some electrons that have become statically concentrated instead of moving in orbits. Then, a repulsive force appears. Since such a force did not appear before, it is clear that such a force was cancelled out by the force created by the motion of the electrons. In other words, the repulsive force generated by the charges of protons and the electrons was cancelled by the force generated by the motion of the initially moving charges of the electrons.

However, this repulsive force cannot be proportional to the charge density. We have equal numbers of negatively charged electrons and positively charged protons with equal charge. This would lead to the cancellation of the forces generated by particles charges. However, if such a force is proportional to the charge density square, then these two kinds of forces would be added up, instead of cancelled out. Moreover, since the lifter has a limited height, one should expect that this repulsive gravitational force would diminish faster than the attractive gravitational force. Thus, if we assume that the force is proportional to mass as usual, the static charge-mass interaction would be a repulsive force between particles with charge density D_q and another particle of mass m would have the following form,

$$F_r \approx KmD_q^2/r^n \quad \text{where} \quad n > 2\,, \tag{9}$$

r is the distance between the two particles, and K is the coupling constant. In formula (9), the coupling constant K and n the power of r can be determined by experiments. The simplest case would be n = 3.

Formula (9) is derived from the observations with common physical sense. The experimental results are that the charged capacitors have reduced weight. If the lift force is large enough, it will hover over the earth [33, 34].

According to general relativity, if the electric energy leads to a repulsive force toward a mass, the magnetic energy would lead to an attractive force from a current toward a mass [8, 35]. Due to that a charged capacitor has reduced weight, it is necessary to have the current-mass interaction to be cancelled out by the effect of the charge-mass interaction. Thus, the existence of the current-mass attractive force would solve a puzzle, i.e., why a charged capacitor exhibits the charge-mass repulsive force since a charged capacitor has no additional electric charges. In fact, the charge-mass repulsive force would be cancelled by the current-mass force as Galileo, Newton and Einstein implicitly assumed.

The existence of such a current-mass attractive force has been discovered by Martin Tajmar and Clovis de Matos [36] from the European Space Agency. Martin et al found that a spinning ring of superconducting material increases its weight more than expected. Thus, they believed that general relativity was wrong. However, according to quantum theory, spinning superconductors should produce a weak magnetic field. Thus, they also measured the current-mass interaction to the earth! The current-mass interaction would generate a force which is perpendicular to the current.

Since the weight addition from a current-mass interaction is directional, the weight of a magnet is directional dependent as our experiment verified [36]. *This directional dependence of weight is a completely new phenomena that verify the existence of the current-mass interaction.*

One may ask what the formula for the current-mass force is. Unlike the charge-mass repulsive force, which can be derived from general relativity; this general force would be beyond general relativity since a current-mass interaction would involve the acceleration of a charge, this force would be time-dependent and generates electromagnetic radiation. Moreover, when the radiation is involved, the radiation reaction force and the variable of the fifth dimension must be considered [37]. Thus, we are not yet ready to derive the current-mass interaction. Nevertheless, we may assume that, for a charged capacitor, the resulting force is the interaction of net macroscopic charges with the mass [28].

Experimentally, the repulsive force would be proportional to the potential square, V^2 where V is the electric potential difference of the capacitor (Q = CV, C is the capacitance and Q is the charge). This has been verified by the experiments of Musha [38, 39]. Thus, the factor of charge density square in heuristic Eq. (9) is correct. Moreover, the hovering of the lifter shows that the repulsive force would diminish faster than the gravitational force. However, even the $1/r^3$ factor in the repulsive force is verified, the calculation would still depend on the detailed modeling [40]. Although the initial thrust due to the electric field is directional, the weight reduction effect for charged capacitors is not directional and it stays if the potential does not change. This is verified by Liu [24] with the roll-up capacitors. Thus, the repulsive force on the charged capacitor is the same force that derived from general relativity [30].

One may ask, what would the weight of the capacitor be after it is discharged? It takes time for a capacitor to recover its weight after being discharged [41]. This was observed because the rolled-up capacitors keep heat better. A discharged capacitor needs time to dissipate the heat generated by discharging, and the motions of its charges would accordingly recover to the previous state. Thus, this connects the heat with a reduction of the weight, and this explains also the experiment on the weight reduction of a piece of heat-up metal. In other words, Einstein is clearly wrong.

VI. The Non-Linear Einstein Equation & its Incompatibility with the Linearized Equation

The Einstein equation is the heart of general relativity. However, many results in general relativity, except the perihelion of Mercury, are actually derived from the linearized equation. A problem is that the Einstein equation and the linearized equation are consistent only for the static cases. For the dynamic case, they are actually independent equations. In particular, the Einstein equation has no dynamic solutions [42-44], but the linearized equation does.

Historically, it is Einstein's calculation of the perihelion in agreement with observation made him to have confidence on his theory [45]. However, A. Gullstrand [46], the chairman of the Nobel Committee (1920-1929) suspected that his calculation is invalid because Einstein failed to show that his calculation can be derived from the required perturbation approach. This is why Einstein obtained a Nobel Prize from his work in photoelectric effects, instead of general relativity as most theorists expected. It should be noted that D. Hilbert did not come to defend Einstein's calculation

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[45] although he obtained the same result with the same method earlier than Einstein.

In 1993, D. Christodoulou and S. Klainerman [47] from Princeton University claimed that they have constructed dynamic solutions for the Einstein equation. The 1993 Nobel Committee was convinced that the Einstein equation had a dynamic solution, and accepted the invalid calculation of J. H. Taylor and T. Damour and awarded the 1993 Nobel Prize for physics to Hulse and Taylor [48].

However, in 1995 [42] it is found that the Einstein equation actually has no bounded dynamic solution. Moreover, Christodoulou and Klainerman actually have not completed a construction for any dynamics solution [49]. Nevertheless, the calculation of Taylor and Damour can be modified to justify their conclusion [43, 44]. It should be noted that the errors of Christodoulou and Klainerman was built on accumulated errors of Wheeler et al [30].

Earlier in 1973 Misner, Thorne, and Wheeler [30] [13)] erroneously claimed they have obtained a bounded wave solution because of their inadequacy in mathematics. They started from a metric of the form,

$$-ds^2 = c^2dt^2 - dx^2 - L^2\left(e^{2\beta}dy^2 + e^{-2\beta}dz^2\right) \tag{10}$$

where $L = L(u)$, $\beta = \beta\ (u)$, $u = ct - x$, and c is the light speed. Then, the Einstein equation $G_{\mu\nu} = 0$ becomes

$$\frac{d^2L}{du^2} + L\left(\frac{d\beta}{du}\right)^2 = 0 \tag{11}$$

Then, they [30] claimed that Eq. (11) has a bounded solution, compatible with a linearization of metric (10).

However, it has been shown with undergraduate mathematics [50] that Misner et al. are incorrect and Eq. (10) does not have a physical solution that satisfies Einstein's requirement on weak gravity. Moreover, Misner et al. [30] also make other serious errors in physics as shown in their eq. (40.14) for the proper time measured by an earth-based clock. It turns out that this is due to their mathematical errors at the undergraduate level [50].

On the other hand, from the Maxwell-Newton approximation, Einstein [51] obtained a solution as follows:

$$-ds^2 = c^2dt^2 - dx^2 - (1+2\phi)dy^2 - (1-2\phi)dz^2 \tag{12}$$

where ϕ is a bounded function of $u\ (= ct - x)$. Note that metric (12) is the linearization of metric (10) if $\phi = \beta\ (u)$. Thus, the waves illustrate that the linearization is not valid for the dynamic case when gravitational waves are involved.

Also, in 1984 Wald [5] claimed that he can get a second order solution, but he did not provide one.

Many believed that the Einstein equation has bounded dynamic solutions because the linearized equation has. We shall give an example to show this is false. Consider the metric obtained by Bondi, Pirani, & Robinson [52] as follows:

$$ds^2 = e^{2\varphi}\left(d\tau^2 - d\xi^2\right) - u^2\begin{bmatrix}\cosh 2\beta\left(d\eta^2 + d\varsigma^2\right) \\ +\sinh 2\beta\cos 2\theta\left(d\eta^2 - d\varsigma^2\right) \\ -2\sinh 2\beta\sin 2\theta\, d\eta\, d\varsigma\end{bmatrix} \tag{13a}$$

where φ, β and θ are functions of u (= τ - ξ). It satisfies the differential equation (i.e., their Eq. [2.8]),

$$2\phi' = u\left(\beta'^2 + \theta'^2\sinh^2 2\beta\right) \tag{13b}$$

which is a special cases of $G_{\mu\nu} = 0$. They claimed this is a wave from a distant source and weak gravity invalid. The metric is irreducibly unbounded due to the factor u^2. Linearization does not make sense since u is not bounded.

Moreover, when gravity is absent, it is necessary to have $\phi = \sinh 2\beta = \sin 2\theta = 0$. These would reduce (13a) to

$$ds^2 = (d\tau^2 - d\xi^2) - u^2(d\eta^2 + d\zeta^2) \tag{13c}$$

However, this metric is not equivalent to the flat metric. Thus, metric (13c) violates the principle of causality (see Appendix A). This challenges the view that both Einstein's notion of weak gravity and his covariance principle are valid because (13 c) cannot be transform to the flat metric and (13a) cannot be transformed into a metric of weak gravity.

These conflicting views are supported respectively by the editors of the "Royal Society Proceedings A" and the "Physical Review D"; thus there is no general consensus. Apparently Einstein did not know that, for a dynamic case, the Einstein equation and the linearized equation are independent equations [53]. Einstein was puzzled that he can have gravitational solution from the linearized equation, but he cannot obtain a bounded gravitational wave solution. So, when Einstein was asked about the existence of gravitational, his last words were that I do not know [54].

VII. The Non-Existence of a Bounded Dynamic Solution for a Two-Body Problem in General Relativity

According to the principle of causality, weak sources would produce a weak field, i.e.,

$$g_{\mu\nu} = \eta_{\mu\nu} + \gamma_{\mu\nu}, \text{ where } 1 >> |\gamma_{\mu\nu}| \tag{14}$$

and $\eta_{\mu\nu}$ is the flat metric. However, eq. (14) is valid, only if the Einstein equation is valid. Since the strength of a source can be reduced, to show the non-existence of a

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dynamic solution, it is sufficient to show the case of weak gravity.

Unfortunately, many believe that condition (14) for weak gravity is always valid for the Einstein equation. They believed that an approximate weak solution can be derived through the approach of the field equation being linearized. The linearized Einstein equation with the linearized harmonic gauge $\partial^\mu \bar{\gamma}_{\mu\nu} = 0$ is

$$\frac{1}{2}\partial^\alpha\partial_\alpha\bar{\gamma}_{\mu\nu} = \kappa T_{\mu\nu} \text{ where } \bar{\gamma}_{\mu\nu} = \gamma_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu}(\eta^{cd}\gamma_{cd}), \quad (15)$$

Note that we have

$$G_{\mu\nu}=G_{\mu\nu}^{(1)}+G_{\mu\nu}^{(2)} \text{ and } G^{(1)}{}_{\mu\nu} = \frac{1}{2}\partial^\alpha\partial_\alpha\bar{\gamma}_{\mu\nu} + H^{(1)}{}_{\mu\nu}, \quad (16)$$

where

$$H^{(1)}_{\mu\nu} = -\frac{1}{2}\partial^\alpha[\partial_\mu\bar{\gamma}_{\nu\alpha} + \partial_\nu\bar{\gamma}_{\mu\alpha}] + \frac{1}{2}\eta_{\mu\nu}\partial^\alpha\partial^\beta\bar{\gamma}_{\alpha\beta}$$

The linearized vacuum Einstein equation means $G^{(1)}{}_{\mu\nu}[\gamma^{(1)}{}_{\alpha\beta}] = 0$. Thus, to have a solution of the second order we must correct $\gamma^{(1)}{}_{\mu\nu}$ by adding to it the term $\gamma^{(2)}{}_{\mu\nu}$ that satisfies

$$G^{(1)}_{\mu\nu}[\gamma^{(2)}{}_{\alpha\beta}] + G^{(2)}_{\mu\nu}[\gamma_{\alpha\beta}] = 0, \text{ where } \gamma_{\mu\nu} = \gamma^{(1)}{}_{\mu\nu} + \gamma^{(2)}{}_{\mu\nu} \quad (17)$$

which is the correct form of eq. (4.4.52) in Wald's book [5] (Wald did not distinguish $\gamma_{\mu\nu}$ from $\gamma^{(1)}{}_{\mu\nu}$).

However, detailed calculation shows that this equation (17) does not have a solution for the dynamic case [42-44]. In fact, as shown by the example in the last section, for a dynamic case, the linealized equation and the Einstein equation are independent equations [53].

It was believed that the linear Maxwell-Newton Approximation [42] (or the linearized Einstein equation),

$$\frac{1}{2}\partial^c\partial_c\bar{\gamma}_{\mu\nu} = KT(m)_{\mu\nu}, \text{ where } \bar{\gamma}_{\mu\nu} = \gamma_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu}(\eta^{cd}\gamma_{cd}) \quad (18a)$$

and

$$\bar{\gamma}_{\mu\nu}(x^i, t) = \frac{K}{2\pi}\int \frac{1}{R} T_{\mu\nu}[y^i, (t - R)]d^3y,$$

where $$R^2 = \sum_{i=1}^{3}(x^i - y^i)^2 \quad (18b)$$

provides the first-order approximation for the Einstein equation (3). However, this was verified for the static case only. The Cauchy data of eq. (3) must satisfy four constraint equations, $G_{\mu t} = -KT(m)_{\mu t}$ (μ = x, y, z, t) since $G_{\mu t}$ contains only first-order time derivatives [55]. This shows that (18a) would be dynamically incompatible with Einstein equation (3).

In 1957, Fock [56] pointed out that, in harmonic coordinates, there are divergent logarithmic deviations from expected linearized behavior of the radiation. This was misinterpreted to mean merely that the contribution of the complicated nonlinear terms in the Einstein equation cannot be dealt with satisfactorily following this method and that another approach is needed. Subsequently, vacuum solutions that do not involve logarithmic deviation were founded by Bondi, Pirani & Robinson [52] in 1959. Thus, the interpretation appears to be justified and the faith on the dynamic solutions maintained. In 1995 [42], it is recognized such a symptom shows the absence of bounded dynamic solutions.

Equation (18) shows that a gravitational wave is bounded and is related to the dynamic of the source. These are useful to prove that eq. (18), as the first-order approximation for a dynamic problem, is incompatible with the Einstein equation (3). According to the principle of causality, it is sufficient to consider the case of weak gravity. Consider, $G^{(2)}{}_{\mu\nu}$ ($G_{\mu\nu} \equiv G_{\mu\nu}{}^{(1)} + G_{\mu\nu}{}^{(2)}$) is at least of second order in terms of the metric elements. For an isolated system located near the origin of the space coordinate system, $G^{(2)}{}_{\mu t}$ at large r (= $[x^2 + y^2 + z^2]^{1/2}$) is of $O(K^2/r^2)$ [5, 55].

One may obtain some general characteristics of a dynamic solution for an isolated system as follows:

1) The characteristics of some physical quantities of an isolated system:

For an isolated system consisting of particles with typical mass $\overline{M}$, separation $\bar{r}$, and velocities $\bar{v}$, Weinberg [55] estimated, the power radiated at a frequency ω of order $\bar{v}/\bar{r}$ will be of order

$$P \approx \kappa(\bar{v}/\bar{r})^6\,\overline{M}^2\,\bar{r}^4 \text{ or } P \approx \overline{M}\,\bar{v}^8/\bar{r}, \quad (19)$$

since $\kappa\overline{M}/\bar{r}$ is of order $\bar{v}^2$. The typical deceleration $\bar{a}_{rad}$ of particles in the system owing this energy loss is given by the power P divided by the momentum $\overline{M}\,\bar{v}$, or $\bar{a}_{rad} \approx \bar{v}^7/\bar{r}$. This may be compared with the accelerations computed in Newtonian mechanics, which are of order $\bar{v}^2/\bar{r}$, and with the post-Newtonian correction of $\bar{v}^4/\bar{r}$. Since radiation reaction is smaller than the post-Newtonian effects by a factor $\bar{v}^3$, if $\bar{v}$ << c, the velocity of light, the neglect of radiation reaction is perfectly justified. This allows us to consider the motion of a particle in an isolated system as almost periodic.

Consider two particles of equal mass with an almost circular orbit in the x-y plane whose origin is the center of the circle (i.e., the orbits are a circle if radiation is neglected). Thus, the principle of causality implies that the metric $g_{\mu\nu}$ is weak and very close to the flat metric at

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distance far from the source and that $g_{\mu\nu}$ (x, y, z, t') is an almost periodic function of t' (= t - r/c).

2) The expansion of a bounded dynamic solution $g_{\mu\nu}$ for an isolated weak gravitational source:

According to eq. (18), a first-order approximation of metric $g_{\mu\nu}$ (x, y, z, t') is bounded and almost periodic since $T_{\mu\nu}$ is. Physically the principle of causality requires $g_{\mu\nu}$ to be almost periodic in time since the motion of a source particle is. Such a metric $g_{\mu\nu}$ is asymptotically flat for a large distance r, and the expansion of a bounded dynamic solution is:

$$g_{\mu\nu}(n^x, n^y, n^z, r, t') = \eta_{\mu\nu} + \sum_{k=1}^{\infty} f_{\mu\nu}{}^{(k)}(n^x, n^y, n^z, t')/r^k,$$

where $n^\nu = x^\nu/r$. (20a)

3) The non-existence of dynamic solutions:

It follows expansion (20a) that the non-zero time average of $G^{(1)}{}_{\mu t}$ would be of $O(1/r^3)$ due to

$$\partial_\mu n^\nu = (\delta^\nu{}_\mu + n^\nu n_\mu)/r, \qquad (20b)$$

since the term of $O(1/r^2)$, being a sum of derivatives with respect to t', can have a zero time-average. If $G^{(2)}{}_{\mu t}$ is of $O(K^2/r^2)$ and has a nonzero time-average, consistency can be achieved only if another term of time-average $O(K^2/r^2)$ at vacuum be added to the source of the Einstein equation (3). Note that there is no plane-wave solution for $G_{\mu\nu} = 0$.

It will be shown that there is no dynamic solution for the Einstein equation with a massive source. Let us define

$$\gamma_{\mu\nu} = \gamma^{(1)}{}_{\mu\nu} + \gamma^{(2)}{}_{\mu\nu}\ ; \qquad \bar{\gamma}^{(i)}{}_{\mu\nu} = \gamma^{(i)}{}_{\mu\nu} - \frac{1}{2}\eta_{\mu\nu}(\gamma^{(i)}{}_{cd}\,\eta^{cd}),$$

where i = 1, 2;

and

$$\frac{1}{2}\partial^\alpha\partial_\alpha\bar{\gamma}^{(1)}{}_{\mu\nu} = K\,T(m)_{\mu\nu}. \qquad (21)$$

Then $\bar{\gamma}^{(1)}{}_{\mu\nu}$ is of a first-order; and $\gamma^{(2)}{}_{\mu\nu}$ is finite. On the other hand, from the Einstein equation (3), one has

$$\frac{1}{2}\partial^\alpha\partial_\alpha\bar{\gamma}^{(2)}{}_{\mu\nu} + H^{(1)}{}_{\mu\nu} + G^{(2)}{}_{\mu\nu} = 0\,. \qquad (22)$$

For a dynamic case, equation (22) may not be satisfied. If (21) is a first-order approximation, $G^{(2)}{}_{\mu\nu}$ has a nonzero time-average of $O(K^2/r^2)$ [1] (but $[\partial^\alpha\partial_\alpha\bar{\gamma}^{(2)}{}_{\mu\nu}/2 + H^{(1)}{}_{\mu\nu}]$ would have); and thus $\bar{\gamma}^{(2)}{}_{\mu\nu}$ cannot have a solution.

However, if $\bar{\gamma}^{(2)}{}_{\mu\nu}$ is also of the first-order of K, one cannot estimate $G^{(2)}{}_{\mu\nu}$ by assuming that $\bar{\gamma}^{(1)}{}_{\mu\nu}$ provides a first-order approximation. For example, equation (18) does not provide the first approximation for the static Schwarzschild solution, although it can be transformed to a form such that (18) provides a first-order approximation [22]. According to eq. (16), $\bar{\gamma}^{(2)}{}_{\mu\nu}$ will be a second order term if the sum $H^{(1)}{}_{\mu\nu}$ is of second order. From (16), this would require $\partial^\mu\bar{\gamma}_{\mu\nu}$ being of second order. For weak gravity, it is known that a coordinate transformation would turn $\partial^\mu\bar{\gamma}_{\mu\nu}$ to a second order term. (Eq. [22] implies that $\partial^c\partial_c\bar{\gamma}^{(2)}{}_{\mu\nu} - \partial^c[\partial_\nu\bar{\gamma}_{\mu c} + \partial_\mu\bar{\gamma}_{\nu c}] + \eta_{\mu\nu}\partial^\alpha\partial^\beta\bar{\gamma}_{\alpha\beta}$ would be of second order.) Thus, it is possible to turn (21) to become an equation for a first-order approximation for weak gravity.

Since it has been proven that (18) necessarily gives a first-order approximation [15], a failure of such a coordinate transformation means only that such a solution is not valid in physics. Moreover, for the dynamic of massive matter, experiment [22] supports the fact that Maxwell-Newton Approximation (11) is related to a dynamic solution of weak gravity [16]. Thus, theoretical considerations as well as experiments eliminate other unverified speculations thought to be possible since 1957.

As shown, the difficulty comes from the assumption of boundedness, which allows the existence of a bounded first-order approximation, which implies that a time-average of the radiative part of $G^{(2)}{}_{\mu\nu}$ is non-zero. The present method has an advantage over Fock's approach to obtaining logarithmic divergence [56] for being simple and clear.

In short, according to Einstein's radiation formula, a time average of $G^{(2)}{}_{\mu t}$ is non-zero and of $O(K^2/r^2)$ [5].

Although (18) implies $G^{(1)}{}_{\mu t}$ is of order K^2, its terms of $O(1/r^2)$ can have a zero time average because $G^{(1)}{}_{\mu t}$ is linear on the metric elements. Thus, the Einstein equation (3) in vacuum cannot be satisfied. However, a static metric can satisfy (3), since both $G^{(1)}{}_{\mu\nu}$ and $G^{(2)}{}_{\mu\nu}$ are of $O(K^2/r^4)$ in vacuum. Note that $G_{\mu t} = KT(m)_{\mu t}$ are constraints on the initial data.

In conclusion, assuming the existence of dynamic solutions of weak gravity for Einstein equation (3) is invalid. This means that general relativity has not yet totally superseded Newtonian gravity, which has dynamic solutions [23]. Unfortunately, because of inadequacy in mathematics, many theorists carelessly follow the erroneous and groundless claims of Christodoulou and Klainerman [47]. However, nobody was able to produce a bounded dynamic solution. Furthermore, the positive mass theorem of Schoen & Yau, which eliminates all the dynamic solutions with a bounded assumption, misleads us that the Einstein equation had bounded dynamic solution.

VIII. A Rectified Einstein Equation and the Anti-Gravity Coupling

From the above analysis, there is a conflict between the Einstein equation, which has no dynamic solution and its linearized equation, which has a dynamic solution. The conflict is due to that the second order terms $G^{(2)}{}_{\mu\nu}$ cannot be eliminated in the Non-linear Einstein equation. Thus, a solution is the 1995 update of the equation [42] as follows:

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = K\, [T(m)_{\mu\nu} - t(g)_{\mu\nu}], \qquad (23)$$

where $t(g)_{\mu\nu}$ is the energy-stress tensors for gravity. [14)] Then, from (23), the equation in vacuum is

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = -K\, t(g)_{\mu\nu} \qquad (23')$$

Note that $t(g)_{\mu\nu}$ is equivalent to $G^{(2)}{}_{\mu\nu}$ (and Einstein's gravitational pseudotensor) in terms of his radiation formula.

When gravitational wave is present, the gravitational energy-stress tensor $t(g)_{\mu\nu}$ is non-zero. This explains Einstein's puzzle [54] why there is no bounded gravitational wave solution for $G_{\mu\nu} = 0$ as shown in solution (13).[15)] For the dynamic case, the linear equation (18) is the linearization of (23) but not of the 1915 Einstein equation. This explains why the Einstein equation does not have a wave solution.

Note that the radiation of the binary pulsar can be calculated without detailed knowledge of $t(g)_{\mu\nu}$. From (23'), the approximate value of $t(g)_{\mu\nu}$ at vacuum can be calculated through $G_{\mu\nu}/K$ as before since the first-order approximation of $g_{\mu\nu}$ can be calculated through (18). In view of the facts that $Kt(g)_{\mu\nu}$ is of the fifth order in a post-Newtonian approximation, that the deceleration due to radiation is of the three and a half order in a post-Newtonian approximation [55] and that the perihelion of Mercury was successfully calculated with the second-order approximation from (3), the orbits of the binary pulsar can be calculated with the second-order post-Newtonian approximation of (23) by using (3). Thus, the approaches of Damour and Taylor [57, 58] would be essentially valid except that they did not realize the crucial fact that (18) is actually an approximation of the updated equation (23) [33].

In light of the above, the Hulse-Taylor experiments support the anti-gravity coupling being crucial to the existence of the gravitational wave [44], and (18) being an approximation of weak waves generated by massive matter. Thus, it has been verified that Einstein equation (3) is not compatible with radiation, but the updated Einstein equation is.

The 1995 updated Einstein equation actually was first proposed by Lorentz [59] and Levi-Civita [60] as follows;

$$\kappa t(g)_{ab} = G_{ab} + \kappa T_{ab} \qquad (24)$$

where T_{ab} is the sum of other massive energy-stress tensors. Then, the gravitational energy-stress tensor $t(g)_{ab}$ takes a covariant form. However, Einstein [61] objected on the grounds that his field equation implies $t(g)_{ab} = 0$. Moreover, Einstein had treated the gravitational energy in the same coupling as other energy. Einstein is wrong since his equation is proven invalid for the dynamic case. Thus, eq. (23) should be called the Lorentz-Levi-Einstein equation. An independent evidence for unboundedness is that the calculated radiation depends on the approached chosen [62].

It should be noted that the anti-gravity coupling is a general feature that appears in where the gravitational wave is present. For instance, it has been shown that such coupling is necessary to appear in the Einstein equation for the gravitational waves generated by an electromagnetic wave [17, 18].

While eq. (23) is consistent with the linearized equation for the massive case and can do an approximate calculation for the gravitational radiation, it is still not yet clear that it is the exact equation. For this, our position is that this is the best we can get so far. Moreover, the non-unique signs of coupling is consistent with that $E = mc^2$ is conditionally valid.

IX. The Space-Time Singularity Theorems and the Assumption of Unique Sign of Couplings

In physics, the existence of singularities suggests problematic assumptions. Nevertheless, in current theory of general relativity, the existence of space-time singularities plays a central role on the notion of black holes and the expanding universe. However, these two speculations have not been firmly verified in spite of the efforts of generations of physicists. Thus, one may question the validity of general relativity in spite of earlier success.

The existence of space-time singularities is due to the spacetime singularity theorems of Hawking and Penrose [5]. The mathematical validity of these theorems is highly reliable because Penrose have won his arguments in mathematics against the theoretical physicist, E. M. Lifshitz [8] in a well-known long dispute. Accordingly, the problem should be in the common physical assumption of these theorems. Moreover, the static Einstein equation has passed various tests with surprises. Thus, the problem seems to be on the dynamic cases of the Einstein equation. This is related to the energy conditions of these theorems. These singularity theorems [5] are listed as the following:

Theorem 1. Let (M, g_{ab}) be a globally hyperbolic spacetime with $R_{ab}\xi^a\xi^b \geq 0$ for all timelike ξ^a, which will be the case if Einstein equation is satisfied with the

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strong energy condition holding for matter. Suppose there exists a smooth (or at least C^2) spacelike Cauchy surface Σ for which the trace of the extrinsic curvature (for the past directed normal geodesic congruence) satisfies $0 > C \geq K$ everywhere C is a constant. Then no past directed timelike curve from Σ can have length greater than $3/|C|$. In particular, all past directed timelike geodesic are incomplete.

Theorem 2. Let (M, g_{ab}) be a strongly causal spacetime with $R_{ab}\xi^a\xi^b \geq 0$ for all timelike ξ^a, as will be the case if Einstein's equation is satisfied with the strong energy condition holding for matter. Suppose there exists a compact, edgeless, achronal smooth spacelike hypersurface S such that for the past directed normal geodesic congruence form S we have $0 > K$ everywhere on S. Let C denote the maximum value for K, so $0 > C \geq K$ everywhere on S. Then at least one inextendible past directed timelike geodesic from S has length no greater that $3/|C|$.

Theorem 3. Let (M, g_{ab}) be a connected, globally hyperbolic spacetime with a noncompact Cauchy surface Σ. Suppose $R_{ab}k^ak^b \geq 0$ for all null k^a, as will be the case if (M, g_{ab}) is a solution of Einstein's equation with matter satisfying the weak or strong energy condition. Suppose, further, that M contains a trapped surface T. Let $0 > \theta_0$ denote the maximum value of θ for both sets of orthogonal geodesic on T. Then at least one inextendible future directed orthogonal null geodesic from T has affine length no greater than $2/|\theta_0|$.

Theorem 4. Suppose a spacetime (M, g_{ab}) satisfies the following four conditions. (1) $R_{ab}v^av^b \geq 0$ for all timelike and null v^a, as will be the case if Einstein's equation is satisfied with the strong energy condition holding for matter. (2) The timelike and null generic conditions are satisfied. (3) No closed timelike curve exists. (4) At least one of the three properties holds: (a) (M, g_{ab}) posses a compact achronal set without edge [i.e., (M, g_{ab}) is a closed universe], (b) (M, g_{ab}) possesses a trapped surface, or (c) there exists a point $p \in M$ such that the expansion of the future (or past) directed null geodesics emanating from p becomes negative along each geodesic in this congruence. Then (M, g_{ab}) must contain at least one incomplete timelike or null geodesic.

The energy condition is related to the energy-momentum tensor T_{ab}. According to the Einstein equation [2]

$$G_{ab} \equiv R_{ab} - (1/2)\, g_{ab}\, R = 4\pi T_{ab},$$

one would have

$$R_{ab} = 8\pi\, [T_{ab} - (1/2)g_{ab}\, T] \quad \text{where} \quad T = g^{ab}T_{ab} \qquad (25)$$

Then,

$$R_{ab}\,\xi^a\xi^b = 8\pi\, [T_{ab}-(1/2)g_{ab}T]\, \xi^a\xi^b = 8\pi\, [T_{ab}\xi^a\xi^b + (1/2)T],$$

$$\text{for a unit timelike} \quad \xi^a \qquad (26)$$

It is believed that for all physically reasonable classical matter the energy condition is non-negative, i.e.,

$$T_{ab}\, \xi^a\xi^b \geq 0 \qquad (27)$$

for all timelike ξ^a. This assumption is known as the weak energy condition. However, it also seems physically reasonable that the stress of matter will not become so large and negative as to make the right-hand side of eq. (3) negative. This assumption,

$$T_{ab}\, \xi^a\xi^b \geq -(1/2)T \qquad (28)$$

for all unit timelike unit vector ξ^a, is known as the strong energy condition. *An implicit assumption of these energy-conditions (26)-(28) is that all the coupling constants have the same sign.*

However, it has been shown that this implicit assumption of unique sign for all the coupling constants is invalid in physics because it leads to the non-existence of dynamic solutions for the problem of photons and the dynamic case of massive sources. Although even Einstein admitted that Hawking's theory is based on general relativity, it is based on an oversight error of Einstein, $E = mc^2$. This explains why Hawking has no verified correct predictions.

Thus, an assumption that restricts to only bounded solutions would exclude all the dynamic solutions. This is why the positive energy theorem of Scheon and Yau [63] is invalid and misleading. However, the Fields Medal was awarded to Yau (1982) and Witten (1990) for their work including the misleading theorem. This is due to that mathematicians *such as Atiyah* [16)] *and Faddeev*[17)], *do not understand physics* [64]. Also, since the singularity theorems are irrelevant in physics, the claims of an expanding universe and the existence of black holes need new justifications.

It is interesting that Hawking is the only theorist who has no known verified correct prediction in his life. We are not sure that Hawking can be called a physicist because he failed to see that a physical solution must be bounded. In my opinion, he is essentially a mathematician, but does not understand physics.

X. Problems in Newtonian Gravity

Newton's inverse-square law of gravitation is the oldest standing mathematical description of a fundamental interaction. Experimental tests of gravity's distance-dependence define a frontier between our understanding of gravity and many proposed forms of new physics. As gravity is $\sim 10^{40}$ times weaker than electromagnetism, gravity remains hidden by experimental backgrounds at distances smaller than the diameter of a fine human hair. The recent talk of Charles Hagedorn [65] surveys the past, present, and near-future of the experimental field, with substantial emphasis on precision sub-millimeter laboratory experiments. However, Hagedorn did not know as most of the APS members, the crucial fact that the measured weight of testing matter actually depends on its temperature [41].

Although Faller [66] is aware of that error budgets in the measurements of the Newtonian coupling constant are fundamentally flawed because they cannot make allowances for error sources that have not been thought of. However, he did not know that the measurements to obtain the Big G coupling constant could not be accurate due to ignorance on the influence of heat to weight [41]. Thus, the Newtonian coupling obtained by J. Luo (罗俊) is questionable [67].

Since the measured Newtonian gravity is actually temperature dependent [41], in principle, the temperature dependence must be understood before an accurate test of Newton's inverse square law. This would also means that Newtonian gravity can be understood only if the repulsive gravity has been understood.

Einstein did not see that for the dynamic case, the Einstein equation does not have any bounded solution. Thus, the linearization actually cannot be executed, and the "linearized" equation is an unrelated equation. *Therefore, the Newtonian gravity has not been superseded yet.* Einstein was puzzled [53] why his equation does not produce the gravitational wave solution. This is due to that Einstein like most physicists incorrectly assumed that a physical solution always exists, once an accurate result has been obtained.

One might argue that the temperature dependence of gravity is expected since an increase of temperature means the increase of energy. The problem is, however, that an increase of temperature leads to a reduction of weight [41]. [18)]

XI. The Repulsive Gravitation and the Necessity of Extending General Relativity

Newton and Einstein give an over-simplified picture for gravitation. In particular, the gravitational effects of the electromagnetic energy were neglected by Einstein. They overlooked the repulsive gravitation due the mass-charge interaction and the attractive gravitation due to the current-mass interaction [7].

Due to theoretical errors, essentially nothing has been done on the energy of electromagnetism until 1997 [12]. Now, let us reexamine again the Reissner-Nordstrom metric [30] (with c =1) for a particle P as follows:

$$ds^2 = \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)dt^2 - \left(1 - \frac{2M}{r} + \frac{q^2}{r^2}\right)^{-1} dr^2 - r^2 d\Omega^2 , \quad (8)$$

where q and M are the charge and mass of a particle, and r is the radial distance from the particle center. In metric (8), the gravitational components generated by electricity have not only a very different radial coordinate dependence but also a different sign that makes it a new repulsive gravity in general relativity [7].

Nevertheless, theorists such as Herrera, Santos, & Skea [68] argued that M in (8) involves the electric energy. Then they obtained a metric that would imply a charged ball would increase its weight as the charge q increased [7]. However, this is in disagreement with experiments [27]. Nevertheless, they are not alone. For instance, Nobel Laureates't Hooft [69][19)] and Wilczek [70][20)] also have mistaken that m = E/c² was universally true.

On the other hand, if the mass M is the inertial mass of the particle, the weight of a charged metal ball can be reduced [7]. Thus, experiments on two metal balls [27] supports that the mass does not include electric energy since a charged ball has a reduced weight. This is an experimental direct proof that the electric energy is not equivalent to mass. It will be shown that such a force leads to the necessity to extend the theoretical framework of general relativity.

To see the necessity of extending relativity, we consider the force on a test particle with mass m, and

$$\frac{d^2x^\mu}{ds^2} + \Gamma^\mu{}_{\alpha\beta}\frac{dx^\mu}{ds}\frac{dx^\nu}{ds} = 0,$$

where $\Gamma^\mu{}_{\alpha\beta} = (\partial_\alpha g_{\nu\beta} + \partial_\beta g_{\nu\alpha} - \partial_\nu g_{\alpha\beta})g^{\mu\nu}/2$ (29)

and $ds^2 = g_{\mu\nu}dx^\mu dx^\nu$, according to Einstein. Note, the gauge affects only the second order approximation of g_{tt} [55].

Let us consider only the static case. For a test particle *p* with mass m at **r**, the force on *p* is

$$-m\frac{M}{r^2} + m\frac{q^2}{r^3} \quad (30)$$

in the first order approximation because $g^{rr} \cong -1$. Thus, the second term is a repulsive force.

If the particles are at rest, then the force acting on the charged particle *P* has the same magnitude

$$(m\frac{M}{r^2} - m\frac{q^2}{r^3})\,\hat{r}\text{, where } \hat{r} \text{ is a unit vector} \quad (31)$$

because the action and reaction forces are equal and in the opposite directions. However, for the motion of the charged particle with mass M, if one calculates the metric according to the particle *p* of mass m, only the first term is obtained.

Then, it is necessary to have a repulsive force with the coupling q^2 to the charged particle *P* in a gravitational field generated by mass m. Thus, force (31) to particle *P* is beyond the framework of gravitation +

electromagnetism. As predicted by Lo, Goldstein, & Napier [37], general relativity would lead to the necessity of its extension.

The repulsive force in (8) comes from the electric energy [7]. An immediate question would be whether such a charge-mass repulsive force mq^2/r^3 is subjected to electromagnetic screening. Physically, this force, being independent of a charge sign, should not be subjected to such a screening. However, it could be according to Maxwell.

Note that this force can be considered as a result of q^2 interacting with a field created by the mass m. Thus such a field is independent of electromagnetism and is beyond general relativity, and the need of unification is established. To test such a possibility, one can measure whether there is such a repulsive force outside a charged capacitor.[21)] When the charged particle P is moved, one must consider also the force due to attractive current-mass interaction.

The existence of such a current-mass attractive force has been verified by Martin Tajmar and Clovis de Matos [35].[22)] Moreover, such interaction could be identified as the cause for the anomaly of flybys.

In short, there are three factors that determine the weight of matter. They are; 1) the mass of the matter; 2) the charge-mass repulsive force; and 3) the attractive current-mass force. For a piece of a heated-up metal, the current-mass attractive force due to orbital electrons is reduced, but the charge-mass repulsive force would increase. Therefore, a net result is a reduction of weight [7] instead of increased weight as Einstein predicted. Thus, to test the inverse square law accurately, one must know exactly how temperature affects the weight.

XII. Einstein's Conjecture of Unification and the Five-Dimensional Relativity

The coupling with q^2 leads to a five-dimensional space of Lo et al. [37] since such a coupling does not exist in a four-dimensional theory, the five dimensional theories of Kaluza [71] or Einstein & Pauli [72].

Now let us give a brief introduction of the five-dimensional relativity. The five dimensional geodesic of a particle is

$$\frac{d}{ds}\left(g_{ik}\frac{dx^k}{ds}\right)=\frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{ds}\frac{dx^l}{ds}+\left(\frac{\partial g_{5k}}{\partial x^i}-\frac{\partial g_{5i}}{\partial x^k}\right)\frac{dx^5}{ds}\frac{dx^k}{ds}-\Gamma_{i,55}\frac{dx^5}{ds}\frac{dx^5}{ds}-g_{i5}\frac{d^2x^5}{ds^2} \qquad (32a),$$

$$\frac{d}{ds}\left(g_{5k}\frac{dx^k}{ds}+\frac{1}{2}g_{55}\frac{dx^5}{ds}\right)=\Gamma_{k,55}\frac{dx^5}{ds}\frac{dx^k}{ds}-\frac{1}{2}g_{55}\frac{d^2x^5}{ds^2}+\frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{ds}\frac{dx^k}{ds}, \qquad (32b)$$

where $ds^2 = g_{\mu\nu}dx^\mu dx^\nu$, μ, ν = 0, 1, 2, 3, 5 ($d\tau^2 = g_{kl}dx^k dx^l$; k, l = 0, 1, 2, 3).
If instead of *ds*, $d\tau$ is used in (32), for a test particle with charge q and mass M, the Lorentz force suggests

$$\frac{q}{Mc^2}\left(\frac{\partial A_i}{\partial x^k}-\frac{\partial A_k}{\partial x^i}\right)=\left(\frac{\partial g_{i5}}{\partial x^k}-\frac{\partial g_{k5}}{\partial x^i}\right)\frac{dx^5}{d\tau}. \qquad (33a)$$

Thus,

$$\frac{dx^5}{d\tau}=\frac{q}{Mc^2}\frac{1}{K}, \quad K\left(\frac{\partial A_i}{\partial x^k}-\frac{\partial A_k}{\partial x^i}\right)=\left(\frac{\partial g_{i5}}{\partial x^k}-\frac{\partial g_{k5}}{\partial x^i}\right)$$

and

$$\frac{d^2x^5}{d\tau^2}=0 \qquad (33b)$$

where *K* is a constant. It thus follows that (32) is reduced to

$$\frac{d}{d\tau}\left(g_{ik}\frac{dx^k}{d\tau}\right)=\frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{d\tau}\frac{dx^l}{d\tau}+\left(\frac{\partial A_k}{\partial x^i}-\frac{\partial A_i}{\partial x^k}\right)\frac{q}{Mc^2}\frac{dx^k}{d\tau}-\Gamma_{i,55}\left(\frac{q}{Mc^2}\right)^2\frac{1}{K^2}, \qquad (34a)$$

$$\frac{d}{d\tau}\left(g_{5k}\frac{dx^k}{d\tau}+\frac{1}{2}g_{55}\frac{q}{KMc^2}\right)=\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau}+\frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{d\tau}\frac{dx^k}{d\tau}. \qquad (34b)$$

One may ask what the physical meaning of the fifth dimension is. Our position is that the physical meaning of the fifth dimension is not yet very clear [37], except some physical meaning is given in the equation, $dx^5/d\tau = q/Mc^2K$ where M and q are respectively the mass and charge of a test particle, and *K* is a constant. We shall denote the fifth axis as the w-axis. Our approach is to find out the full physical meaning of the w-axis as our understanding gets deeper.

For a static case, we have the forces on the charged particle P in the ρ-direction

$$-\frac{mM}{\rho^2} \approx \frac{Mc^2}{2}\frac{\partial g_{tt}}{\partial \rho}\frac{dct}{d\tau}\frac{dct}{d\tau} g^{\rho\rho}, \quad \text{and} \quad \frac{mq^2}{\rho^3} \approx -\Gamma_{\rho,55}\frac{1}{K^2}\frac{q^2}{Mc^2}\, g^{\rho\rho} \tag{35a}$$

and

$$\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau} = 0, \quad \text{where } \Gamma_{k,55} \equiv \frac{\partial g_{k5}}{\partial x^5} - \frac{1}{2}\frac{\partial g_{55}}{\partial x^k} = -\frac{1}{2}\frac{\partial g_{55}}{\partial x^k} \tag{35b}$$

in the (-r)-direction. The meaning of (35b) is the energy momentum conservation. Thus,

$$g_{tt} = 1 - \frac{2m}{\rho c^2}, \quad \text{and } g_{55} = \frac{mMc^2}{\rho^2}K^2 + \text{constant} \quad \left(\text{or } \frac{1}{MK^2c^2}g_{55} = \frac{m}{\rho^2} + \text{constant.}\right) \tag{36}$$

In other words, g_{55} is a repulsive potential, and g_{55}/M is also a function of a distance mass m.

On the other hand, because g_{55} is independent of q, this force would penetrate electromagnetic screening. From the above, it is also possible that a charge-mass repulsive potential would exist for a metric based on the mass M of the charged particle P. However, because p is neutral, there is no charge-mass repulsion force (from $\Gamma_{k,\,55}$) on p.

Thus, general relativity must be extended to accommodate the charge-mass interaction, as Einstein conjectured. For this, a five-dimensional relativity is a natural candidate. According to Lo et al. [37], the charge-mass interaction would penetrate a charged capacitor. To verify the five-dimensional theory, one can simply test the repulsive force on a charged capacitor. This has been experimentally confirmed [7]. On the other hand, from four-dimensional theory, we would not get a repulsive force acting on a test massive particle outside a capacitor since the electromagnetic field would be screened out. Thus, one may expect that there are surprises in five-dimensional theory.

However, journals such as the Physical Review and Proceedings of the Royal Society A, still have not recognized these important experiments due to inadequacy in nonlinear mathematics and blind faith toward Einstein. They all, like Hawking, believed in the invalid speculation E = mc².

XIII. Applications of the Charge-Mass Repulsive Force and Anomaly of the Space Probes

The Reissner-Nordstrom metric was first published in 1916, the same year that first paper on general relativity was published. Thus, the repulsive charge-mass interaction should have been discovered shortly afterward. However, this was not recognized until 1997 [36], because Einstein and his followers believed in his invalid speculation of E = mc².

However, the existence of repulsive gravitation was inadvertently verified by the charged metal ball experiment [39] in 2005. One may ask whether the repulsive gravitation has some effects on astrophysics. In addition to the temperature and the composition of the test particle, the gravity also has some issues related to the sun.

Note that, the calculation of metric (8) is essentially based on general relativity. However, it is important to see this is crucial to establish a charge-mass repulsive force, which is independent of electromagnetism.

Then, the charge-mass repulsive force between a point charge q and a point mass m is

$$F = \frac{q^2 m}{r^3} \tag{37}$$

in the r-direction. The five-dimensional theory supports that it is not subjected to electromagnetic screening, and this is supported by the experiment of weighing charged capacitors [52] because a concentration of charges would provide such repulsion. This new force is different from Newtonian attractive force, which is inversely proportional to the square of the distance. Thus such a repulsive force would become weak faster than gravity at long distance.

Due to such a force, a capacitor lifter hovers on earth only in a limited height [50]. Note that the lifter does not need a continuation of power supply, and it is essentially due to the positive and negative static charges. This provides a theoretical basis for the reported phenomena that some monks can hover above the earth. Similarly, in the Chinese martial arts, there are speculations of the exceptional ability of high jump and walking on top of water and snow. Now, these are actually possible in terms of the law of physics although how these could be done is not yet clear. Previously, such exceptional abilities were simply disregarded as miracle since it would be against the law of physics.

The space probes also give a good opportunity to check the mass-charge interaction. If the repulsive force comes from the sun, then m in (37) would be m_p the mass of the pioneer, and distance r would be R the distance between the sun and the space probe.

However, the charge term is not clear since for the sun we do not know what the non-linear term for the charge square should be.

Nevertheless, since such forces act essentially in the same direction, we could use a parameter P_s to represent the collective effect of the charges. Then, the effective repulsive force F_p would be [23)]

$$F_p = \frac{P_s m_p}{R^3} . \tag{38}$$

Since the neutral sun emits light and is in an excited state, the sun has many locally charged particles, whose effect exceed the attractive effects of motion of charge and thus P_s is not negligible. If the data fits well with a parameter P_s, then this would be a confirmation of the charge-mass interaction.

Since this force is much smaller than the gravitational force from the sun, in practice the existence of such a repulsive force would result in a very slightly smaller mass M_{ss} for the sun of mass M_s, i.e.

$$F = \frac{M_s m_p}{R^2} - \frac{P_s m_p}{R^3} \tag{39a}$$

and

$$\frac{M_s m_p}{R_0{}^2} - \frac{P_s m_p}{R_0{}^3} = \frac{M_{ss} m_p}{R_0^2} \tag{39b}$$

where R_0 is the distance from earth to the sun. Then, we have

$$F = \frac{M_{ss} m_p}{R^2} + \frac{P_s m_p}{R^2}\left(\frac{1}{R_0} - \frac{1}{R}\right) \tag{40}$$

Thus, it appears that there is an additional attractive force for $R >> R_0$.

Moreover, such a force would not be noticeable from a closed orbit since the variation of the distance from the sun is small. However, for open orbits of the pioneers, there are great variations. When the distance is very large, the repulsive force becomes negligible, and thus an additional attractive force would appear as the anomaly. Such a force would appear as a constant over a not too long distance. Thus, the repulsive fifth force seems to be the only force that satisfies the overall requirements from the data [53]. However, this problem does not affect the gravity of the moon where there is no charged particles, thus the orbits around the moon are reliable.

Some claimed that the Pioneer Space-Probe Anomaly has been resolved by a heat-radiation model. However, a discoverer of the anomaly, Erik Anderson (April 1, 2011 at 12:57) commented, "…Science will have suffered the worst sort of dysfunction if the Pioneer Anomaly gets swept under the convenient rug of 'the plausible.' Even so, we will still have the Earth flyby anomalies and the so-called 'A.U.' anomaly left uncovered. All three anomalies seem to be manifestations of a singular phenomenon — the latter two cannot be dismissed as heat radiation. Heat-radiation models, like string theory, can be customized to fit any set of observational parameters. There is no limit on sophistication. We should not be so easily impressed. Nothing has been resolved." I would like or add also that there is no evidence that can justify a heat-radiation model. It seems such modeling reflex only a blind faith on Einstein.

When the four planetary probes experienced unaccountable changes in velocity as they passed Earth, they experienced an additional repulsive force from the Earth because the core of the globe has charged currents. Moreover, depending on the way of approaching the globe, a planetary probe would also experience an additional attractive force due to current-mass interaction. Thus, a planetary probe would have an additional acceleration or de-acceleration. These cannot be modeled with a heat-radiation model.[24)]

Therefore, there are two forces acting on a planet, one attractive and another repulsive with different strengths and distance dependencies. It is possible that these forces would have an effect on the spins of the planets. A speculation is that such a coupling would supply the energy that heats up planets internally. Current explanations for such heat as being due to radiation decay are not satisfactory since there has been no radioactive material discovered from volcanoes. Thus, a new area for experimental and theoretical development of the charge-mass interaction and higher dimensional unification are opened for physicists to explore. Now, fundamental physics will be more alive again.

XIV. Invalidity of the Covariance Principle

Because of the Bianchi Identity, the Einstein equation requires an additional condition to make the solution definite. Such a condition is called the gauge condition. The commonly used gauges are the harmonic gauge, the isotropic gauge, the Schwarzschild gauge, etc. The covariance principle states that all the gauges are invariance in physics. However, as Zhou Pei Yuan [73] pointed out, the covariance principle leads to "the concept that coordinates don't matter in the interpretation of Einstein's theory … and necessarily leads to mathematical results which can hardly have a physical interpretation and are therefore a mystification of the theory." Thus, Zhou [73] proposed the harmonic gauge. It will be shown that this covariance principle is invalid in physics through explicit examples.

Einstein's principle of general relativity states "The law of physics must be of such a nature that they apply to systems of reference in any kind of motion. Einstein later extended this principle to unrestricted mathematical covariance and called it as the "principle of covariance" [2]. He stated, "The general laws of nature are to be expressed by equations which hold good for all systems of co-ordinates, that is, are co-variant with respect to any substitutions whatever (generally co-variant)." However, the gauge conditions such as the harmonic gauge are known to be not a tensor condition. Thus, validity of this principle needs to be tested and verified.

A simple test of this principle is possible due to the fact that there are different gauges such as the harmonic, the isotropic and the Schwarzschild gauges for a given frame of reference. Since a physical quantity in a classical theory is uniquely determined by measurement, any physical quantity should be gauge invariant among those gauges of a given frame. Based on that both the Schwarzschild and the harmonic solution produced the same first order deflection of a light ray, Einstein [74] remarked, "It should be noted that this result, also, of the theory is not influenced by our arbitrary choice of a system of coordinates." However, such a claim is premature because this gauge invariance should have been supported by all physical quantities in all orders.

In Einstein's arguments for this principle, he emphasized that a physical theory is about the coincidences of the space-time points, but the meaning of measurements is crucially omitted [2]. However, to describe events, one must be able to relate events of different locations in a definite manner. Eddington [75] commented, "space is not a lot of points close together; it is a lot of distances interlocked." Moreover, as pointed out by Morrison, the "covariance principle" is invalid because it disrupts the necessary physical continuity from special relativity to general relativity [76, 77]. In fact, Einstein's "principle of covariance" has no theoretical basis in physics or observational support beyond allowed by the principle of general relativity [76].

Nevertheless, many still believe in this invalid "covariance principle", in part, because gauge invariance has a long history starting from classical electrodynamics. Later, the notion of gauge invariance has been developed to non-Abelian gauge theories such as the Yang-Mills theory [78]. [25)] However, electromagnetisms are actually not gauge invariance since the electromagnetic potentials actually are physically effective, as Aharonov & Bohm [79] pointed out. In fact, all the physical Yang-Mills theories are not gauge invariant (Appendix C) since the invariance must be broken such that masses can be created for Fermions. These facts support the view that gauge invariance in a theory would be a manifestation that there are some deficiencies in the physical theory [80, 81].

Thus, it is clear that C. N. Yang does not understand gauge theory as Salam and Weinberg [82] *pointed out.* In fact his misunderstanding of gauge started from their paper on the gauge invariance in their paper on Yang-m-Mills theory. A consequence is that Yang believed in Einstein's covariance principle, and thus wrongly against Zou Pei-Yuan. This could be a main reason that Zhou's rectification of general relativity was not well accepted (see Appendix B).

a) Invalidity of covariance principle and the bending of light

It has been shown by Bodenner & Will [83] and Gérard & Piereaux [84] that the deflection angle is gauge invariant to the second order. However, the calculation of the deflection to the second order actually manifests intrinsic gauge non-invariance. They are based on the assumption that the metric for a spherical coordinate system takes the form,

$$ds^2 = A^2(r)\, c^2dt^2 - B^2(r)dr^2 - D(r)^2\, r^2\, (d\theta^2 + \sin^2\theta\, d\varphi^2), \quad (41)$$

This coordinate system is attached to a static Sun with spherical symmetry mass distribution. In fact, the spherical coordinate system (r, θ, φ) is necessarily defined on the Euclidean-like structure [85, 86] of the frame of reference.

From metric (41), for a weak field, the deflection angle is derived [83, 84] as

$$\alpha(b) = \frac{4GM}{c^2 b}\left[1 + \frac{15\pi}{16}\frac{GM}{c^2 b}\right] + O\left(\frac{m^3}{b^3}\right), \quad \text{where} \quad b = \frac{D(r_0)}{A(r_0)} r_0 \quad \text{and} \quad m = \frac{GM}{c^2} \quad (42a)$$

Here, $\kappa = G/c^2 = 7.425\text{x}10^{-29}\text{cmg}^{-1}$, M is the total mass, "$r_0$" is the closest (Euclidean-like) distance from the center of the sun to the light ray, and "b" is the impact parameter of the light ray. For the first order, as Einstein, we obtained,

$$\alpha(b) \sim 4m/b \sim 4m/r_0 \qquad \text{since } A(r) \sim D(r) \sim 1. \quad (42b)$$

Thus, α(b) is gauge invariant. However, the impact parameter b can be measured only indirectly.

To see the invariant b, let us consider the harmonic, the isotropic and the Schwarzschild metrics as follows:

$$ds^2 = \frac{\rho - M\kappa}{\rho + M\kappa} c^2dt^2 - \frac{\rho + M\kappa}{\rho - M\kappa} d\rho^2 - (\rho + M\kappa)^2 (d\theta^2 + \sin^2\theta\, d\phi^2), \quad (43a)$$

where

$$\xi = \rho \sin\theta \cos\varphi, \quad \zeta = \rho \sin\theta \sin\varphi, \quad \eta = \rho \cos\theta, \quad \text{and} \quad \rho > M\kappa. \quad (43b)$$

$$ds^2 = [(1 - M\kappa/2r)^2/(1 + M\kappa/2r)^2]\, c^2dt^2 - (1 + M\kappa/2r)^4\, (dr^2 + r^2d\theta^2 + r^2\sin^2 d\phi^2) \quad (44a)$$

where

$$x = r \sin\theta \cos\varphi, \quad y = r \sin\theta \sin\varphi, \quad z = r \cos\theta, \quad \text{and} \quad r > M\kappa \tag{44b}$$

$$ds^2 = (1 - 2M\kappa/r')c^2dt^2 - (1 - 2M\kappa/r')^{-1}dr'^2 - r'^2(d\theta^2 + \sin^2\theta d\phi^2), \tag{45a}$$

where

$$x' = r' \sin\theta \cos\phi, \quad y' = r' \sin\theta \sin\phi, \quad z' = r' \cos\theta \quad \text{and} \quad r' > 2 M\kappa.\kappa \tag{45b}$$

Since ds^2 is gauge invariant, from (43) and (45) one gets $[(\rho + M\kappa)/(\rho - M\kappa)]d\rho^2 = (1 - 2M\kappa/r')^{-1}dr'^2$. It follows that

$$\frac{\rho - M\kappa}{\rho + M\kappa} = (1 - 2M\kappa/r'), \quad (\rho + M\kappa)^2 = r'^2, \quad \text{and} \quad r' = \rho + M\kappa, \quad \text{for} \quad r' >. 2M\kappa \tag{46a}$$

Similarly, from (44) and (45) one gets $(1 + M\kappa/2r)^4dr^2 = (1 - 2M\kappa/r')^{-1}dr'^2$. It follows that

$$(1-M\kappa/2r)^2/(1+M\kappa/2r)^2 = (1-2M\kappa/r'), \ (1+M\kappa/2r)^4r^2 = r'^2, \text{ and } r' = r(1+M\kappa/2r)^2 \text{ for } r' > 2M\kappa. \tag{46b}$$

Therefore, equations (46a) and (46b) show that the shortest distance from the sun center ρ_0, r_0, or r'_0 in terms of the Euclidean-like structure of the respective gauge are different. Thus, these structures are different for different gauges.

The first order of deflections are the same for the harmonic and the Schwarzschild gauge because $4m/\rho_0 \sim 4m/r'_0$ to the first order, according to eq. (46a). Accordingly, the shortest distance from the sun is a physical quantity although it is not gauge invariant. Einstein's approach is necessary since the actual physical gauge in physics is not known.

If b_s, b_h and b_I respectively denote the impact parameters and if d_s, d_h, and d_I are respectively denote the closest distance (in their respective Euclidean-like structure [83, 84]) for different gauges, then according to eq. (42a), we have,

$$b_s = \frac{D(d_s)}{A(d_s)} d_s = \frac{d_s}{(1 - 2m/d_s)^{1/2}} = d_h \frac{(1 + m/d_h)}{(1 - m/d_h)} = \frac{D(d_h)}{A(d_h)} d_h = b_h \tag{47a}$$

and

$$b_s = \frac{D(d_s)}{A(d_s)} d_s = \frac{d_s}{(1 - 2m/d_s)^{1/2}} = d_I \frac{(1 + m/2d_I)^3}{(1 - m/2d_I)} = \frac{D(d_I)}{A(d_I)} d_I = b_I \tag{47b}$$

Then, b is the same for all three gauges. In terms of the shortest distance, the deflection angle is respectively,

$$\alpha(b) = \frac{4m}{d_s}\left[1 + (\frac{15\pi}{16} - 1)\frac{m}{d_s}\right] + O\left(\frac{m^3}{d_s{}^3}\right), \qquad b = \frac{D(d_s)}{A(d_s)} d_s = \frac{d_s}{(1 - 2m/d_s)^{1/2}} \tag{48a}$$

$$\alpha(b) = \frac{4m}{d_h}\left[1 + (\frac{15\pi}{16} - 2)\frac{m}{d_h}\right] + O\left(\frac{m^3}{d_h{}^3}\right), \qquad b = \frac{D(d_h)}{A(d_h)} d_h = d_h \frac{(1 + m/d_h)}{(1 - m/d_h)} \tag{48b}$$

$$\alpha(b) = \frac{4m}{d_I}\left[1 + (\frac{15\pi}{16} - 2)\frac{m}{d_I}\right] + O\left(\frac{m^3}{d_I{}^3}\right), \qquad b = \frac{D(d_I)}{A(d_I)} d_I = d_I \frac{(1 + m/2d_I)^3}{(1 - m/2d_I)}. \tag{48c}$$

When the closest distance r_0 is obtained from a measurement, the relation between the distance r_0 and b would be

$$b \approx m + r_0, \tag{49a}$$

or

$$b \approx 2m + r_0 \tag{49b}$$

depending on what gauge (Schwarzschild, isotopic or harmonic) is valid in physics. Accordingly, one has to decide first what the actual gauge is in reality. Thus, this gauge invariance has no meaning in physics unless the first order of the metric is known that (49a) or (49b) can be chosen. This example shows that Zhou Pei-Yuan is right.

Some incorrectly claimed that "r_0" is only an arbitrary label. However, according to Einstein [2, 74], r_0 is not arbitrary. Bodenner & Will [83] argued that *b* is the ratio of angular momentum J to energy E for the photon (J = b E). However, to measure J, similar problems would occur [87]. Thus, they do not have a valid argument.

Thus, general relativity is intrinsically not gauge invariant since the shortest distance from the sun center is gauge dependent although the impact parameter b is the same. This is consistent with Einstein's equivalence principle, which requires the physical gauge being unique for a given frame [88] since measurements should be unique in a given frame.

Moreover, invalidity of the gauge invariance can be seen explicitly from the light speeds as follows:

$$\frac{dr'}{dt} = c\left(1 - \frac{2M\kappa}{r'}\right) = \frac{d\rho}{dt} = \frac{dr}{dt}\left(1 - \frac{M\kappa}{2r}\right)\left(1 + \frac{M\kappa}{2r}\right), \tag{50a}$$

$$\frac{r'd\theta}{dt} = c\left(1 - \frac{2M\kappa}{r'}\right)^{\frac{1}{2}} = \frac{\rho d\theta}{dt}\left(1 + \frac{M\kappa}{\rho}\right) = \frac{rd\theta}{dt}\left(1 + \frac{M\kappa}{2r}\right)^2, \tag{50b}$$

$$\sin\theta\frac{r'd\varphi}{dt} = c\left(1 - \frac{2M\kappa}{r'}\right)^{\frac{1}{2}} = \sin\theta\frac{\rho d\varphi}{dt}\left(1 + \frac{M\kappa}{\rho}\right) = \sin\theta\frac{rd\varphi}{dt}\left(1 + \frac{M\kappa}{2r}\right)^2. \tag{50c}$$

Thus, the light speeds ($ds^2 = 0$), calculated from the Schwarzschild solution, the harmonic solution, and the isotropic solution, are explicitly not invariant although they are diffeomorphic solutions. Perhaps due to such a violation, some theorists [89] insist that the measured light speed in vacuum is always c although Einstein has remarked that the light speeds are no longer a constant since a light ray bends [2, 74]. This illustrates how the so-called experts change Einstein's theory to cover up their errors. To determine the physical valid gauge, one may use Zhou's experiment [90].

b) *Invalidity of Covariance Principle and the de Sitter Precession Formulas*

Since r_0 is not gauge invariant, there should be other examples of such a violation. For instance, from the Maxwell-Newton Approximation [42, 44], one would obtain a formula for the *de Sitter* precession [89] as follows:

$$\frac{d\vec{S}}{d\tau} = -2(\vec{v}\bullet\vec{S})\vec{\nabla}\Phi + v(\vec{S}\bullet\vec{\nabla}\Phi) + \vec{S}(\vec{v}\bullet\vec{\nabla}\Phi) = \vec{v}\times(\vec{S}\times\vec{\nabla}\Phi) + \vec{S}\times(\vec{v}\times\vec{\nabla}\Phi), \text{ where } \phi = -\kappa M/r \tag{51a}$$

v is the velocity of the gyroscope, and **S** is the spin.

However, from the Kerr metric, one would have a formula [91] as follows:

$$\frac{d\vec{S}}{d\tau} = -3(\vec{v}\bullet\vec{S})\vec{\nabla}\Phi + 3\hat{r}(\vec{S}\bullet\hat{r})(\vec{v}\bullet\vec{\nabla}\Phi), \tag{51b}$$

where $\hat{r}$ is the unit vector in the r-direction.

For a circular orbit, the situation in Gravity Probe-B, since $(\vec{v}\bullet\vec{\nabla}\Phi) = 0$, from (51a) and (51b) we have

$$\frac{d\vec{S}}{d\tau} = -2(\vec{v}\bullet\vec{S})\vec{\nabla}\Phi + v(\vec{S}\bullet\vec{\nabla}\Phi) \tag{51a'}$$

and

$$\frac{d\vec{S}}{d\tau} = -3(\vec{v}\bullet\vec{S})\vec{\nabla}\Phi, \tag{51b'}$$

respectively. However, although they are different, it is difficult to distinguish them experimentally. Since the time average of (S•v) $\nabla\phi$ + v (S•$\nabla\phi$) is zero, there is no difference because the experiment measures only the time average.

Invalidity of the covariance principle implies that Einstein's theory is incomplete. Fortunately, it has been proven, *independent of the Einstein equation,* that the Maxwell-Newton Approximation, which uses the harmonic gauge, is valid for the first order approximation of a physical gauge for gravity induced by massive sources [92] such that the binary pulsar experiment can be explained satisfactorily [42, 44]. This implies that the second order of the deflection angle can be obtained from measuring the shortest distance r_0 from the sun center since b ≈ 2m + r_0 is valid. Clearly r_0 is not an arbitrary label although the Royal Society is correct in finding out inconsistency in Einstein's theory [52].

Looking back, one may wonder why many tried so hard to justify Einstein's covariance principle. Remember, Einstein justified his theory of measurement in his initial paper on general relativity [2] as if a natural consequence of extending special Relativity [2, 74]. Therefore, many believed such a theory could not be incorrect. Also, nobody asked why special relativity which has nothing to do with gravitation, leads to the need of a different measurement? However, Einstein also had to create the covariance principle to remedy the related problems. Thus, invalidity of this principle would imply also invalidity of his theory of measurement. *Recently, it has been found that Einstein's justification is actually based on invalid applications of special relativity* [93]. *Then, it would become clearer to many that his covariance principle can be incorrect. The popularity of this principle shows that many do not understand physics.*

A remaining problem is what the correct gauge is? For this we have no answer yet. However, Zhou has proposed the harmonic gauge, which is consistent with the Maxwell=Newton Approximation. Maybe Zhou is right on this too.

XV. The Equivalence Principle and its Misinterpretations

General relativity was started with the equivalence principle. Then, for massive sources, the Einstein equation was derived by extending the Newtonian equation for gravity [2]. However, it has been shown that Einstein missed the gravitational energy-stress tensor with an anti-gravitational coupling, and thus there is no dynamic solution. For the source of an electromagnetic wave, the Einstein equation is very different, and an anti-gravitational coupling for the photonic energy-stress tensor is necessary. Moreover, the covariance principle has been proven invalid by explicit examples. We shall show that Einstein's equivalence principle is supported by experiments, and thus valid.

Unfortunately, although many agree that Einstein's equivalence principle is the foundation of general relativity, there is no book or reference, other than Einstein's own work, that explains this principle correctly [88, 94]. Many failed to see the physical contents of Einstein's equivalence principle; and some even confused this principle with Einstein's invalid 1911 assumption of equivalence [95]. Here, we clarify first what his 1911 assumption is.

In 1911 Einstein assumed the equivalence of a uniformly accelerated system K' and a stationary system of coordinates K with a uniform Newtonian gravitational potential ϕ. Currently many assume the Newtonian metric form,

$$d\tau^2 = (1 + 2\phi)\, dt^2 - dx^2 - dy^2 - dz^2, \qquad (52)$$

that later Fock [56] has proved to be impossible. From this metric (1), Einstein derived the gravitational redshifts, but an incorrect light velocity that leads to only one half of the observed light bending angle [96].

In 1916, however, Einstein assumed the equivalence of a uniformly accelerated system K' and a stationary system of coordinate K with an *unspecified* metric form that generates a uniform gravitation. In his book, Einstein [74] wrote:

> "Let now K be an inertial system. Masses which are sufficiently far from each other and from other bodies are then, with respect to K, free from acceleration. We shall also refer these masses to a system of co-ordinates K', uniformly accelerated with respect to K. Relatively to K' all the masses have equal and parallel accelerations; with respect to K' they behave just as if a gravitational field were present and K' were unaccelerated. Overlook-ing for the present the question as to the "cause" of such a gravitational field, which will occupy us later, there is nothing to prevent our conceiving this gravitational field as real, that is, the conception that K'; is 'at rest' and a gravitational field is present we may consider as equivalent to the conception that only K is an 'allowable' syst-em of co-ordinates and no gravitational field is present. The assumption of the complete physical equivalence of the systems of coordinates, K and K', we call the "principle of equivalence;" this principle is evidently intimate-ly connected with the law of the equality between the inert and the gravitational mass, and signifies an extension of the principle of relativity to coordinate systems which are non-uniform motion relatively to each other."

In this statement, the gravitational mass is defined without considering the repulsive gravitation. However, the press release of the 1993 Nobel Committee [48], claimed the equivalence principle as the identity between gravitational and inertial mass (due to Newton and Galileo). This is incorrect because of the existence of repulsive gravity. Later, Einstein made clear that a gravitational field is generated from a space-time metric, but is not a Newtonian potential. (However, the latter was not explicitly stated.) Moreover, concurrent with Einstein's equivalence principle of 1916, Einstein makes the claim of the Einstein-Minkowski condition as a consequence [2].

A problem is that since Einstein did not provide an example to illustrate his equivalence principle, a careless reader could mistake the 1911 assumption of equivalence as the 1916 equivalence principle. It is not until 2007 that a metric for uniform gravity [88] was published as follows:

$$ds^2 = (c^2 - 2U)\, dt'^2 - (1 - 2U/c^2)^{-1} dx'^2 - (dy'^2 + dz'^2), \qquad (53)$$

where $c^2/2 > U(x', t') = (at)^2/2$, "a" is the acceleration of system K'(x' y' z') with respect to K(x, y, z, t) in the x-direction. Metric (53) shows the time dilation and space contractions clearly. Here, dt' is defined locally by $cdt' = cdt - (at/c)dx'[1 - (at/c)^2]^{-1}$. Moreover, metric (2) is equivalent to the metric

$$ds^2 = (c^2 - a^2t^2)dt^2 - 2at\, dtdx' - dx'^2 - (dy'^2 + dz'^2) \qquad (53')$$

that was derived by Tolman [96]. It was a surprise that U is actually time dependent, and this explains the earlier failed derivation of such a metric [97]. Now, clearly the 1916 principle is different from the 1911 assumption.

To avoid the usual association of an elevator with the gravity of Earth, the equivalence of accelerated frame and uniform gravity is best described, as Einstein did, in terms of a uniformly accelerated chest [98]. Nevertheless, due to the popular "Einstein's elevator" of Bergmann [99], Einstein was often falsely accused of ignoring the tidal force [14]. [5)]

To illustrate the equivalence principle further, consider a disk K' uniformly rotating w. r. t. an inertial system (x, y, z, t), a metric for the disk of space K' (x', y', z') is derived [100]. According to Landau & Lifshitz [101], the metric is

$$ds^2 = (c^2 - \Omega^2 r^2)\, dt^2 - 2\Omega r^2\, d\phi' dt - dr^2 - r^2\, d\phi'^2 - dz'^2, \quad (54)$$

where Ω is an angular velocity relative to an inertial system K (x, y, z, t), z and z' coincide with the rotating axis, and $r^2 = x^2 + y^2 = x'^2 + y'^2$. Metric (54) is equivalent to its canonical form,

$$ds^2 = (c^2 - \Omega^2 r'^2) dt'^2 - dr'^2 - (1 - \Omega^2 r'^2/c^2)^{-1} r'^2\, d\phi'^2 - dz^2, \quad (54'a)$$

where

$$cdt' = cdt - (r\Omega/c) r d\phi' [1 - (r\Omega/c)^2]^{-1}. \quad (54'b)$$

Then it is clear that the local light speed cannot be larger than c. However, (54'b) is not integrable [100] because local time dt' is related to different inertial systems at different r or time t. Thus, to obtain the correct space contractions, one must first transform the metric to a canonical form such that the space contractions are clear.

The fact that the local time t'is not a global time was a problem that leads to the rejection by the editorial of the Royal Society [100]. This rejection is incorrect since validity of metric (3') can be derived theoretically with special relativity. Experimentally, the time dilation from metric (54'a) for the local metric, $ds^2 = c^2dT^2 - dX^2 - dY^2 - dz^2$, is

$$dT = [1 - (r\Omega/c)^2]^{1/2}\, dt'. \quad (54'c)$$

From (54'b) the local clock resting at K', if observed from K, would have

$$dt' = dt. \text{ and } dT = [1 - (r\Omega/c)^2]^{1/2}\, dt. \quad (54'd)$$

Moreover, as Kundig [102] has shown, the time dilation (54'd) is valid for a local clock fixed at K'. Hence, Einstein's equivalence principle has experimental supports.. Therefore, the 1993 Nobel Committee press release should not frivolously reject this principle; especially since it was done implicitly.

An earlier source of confusion is that Pauli's invalid version [103] has been mistaken as Einstein's equivalence principle although Einstein has made clear it is a misinterpretation [104]. Since Pauli was an outstanding physicist, and was often critical to theoretical errors, many still rely on his version, instead of the necessary supporting evidences.

For instance, in the book "Gravitation" [30] of Misner, Thorne and Wheeler, there is no reference to Einstein's equivalence principle (i. e. [2] and [74]). Instead, they misleadingly refer to Einstein's invalid 1911 assumption [95] and Pauli's invalid version [103]. Like Pauli, they also did not refer to the related mathematical theorems [105]. In addition, as shown in their Eq. (40.14), they even failed to understand the local time of a particle at free fall [30], a basic of general relativity. Due to their influence, Einstein's equivalence principle was often mistakenly regarded the same as the invalid 1911 assumption. The failure of understanding Einstein's equivalence principle is a source of current errors. [26)]

Note that since the 1911 assumption has been proven invalid by observations in 1919, that Fock [56] misidentified it in 1955 as Einstein's equivalence principle of 1916, *is beyond just incompetence but a deliberate unethical distortion to discredit Einstein*. Unfortunately, many universities, research institutes, as well as the 1993 Nobel Committee are victims of such a distortion. This illustrates that a human folly can happen to Sciences, not just politics.

Moreover, many cannot tell the difference between the principle of 1916 and the assumption of 1911 [88, 106-108]. Einstein's equivalence principle is generally valid because a uniform gravity in the equivalence principle is generated by acceleration but not mass. However, experiments on the equivalence of inertial mass and gravitational mass have not been up-dated beyond the case when the mass-charge interaction is absent [109].

The mathematical theorems related to Einstein's equivalence principle are as follows:

Theorem 1. Given any point *P* in any Lorentz manifold (whose metric signature is the same as a Minkowski space) there always exist coordinate systems (x^μ) in which $\partial g_{\mu\nu}/\partial x^\lambda = 0$ at *P*.

Theorem 2. Given any time-like geodesic curve Γ there always exists a coordinate system (the so-called Fermi coordinates) (x^μ) in which $\partial g_{\mu\nu}/\partial x^\lambda = 0$ along $\Gamma.\Gamma$.

In these theorems, the local space of a particle is locally constant, but not necessarily Minkowski.

However, after some algebra, a local Minkowski metric exists at any given point and along any time-like geodesic curve Γ. In a uniformly accelerated frame, the local space in a free fall is a Minkowski space according to special relativity. What Einstein added to these theorems is that physically such a locally constant metric must be Minkowski. Such a condition is needed for the case of special relativity [88, 94]. This is also the theoretical basis of the Einstein-Minkowski condition that Einstein uses to derive the bending of light rays and the gravitational redshifts [2, 74].

Thus, Pauli's version [103] is a simplified but corrupted version of these theorems as follows:

> "For every infinitely small world region (i.e. a world region which is so small that the space- and time-variation of gravity can be neglected in it) there always exists a coordinate system K_0 (X_1, X_2, X_3, X_4) in which gravitation has no influence either in the motion of particles or any physical process."

Pauli regards the equivalence principle as merely the existence of locally constant spaces. Then, Pauli's version is only a corrupted mathematical statement which may not be physically realizable because of the theorems.

A crucial error is that Pauli extended the removal of uniform gravity to the removal of gravity in a small region. This is simply incorrect in mathematics.

Because he does not understand mathematical analysis, he did not recognize that the removal of gravity in a small region, no matter how small, would be very different from a removal of gravity at one point. The correct statement should replace "no influence" with "approximately little influence". Then, the removal of gravity would be limited to essentially an isolated point as the mathematical theorems allow.

Moreover, Pauli [103], and Will [109, 110], overlooked Einstein's [2] remark, "For it is clear that, e.g., the gravita-tional field generated by a material point in its environment certainly cannot be 'transformed away' by any choice of the system of coordinates…" Apparently, neither Pauli [103] nor the Wheeler School [5, 30, 89, 110] understands the mathematics of the above theorems [105]. Misner et al. [5] claimed that Einstein's equivalence principle is as follows: -

> "In any and every local Lorentz frame, anywhere and anytime in the universe, all the (non-gravitational) laws of physics must take on their familiar special-relativistic form. Equivalently, there is no way, by experiments confined to infinitesimally small regions of spacetime, to distinguish one local Lorentz frame in one region of spacetime frame from any other local Lorentz frame in the same or any other region."

They even claimed this as the Einstein's principle in its strongest form. The truth is, however, this version makes essentially another form of the misinterpretation of Pauli [103]. They do not understand the related mathematics [105], and their followers have similar problems. *This version of the Wheeler School combines errors of Pauli and the 1911 assumption, but ignores the Einstein-Minkowski condition that is the physical essence of Einstein's principle.*

In fact, their phrase, "must take on" should be changed to "must take on approximately". The phrase, "experiments confined to infinitesimally small regions of spacetime" does not make sense since experiments can be conducted only in a finite region. Moreover, in their eq. (40.14) they got an incorrect local time of the earth, in disagreement with Einstein. Thus, clearly these three theorists [30] failed to understand Einstein's equivalence principle [2, 74].

Furthermore, Thorne [8] criticized Einstein's principle with his own distortion [27)] as follows:

> *"In deducing his principle of equivalence, Einstein ignored tidal gravitational forces; he pretended they do not exist. Einstein justified ignoring tidal forces by imagining that you (and your reference frame) are very small."*

However, Einstein has already explained these problems in his letter of 12 July 1953 to Rehtz [104] as follows:

> *"The equivalence principle does not assert that every gravitational field (e.g., the one associated with the Earth) can be produced by acceleration of the coordinate system. It only asserts that the qualities of physical space, as they present themselves from an accelerated coordinate system, represent a special case of the gravitational field."*

Perhaps, Thorne did not know that *the term "Einstein elevator" of Bergmann [99] is misleading.*

As Einstein [104] explained to Laue, "What characterizes the existence of a gravitational field, from the empirical standpoint, is the non-vanishing of the $\Gamma^l{}_{ik}$ (field strength), not the non-vanishing of the R_{iklm}," and no gravity is a special case of gravity. This allows Einstein to conclude that the geodesic equation is also the equation of motion of a massive particle under gravity, which made it possible to conceive a field equation for the metric.

Although Einstein's equivalence principle was clearly illustrated only recently [88, 94, 111], the Wheeler School should bear the responsibility of their misinformation on this principle [30] by ignoring both crucial work of Einstein, i.e., references [2] and [74], and related theorems [105], and giving an invalid version of such a principle. *A main problem is that the Einstein-Minkowski condition [2, 74], which plays a crucial role in measurement, is eliminated.* As shown by Zhou [73, 90], Einstein's equivalence principle is actually inconsistent with his covariance principle.

Einstein [2, 74] uses the satisfaction of his equivalence principle as an assumption to calculate the bending of light in the harmonic and the Schwarzschild gauges. Thus, the satisfactory of the equivalence principle is crucial that the time dilation and space contractions are unique. These errors are responsible for the mistakes in the press release of the 1993 Nobel Committee who was unaware of the non-existence of dynamic solutions and the experimental supports to Einstein's equivalence principle.

XVI. Measurements And Einstein's Invalid Applications Of Special Relativity

The exposition of general relativity started by considering a system of rotating coordinates [2]. However, few know that Einstein's errors started from there. Specifically, Einstein considered an inertial system of reference K (x, y, z, ct) and a system K' (x', y', z') in a uniform rotation Ω relatively to K. The origins of both systems and their z- and z'-axes (the axis of rotation) coincide. The flat metric of K is

$$ds^2 = c^2 dt^2 - dr^2 - r^2 d\phi^2 - dz^2$$

where $x = r\cos\phi$, and $y = r\sin\phi$, (55)

in the cylindrical coordinate system. The metric for $K'(x', y', z')$ has the following form:[54]

$$ds^2 = g_{\mu\nu}dx^\mu dx^\nu, \text{ where } dx^\mu = dx', dy', dz', cdt', \quad (56)$$

and *dt*' is the local time. For reasons of symmetry (i.e., based on the principle of causality[15]), a circle with center at the origin in the *x-y* plane of *K* may at the same time be regarded as a circle in the *x*'-*y*' plane of *K*'.

Einstein argued that if the circle is measured from *K*' because of Lorentz contraction, the circumference would be greater than $2\pi r'$ although the so measured radius $r' = r$. Moreover, based on special relativity, Einstein [2] claimed,

> "An observer at the common origin of co-ordinates, capable of observing the clock at the circumference by means of light, would therefore see it lagging behind the clock beside him … So, he will be obliged to define time in such a way that the rate of a clock depends upon where the clock may be."

Thus, Einstein defined a physical space-time coordinate system together with a metric that relates to local clock rates and local spatial measurements. Subsequently, Einstein concluded

> "We therefore reach this result: In the general theory of relativity, space and time cannot be defined in such a way that differences of the spatial coordinates can be directly measured by the unit measuring-rod, or differences in the time co-ordinate by a standard clock."

However, Whitehead [112] considered this conclusion to be unacceptable. Moreover, Einstein continued, "The method hitherto employed for laying co-ordinate into the space and time continuum in a definite manner thus breaks down, and there seems to be no other way which would allow us to adapt systems of coordinates to the four-dimensional universe so that we might expect from their application a particularly simple formulation of the laws of nature. So there is nothing for it but to regard all imaginable systems of coordinates, on principle, as equally suitable for the description of nature. This comes to requiring that the general laws of nature are to be expressed by equations which hold good for all systems of coordinates, that is, are covariant with respect to any substitutions whatever (generally covariant)."

Nevertheless, many (including this author) had failed to see that his arguments are actually invalid.

To see his errors, consider a particle *P* resting at K'(r', ϕ', z', ct'). The local space of *P* is *L**(*dR*, *dX*, *dz*', *cdT*) with a Minkowski metric. In *K*, *P* has a position (*r*, ϕ, *z)* and its local space (*dr*,*rd*ϕ,*dz*, *cdt*) has the Minkowski metric. These two local spaces have a relative velocity $r\Omega$ in the ϕ-direction. Here *X* has the same direction as *rd*ϕ.

From this example, we can show further that Einstein's justifications for his theory of measurement[1,2] are invalid. According to special relativity, one has $dz = dz'$ and $dr = dR$, and the Lorentz transformations are as follows:

$$r d\phi = [1 - (r\Omega/c)^2]^{-1/2}\,[dX + r\Omega dT], \tag{57a}$$

and

$$c dt = [1 - (r\Omega/c)^2]^{-1/2}\,[cdT + (r\Omega/c)dX];\ . \tag{57b}$$

or

$$dX = [1 - (r\Omega/c)^2]^{-1/2}\,[rd\phi - r\Omega dt], \tag{58a}$$

and

$$dT = [1 - (r\Omega/c)^2]^{-1/2}[dt - (r\Omega/c^2)\, rd\phi]. \tag{58b}$$

It follows that if *dX* is measured simultaneously (i.e., $dt = 0$) from *K*, then from Eq. (58a) one has

$$dX = [1 - (r\Omega/c)^2]^{-1/2}\,[rd\phi]. \tag{59a}$$

This is a space contraction for L* ($dX > r\, d\phi$). For a clock fixed at L* (i.e., $dX = 0$), from Eq. (57b) we have

$$cdT = [1 - (r\Omega/c)]^{1/2}\, cdt \tag{59b}$$

if measured from K. This is a time dilation for L* ($dt > dT$).

From Eq. (59a), Einstein concluded that $U/D > \pi$, where *D* is the diameter of a circle and *U* is its circumference. Since all the measurements in Eq. (59a) are done in *K*, Einstein has mistakenly considered that the integration

$$U = (1/2)[1 - (D\Omega/2c)^2]^{-1/2}\oint D d\phi = \pi D[1 - (D\Omega/2c)^2]^{-1/2} \tag{60}$$

is valid. *The error is that the distance dX in Eq. (59a) is in a local space L*, and all L*s are under different accelerations.* Moreover, the space *K* is in a relative motion with respect to *K*_. Space contractions and the time dilation are incompatible since the space *S* and such a local space *L* are at rest with each other. Thus, Eqs. (59a) and (59b) actually have nothing to do with Einstein's equivalence principle.

In other words, for this case, Einstein's claims for space contractions and the time dilation are supported with invalid arguments. Therefore, to clarify the issue of measurements, one should derive a space-time metric and show that such a metric satisfies Einstein's equivalence principle (see also Appendix D). For the case of a rotating disk, the transformation to a uniformly rotating reference frame *K'(x*', *y*', *z*') with angular velocity Ω has the form

$$x = x'\cos\Omega t - y'\sin\Omega t,\quad y = x'\sin\Omega t + y'\cos\Omega t,\ \text{and}\ z = z', \tag{61a}$$

or

$$r = r',\quad z = z',\ \text{and}\ \phi = \phi' + \Omega t \tag{61b}$$

Then a metric in terms of the coordinates in K'(x', y', z') can be obtained from (B7b); and

$$dr = dr',\ dz = dz',\ \text{and}\ \ d\phi = d\phi' + \Omega dt. \tag{61c}$$

The transformed metric in system K'*(x' y', z', ct) would then have the following form,

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$$ds^2 = (c^2 - \Omega^2 r^2)\, dt^2 - 2\Omega r^2 d\phi' dt - dr^2 - r^2\, d\phi'^2 - dz'^2, \quad (62)$$

$$g^{ct\,ct} = 1,\quad g^{r'r'} = g^{z'z'} = -1,\quad g^{\phi'\phi'} = -(1 - \Omega^2 r'^2/c^2)/r'^2,$$

and $$g^{\phi' ct} = g^{ct\,\phi'} = -\Omega/c \quad (63)$$

are the non-zero elements of the inverse metric. The force acting on particle P at rest with mass m is then mv^2/r'. Moreover, Eq. (61a) implies that

$$r' = r,\ x' = r\cos\phi', \qquad \text{and } y' = r\sin\phi', \quad (64)$$

Thus, (64) means that K'(x', y' z') also has a Euclidean-like structure. Therefore, Einstein's claim is incorrect.

The metric (62) could have led to the "light speed" $r d\phi'/dt$ larger than *c*. To rectify this situation, one must have a metric with the local time *t*' of *K*'. Now, consider the local space *L** from Eqs. (58a), (58b), and (61c). We have

$$dX = [1 - (r\Omega/c)^2]^{-1/2}\, r d\phi', \quad (65a)$$

and

$$dT = [1 - (r\Omega/c)^2]^{1/2} \{dt - [1 - (r\Omega/c)^2]^{-1} (r\Omega/c^2)\, r d\phi'\} \quad (65b)$$

Then

$$ds^2 = (c^2 - \Omega^2 r^2)\{dt - [1 - (r\Omega/c)^2]^{-1}(r\Omega/c^2)\, r d\phi'\}^2$$
$$- dr^2 - [1 - (r\Omega/c)^2]^{-1} r^2\, d\phi'^2 - dz'^2. \quad (65c)$$

Note that the space L* is the local space of the Einstein-Minkowski condition. Consequently, we should have

$$ds^2 = g_{t't'}\, c^2 dt'^2 - dr'^2 - (1 - \Omega^2 r'^2/c^2)^{-1} r'^2\, d\phi'^2 - dz'^2. \quad (66)$$

Now, (65a) implies that the metric has space contractions. According to Landau & Lifshitz [68], we should have

$$ds^2 = (c^2 - \Omega^2 r'^2)\, dt'^2 - dr'^2 - (1 - \Omega^2 r'^2/c^2)^{-1} r'^2\, d\phi'^2 - dz'^2. \quad (67)$$

where

$$c dt' = c dt - (r\Omega/c) r d\phi' [1 - (r\Omega/c)^2]^{-1},$$

and $$dT = [1 - (r\Omega/c)^2]^{1/2}\, dt' \quad (68)$$

Eq. (B1468), which is different from (59b), implies that for a local clock fixed at K' an observer at K would have

$$dt' = dt. \quad (69a)$$

Thus, Einstein's claim on this time dilation is clearly invalid. Moreover, as Kundig [69] has shown, the time dilation (68) is valid. For a local clock fixed at K, however, an observer at K' would have $dt' = [1 - (r\Omega/c)^2]^{-1} dt$.

Moreover, since r = r', (65a) and (59a) imply

$$r d\phi\, [1 - (r\Omega/c)^2]^{-1/2} = dX = r' d\phi'\, [1 - (r\Omega/c)^2]^{-1/2},$$

and $$r d\phi = r' d\phi' \quad (69b)$$

Thus, Einstein's claim of U/D > π is also invalid. And $[1 - (r\Omega/c)^2]^{-1/2}\, r d\phi'$ is a distance measured in the system L*.

Note that metric (62) and canonical metric (67) are related to each other by the relations (61c). However, in (68), dt' is related to dT of the local systems L*(dR, dX, dz', cdT) at different t, r, and ϕ'; and from (68) we have

$$c dt' = c dt - (r\Omega/c)\, r d\phi' [1 - (r\Omega/c)^2]^{-1}. \quad (70)$$

Thus Eq. (70) is not integrable. Nevertheless, the Einstein–Minkowski condition is satisfied.

Therefore, the Euclidean-like structure (64) is physically realizable in terms of measurements.

Einstein stated that the light speed is measured "in the sense of Euclidean geometry,"[2] and all of Einstein's predictions are in terms of the Euclidean-like structure. For instance, a ray of light, traveling the shortest distance Δ from the center of sun with mass *M* will be deflected by an amount $M\kappa/2\pi\Delta$.[1,2] The secular rotation of the elliptic orbit of the planet has the same sense as the revolution of the planet, amounting in radians per revolution of $24\pi^3 a^2/(1 - e^2)c^2T^2$. In addition to Δ, *e* the numerical eccentricity and *a* the semimajor axis of the planetary orbit in centimeters are defined in terms of the Euclidean-like structure, and *T* the period of revolution in seconds is defined in terms of the time of a quasi-Minkowskian space. Thus, Einstein's theory of measurement has not been used in his calculations. Therefore, the criticisms of Whitehead [112] to Einstein's theory are actually supported by Einstein's own calculations.

In short, the Euclidean-like structure is used for his measurements. *In other words, the physical Riemannian space with an Euclidean-like structure is different from a mathematical Riemannian space embedded in a Euclidean space.* Thus, the Riemannian space in physics can be different from a Riemannian space in mathematics.

XVII. The Question of Expanding Universe

The space-time singularity theorems were used to justify the existence of the black holes and the big bang theory. The speculation of back holes is no longer valid because of the existence of repulsive gravitation and the Einstein equation is not valid for the dynamic problems. However, the speculation of big bang and the expanding universe remains. It will be shown there is no evidence for the expanding universe. The speculation of the receding galaxies as evidence is actually due to a misinterpretation of the coordinates.

Hubble's law is often considered as the observational evidence for an expanding universe. It will be shown that Hubble's Law need not be related to the notion of Doppler redshifts of the light from receding Galaxies. Moreover, this notion of receding velocity is

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incompatible with the local light speeds used in deriving the light bending.

The notion of an expanding universe is based on an unverified assumption that a local distance in a physical space is similar to that of a mathematical Riemannian space embedded in a higher dimensional flat space. However, this assumption has been proven as theoretically invalid. In fact, a physical Riemannian space necessarily has a frame of reference, which has a Euclidean-like structure that is independent of the yet to be determined physical metric [85].

Hubble's law is often considered as a manifestation of the Doppler red shift of the light from the receding Galaxies [5]. Thus, the further a galaxy is from the Milky Way, the faster it appears to be receding. However, Hubble himself rejected this interpretation and concluded in 1936 that the Galaxies are actually stationary [113].

It should be pointed out, in the derivation of the receding velocity, an implicit assumption, which implies no expansion for the frame of reference, must be used [5]. Moreover, the receding velocity is incompatible with the light speeds used in deriving the light bending. Thus, the notion of expanding universe is a production due to confusing notion of the coordinates and also inadequate understanding of a physical space.

a) Invalid Interpretations of Hubble's Law

Hubble discovered from light emitted by near by galaxies that the redshifts S are linearly proportion to the present distance L from the Milky Way as follows:

$$S = H\,L \qquad (71)$$

where H is the Hubble constant although the redshifts of distant galaxies will deviate from this linear law with a slightly different constant. In general relativity, it is known that this law can be derived with the following metric [5],

$$ds^2 = -d\tau^2 + a^2(\tau)\{dx^2 + dy^2 + dz^2\}, \qquad (72)$$

since

$$S = \frac{\lambda_2 - \lambda_1}{\lambda_1} = \frac{\omega_1}{\omega_2} - 1 = \frac{a(\tau_2)}{a(\tau_1)} - 1\,, \qquad (73)$$

where ω_1 is the frequency of a photon emitted at event P_1 at time τ_1, and ω_2 is the frequency of the photon observed at P_2 at time τ_2. Furthermore, for nearby galaxies, one has

$$a(\tau_2) \approx a(\tau_1) + (\tau_2 - \tau_1)\dot{a}\,. \qquad (74)$$

If

$$(\tau_2 - \tau_1) = L = \int_1^2 \sqrt{dx^2 + dy^2 + dz^2} \qquad (75)$$

then

$$S = \frac{\dot{a}}{a} L = H\,L, \qquad \text{and} \quad H = \frac{\dot{a}}{a}. \qquad (76)$$

Formula (75) is compatible with the calculation in the bending of light. Please note that Hubble's Law need not be related to the Doppler redshifts. Understandably, Hubble rejected such an interpretation himself [113]. In fact, there is actually no receding velocity since L is fixed (i.e., $dL/d\tau = 0$).

On the other hand, if one chooses to define the distance between two points as Riemannian geometry

$$R = \int_1^2 a(\tau)\,\sqrt{dx^2 + dy^2 + dz^2} = a(\tau)L, \qquad (77)$$

Then

$$v = \frac{dR}{d\tau} = \frac{da}{d\tau} L + \frac{dL}{d\tau} a = \frac{da}{d\tau}\frac{R}{a} = HR\,,$$

if

$$\frac{dL}{d\tau} = 0\,. \qquad (78)$$

Note that according to (77), (75) would have to change into $(\tau_2 - \tau_1) = R$, and (71) into S = H R. Thus,

$$v = S. \qquad (79)$$

This means that the redshifts could be superficially considered as a Doppler effect. Thus, whether Hubble's Law represents the effects of an expanding universe is a matter of the interpretation of the local distance. From the above analysis, the crucial point is what a valid physical velocity in a physical space is.

It should be noted that $dL/d\tau = 0$ means that the space coordinates are independent of the metric. In other words, the physical space has a Euclidean-like structure [85]. However, since L between any two space-points is fixed, the notion of an expanding universe, if it means anything, is just an illusion. Moreover, as pointed out by Whitehead [112], the validity of (77) as the physical distance has no known experimental supports. Another problem is that the velocity in (78) would be incompatible with the light speeds in the calculation of light bending experiment.

Consider a spherical mass distribution with the center at the origin, the metric with the isotropic gauge is,

$$ds^2 = -[(1 - M\kappa/2r)^2/(1 + M\kappa/2r)^2]\,c^2dt^2 + (1 + M\kappa/2r)^4(dx^2 + dy^2 + dz^2) \qquad (80)$$

where $\kappa = G/c^2$ ($G = 6.67 \times 10^{-8}$ erg cm/gm²), M is the total mass, and $r = \sqrt{x^2 + y^2 + z^2}$. Then, if the equivalence principle is satisfied, the light speeds are determined by $ds^2 = 0$ [2, 74], i.e.,

$$\frac{\sqrt{dx^2 + dy^2 + dz^2}}{dt} = c\frac{1 - M\kappa/2r}{(1 + M\kappa/2r)^3} \tag{81}$$

However, such a definition of light speeds is incompatible with the definition of velocity (78) although compatible with (75). Since this light speed is supported by observations, (78) is invalid in physics.

Nevertheless, Liu [114] has defined light speeds, which is more compatible with (78), as

$$\frac{\sqrt{g_{ij}dx^i dx^j}}{dt} = c\frac{1 - M\kappa/2r}{1 + M\kappa/2r} \tag{82}$$

for metric (80). However, (82) implies only half of the deflection implied by (81) [2, 74].

The above analysis also explains why many current theorists insist that the light speeds are not defined even though Einstein defined them clearly in his 1916 paper as well as in his book, "The Meaning of Relativity". They might argued that the light speeds are not well defined since diffeomorphic metrics give different sets of light speeds for the same frame of reference. However, they should note that Einstein defines light speeds after the assumption that his equivalence principle is satisfied [2, 74]. Different metric for the same frame of reference means only that at most only one of such metrics is physically valid, and therefore the definition of light speeds are uniquely well-defined.

However, since the problem of a physical valid metric has not been solved, whether a light speed is valid remains a question. Nevertheless, it has been proven that the Maxwell-Newton Approximation gives the valid first order approximation of the physical metric, the first order of the physically valid light speeds are solved [42]. Since metric (80) is compatible with the Maxwell-Newton approximation, the first order of light speed (72) is valid in physics.

Thus, the groundless speculation that local light speeds are not well defined is proven incorrect. In essence, the velocity definition (78), which leads to the notion of the Doppler redshifts, has been rejected by experiments.

b) A Possible Explanation of Hubble's Law

A major problem in Einstein's theory, as pointed out by Whitehead [112] and Fock [56], is that the physical meaning of coordinates is ambiguous and confusing. In view of this, it is understandable that the notion in an embedded Riemannian space is used when the physical nature of the problem is not yet clear. A major difference between physics and mathematics is that the coordinates in physics must have physical meaning. Since Einstein is not a mathematician, his natural step would be to utilize the existing theory of Riemannian space. However, as Whitehead [112] saw, this created a seemingly irreconcilable problem between coordinates of a curved space-time and physics.

Then, one may ask if the observed gravitational redshifts is not due to an expanding universe, what causes such redshifts that are roughly proportional to the distances from the observer. One possibility is that the scatterings of a light ray along its path to the observer. In physics, it is known that different scatterings are common causes for losing energy of a particle, and for the case of photons it means redshifts. However, to test such a conjecture is impossible since current theory is incapable of handling the inelastic scatterings of lights because Einstein's equation even does not have any dynamic solution [17, 43]. Thus, to solve this puzzle rigorously seems surely in the remote future.

Nevertheless, the assumption that observed redshifts could be due to inelastic scatterings may help to explain some puzzles of observed facts. For instance, it is known that younger objects such as star forming galaxies have higher intrinsic redshifts, and objects with the same path length to the observer have much different redshifts while all parts of the object have about the same amount of redshifts [115]. For alternative cosmology theories, there are others [116].

An advantage of the Euclidean-like structure [85] is that notions used in a Euclidean space could be adapted much easier. Many things would be calculated as if in a Euclidean space as Einstein did, and physics should return to normal.

XVIII. Discussions and Conclusions

In this paper, we solved at least two puzzles 1) Why Hawking has no verified predictions in spite of that he follows Einstein faithfully. 2) Would the lack of breakthrough in physics imply there is no longer any genius? For the first question, it is simply that Hawking follows Einstein's major error $E = mc^2$ that Einstein had mistaken as valid. But, now it is clear that is invalid in theory as well as incorrect that have been proven by three types of experiments. For the second question, currently we do not need a genius, but only careful derivations and examinations that will discover existing errors and eventually lead us to a break through. In fact, too many have attempted to be a genius already.

A problem in general relativity is that people are impressed by Einstein's achievements, but failed to see that even as a genius he too can also make mistakes because Einstein is also a human being. Because of the general inadequacy in mathematics among physicists, they failed to see Einstein's error in mathematics. Moreover, they regarded a Nobel Prize as a certificate for correctness, and thus failed to see that such a prize could mean only partially correct. Also, because most physicists do not understand general relativity, they incorrectly regarded errors in the theory such as the space-time singularity theorems as new achievements.

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They even support such errors with dubious evidence based on their misinterpretations. They also did not see that not all the neutral objects fall with the same acceleration.

Another problem is that many believed that general relativity can deal with only large scale problem. In particular, based on the erroneous spsce-time singularity theorems, Hawking and Penrose claimed that general relativity cannot deal with microscopic problems. This is completely nonsense since one must use general relativity to prove the existence of photons. Consequently, to verify general relativity, we look into the sky. This led to an unusual event that the verification of the gravitational waves without a valid Einstein equation that can generate them [54]. This not only makes such tests expensive but also ignores the possibility of experiments on earth.

For a long time nobody tests Einstein's claim that the weight of a piece of metal would increase after being heated-up. This led to the delay to verify and to confirm the repulsive gravitation, and thus the unification of gravitation and electromagnetism. In addition, editors such as Eric J. Weinberg of the Physical Review D, who does not understand general relativity, are against experiments to test Einstein's claims. The fact is, however, that gravity reduction not only depends on the temperature, but also on the metal used [21].

Currently, the most urgent task is to develop a field equation that can deal with the dynamic problems such as the two-body solution, the generation of gravitational waves, and the problem of repulsive gravitation. In particular, the repulsive gravitation is crucial for the unification of gravitation and electromagnetism. Moreover, since the charge-mass interaction is absent from quantum theory, Einstein is correct that it is not a final theory.

Now, we should have learned from Galileo, physics must be fully supported by real experiments. We must improve our mathematical skills. Above all, as philosopher Hu shih said, we must be careful in our proof even though we are allowed to have bold assumptions. It should be noted also that as experimental skills improved, we may find some of the old experimental tests such as those for Newtonian gravitation are actually inadequate. Since the repulsive gravity is discovered, the measurement of the mass based on gravitation is no longer valid.

However, many physicists just believed the “experts”, who actually do not understand general relativity for various reasons. It is hoped that this paper would help our colleagues understanding of general relativity better.

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Appendix A: The Principle of Causality in Physics

There are two aspects in causality: its relevance and its time ordering. In time ordering, a cause event must happen before its effects. This is further restricted by relativistic causality that no cause event can propagate faster than the light speed in vacuum. The time-tested assumption that phenomena can be explained in terms of identifiable causes will be called the principle of causality. This is the basis of relevance for all scientific investigations. Thus, the principle of causality implies that any parameter in a solution for physics must be related to some physical causes. Moreover, the principle of causality implies a weak source would produce a weak gravity. Here this principle will be elucidated first in connection with symmetries of a field, the boundedness of a field solution, and the validity of a field equation.

In practice, when the considered field is absent, physical properties are ascribed to the space-time as in a "normal" state. For example, the electromagnetic field is zero in a normal state. Then, any deviation from the normal state must have physically identifiable causes. Thus, the principle of causality implies that the symmetry must be preserved if no cause breaks it. The implication of causality to symmetry has been used in deriving the inverse square law from Gauss's law. The normal state of a space-time metric is the flat metric in special relativity. Thus, if a metric does not possess a symmetry, then there must be physical cause(s) which has broken such a symmetry. For a spherically symmetric mass, causality requires that the metric is spherically symmetric and asymptotically flat. Also, a weak cause can lead to only weak gravity. Therefore, Einstein's notion of weak gravity is a consequence of the principle of causality.

However, the physical cause(s) should not be confused with the mathematical source term in the field equation. In general relativity, the cause of gravity is the physical matter itself, but not its energy tensors in the source term of Einstein's field equation. The energy-stress tensors (for example the perfect fluid model) may explicitly depend on the metric. Since nothing should be a cause of itself, such a source tensor does not represent the cause of a metric. For the accompanying gravitational wave of an electromagnetic wave, the physical cause is the electromagnetic wave. Thus, one should not infer the symmetries of the metric based on the source term instead of its causes.

Moreover, inferences based on the source term can be misleading because it may have higher symmetries than those of the cause and the metric. For instance, a transverse electromagnetic plane-wave is not rotationally invariant with respect to the z-direction of propagation. But the related electromagnetic energy-stress tensor component $T(E)_{tt}$ for a circularly polarized wave is. Such an assumption violates causality and results in theoretical difficulties.

Classical electrodynamics implies that the flat metric is an accurate approximation, caused by the presence of weak electromagnetic waves. This physical requirement is supported by the principle of causality which implies such a metric to be a bounded periodic function. However, this required boundedness is not satisfied by solutions in the literature [52, 117, 118]. These solutions also violate causality directly since they involve parameters without any physical cause [15].

They also do not satisfy the equivalence principle [119, 120] although they are Lorentz manifolds.

A necessary and sufficient condition for satisfying the equivalence principle is that a time-like geodesic represents a physical free falling; but this does not mean the existence of Minkowski spaces in a neighborhood. Another problem in general relativity is that many theorists and journals do not understand physics, such as the principle of causality adequately. For instance, the Physical Review accepted unbounded solution as valid in physics. And the Royal Society (London) believed that Hawking is an outstanding physicist in the same status as Newton.

However, these journals are wrong, Hawking follows Einstein's error such as $E = mc^2$ and thus has no observationally confirmed prediction. Moreover, his space-time singularity theorems, which are based on implicit invalid assumptions in physics, are obviously against the principle of causality.

Appendix B: Influence of the Temperature of a Body on its Weight

Dmitriev, Nikushchenko, and Snegov [21] show that a brass metal rod heated by ultrasound confirms a dependence of the weight of the rods on their temperature. Their results can be shown by the following figures.

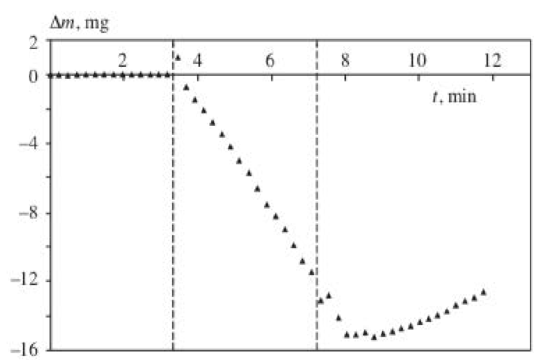

Figure 1: Change in mass of a brass rod mountend in an open holder. Ultrasound Frequency 131.25 kHz. The dashed lines indicate the moments when the ultrasound was switched on and off.

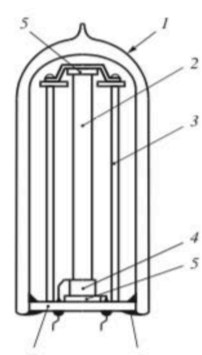

Figure 2: Arrangement of the air tight container: 1) Dewar vassel 2) metal rod 3) holder pillar(textolite cloth-based laminate) 4) piezoelectric transducer 5) foam plastic spacers 6) cold weld 7) holder base(ebonite)

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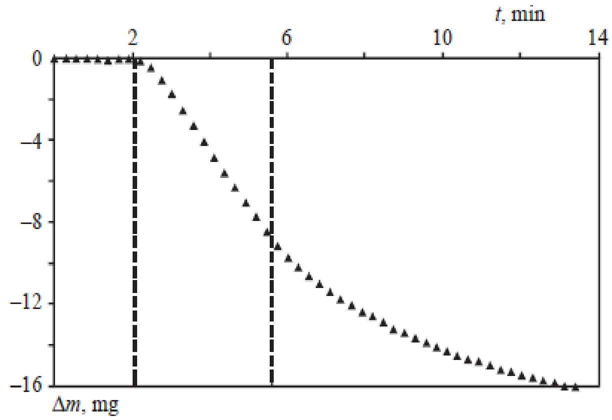

Figure 3: Arrangement of the air tight container: 1) Dewar vassel 2) metal rod 3) holder pillar(textolite cloth-based laminate) 4) piezoelectric transducer 5) foam plastic spacers 6) cold weld 7) holder base(ebonite)

Figure 1 is the change of weight for the brass rod mounted in an open holder. Figure 3 is for the arrangement in an air tight container. Figure 4 is the change of weight for the brass rod in a closed Dower vessel. The brass rod weighs 58.5 g before heated-up, with a length of 140.0 mm, and diameter of 8.0 mm. These figures show that the Dewar vessel is not essential for the weight reduction experiment.

It should be noted that the temperature dependence of gravity also depends on the metal involved. They have measured such dependence for the lead, Copper, Brass, and Duralumin, and find they are different. It would be interesting to find out the rule on such dependence.

A main problem is that they have not been able to correctly identify the cause of the weight reduction. They incorrectly regard the reduction of weight as a reduction of mass. Apparently, they do not understand that when the repulsive gravitation is present, to measure mass through gravitation is no longer valid.

Appendix C: Comments on C. N. Yang and Zhou Pei-Yuan

Nobel Prize has become a certificate for the truth because of the huge accompanying prestige. However, to determine whether a scientific work is actually related to the truth, is the supports of scientific evidence. For instance, Einstein obtained a Nobel Prize in Physics for his proposal of photons that are quantum of electromagnetic energy. However, later evidence shows that the photons include also gravitational energy in addition to electromagnetic energy because the electromagnetic energy is not equivalent to mass.

Thus, although a Nobel Prize in Physics is certainly an achievement, this could be only a partial truth. In other words, there could be errors even for a Nobel Prize. Therefore, a physicist should not be judged by the Prize alone. Besides, as a human institute, the Nobel Committee has also made mistakes. Therefore, if a country cares about its scientific prestige, attention should be on the achievement rather than the Prize.

C. N. Yang is Nobel Laureate in physics, but in my opinion, his scientific achievement is inferior to another Chinese scientist Prof. Zhou Pei-Yuan of Peking University. Some people may object because Zhou has never gotten a Nobel Prize. However, this could be a problem of the Nobel Committee. In my opinion, whether one got a Prize are not the sole criteria for scientific excellence. It is more important whether a scientist can stand alone for the truth in front of an overwhelming objection, and/or his work would be delayed for a long time without him.

Einstein belongs to that category although he also made mistakes. It is very difficult to imagine general relativity without Einstein. Prof. Zhou has the same quality because in his 1983 paper he stood alone in front of an almost unified objection to point out that the Einstein's covariance principle is invalid. Although he did not provide a detailed proof, he is proven correct later in 2008 by concrete examples [87], 25 years later. In fact, Zhou studied general relativity for his Ph. D. in Caltech. In 1937, he had faced Einstein to discuss the problem of coordinates in general relativity. Einstein could not answer his questions on this issue. Besides, he is a well-known authority in fluid dynamics.

On the other hand, Yang is incorrectly convinced that Einstein's covariance principle was valid because of his misconception on gauge invariance. This is confirmed by Yang himself in our personal communications. Probably because of Yang's objection, Zhou's correct viewpoint was not well received in China.

However, since Yang is an author of the Yang-Mills theory, which starts the non-abelian gauge theory, many believed he should have no problem on the gauge invariance. Nevertheless, it should be noted that the notion of gauge invariance in their paper is invalid in physics. The gauge invariance simply does not make sense for particles with different masses. This is why their theory had not produced anything meaningful until 1967 when the spontaneous broken symmetry is employed in the Weinberg's model [121].

It should be noted also almost exactly the same thesis of Yang-Mills was produced by Ron Shaw [122] in his Ph. D. thesis of 1955. Another major contribution of Yang is the Yang-Baxter equation, of which Yang published in 1967 and Baxter in 1972. In view of that the parity non-conservation was produced with T. D. Lee, it is safe to say Yang's work is good, but is not out-standing that cannot be produced for a long time without Yang.

It is on the above basis that I regard Zhou is a better scientist than Yang. Few nations have shown their anxiety for a genius more than the Chinese. Nevertheless, they failed to identify Zhou.

Endnotes

1. Einstein's errors were not generally accepted because the lack of clear evidence, in addition to the general inadequacy of mathematics among physicists, dominating misconceptions in physics and the mathematicians do not understand physics. However, there are three types of experiments that shows $E = mc^2$ is incorrect [29].
2. This π_0 meson experiment is also an evidence that a photon can be considered as a massless particle.
3. Since Einstein won a Nobel Prize for this work, many have incorrectly believed that the photons consist of only electromagnetic energy. Many even have incorrectly taken the Nobel Prize as the standard for truth. This also often leads to an over evaluation of the Prize and the opinions of Nobel Laureates in physics.
4. Some theorists often claimed a result without given one. For instance, Wald [5] claimed that he can obtain a bounded dynamic solution of second order approximation for the Einstein equation.
5. For a linear equation, this compatibility was not a problem, and thus some incorrectly believe this is automatic.
6. Equation (6) is a necessary extension of Einstein's general relativity that Einstein failed to see. A special feature of this equation is that an energy-stress tensor with an anti-gravity coupling must be included. It will be seen that such an anti-gravity coupling must be included for any dynamic case.
7. The purpose of general relativity is to establish that gravity must be propagated with a finite speed. Thus the existence of the gravitational wave is expected. However, Einstein failed to establish the need of a gravitational wave. Nevertheless, this was established in 2006 with a modified Einstein equation.
8. However, Tsipenyuk & Andreev was puzzled because they did not see the existence of a repulsive gravitation.
9. The weight reduction of a charged-capacity was considered as an experimental error, because it was believed that, according to Maxwell's theory, there is no electromagnetic force beyond a charged capacitor.
10. The discovery of the Euclidean-like structure in a physical space clarifies the difference between a physical Riemannian space and a mathematical Riemannian space embedded in a higher dimensional Euclidean space. This was the crucial point needed to settle the difference between Einstein and Whitehead [112].
11. Due to the existence of repulsive gravitation, Einstein no longer can claim that gravitational mass is equivalent to acceleration mass. This is why Einstein reject repulsive gravitation, in addition to his invalid belief on $E = mc^2$.
12. This leads to the settlement that the mass in this metric is just the acceleration mass without wrongly including the electromagnetic energy due to the charge. For this, even Nobel Laureate t' Hooft had mistaken.[69].
13. Note that Wheeler was the thesis advisor of D. Christodoulou. As we shall see that Wheeler's mathematics is erroneous even at the undergraduate level [50]
14. It has been derived from Einstein's equivalence principle that eq.(23) is valid [43].
15. Since the Einstein equation has no gravitational wave solutions, one may wonder how they do the calculation to compare with the data. It seems they simply use the linearized equation to do the calculation. Due to their inadequate mathematics, they are not even aware of this mistake. Thus, they "verified" the gravitational wave without a valid equation that generates such waves [54].
16. Michael Francis Atiyah has been leader of the Royal Society (1990-1995), master of Trinity College, Cambridge (1990-1997), chancellor of the University of Leicester (1995-2005), and President of the Royal Society of Edinburgh (2005-2008). Since 1997, he has been an honorary professor at the University of Edinburgh. However, Atiyah does not understand physics [64].
17. Ludwig D. Faddeev, the Chairman of the Fields Medal Committee, wrote ("On the work of Edward Witten"): "Now I turn to another beautiful result of Witten – proof of positivity of energy in Einstein's theory of gravitation. Hamiltonian approach to this theory proposed by Dirac in the beginning of the fifties and developed further by many people has led to the natural definition of energy. In this approach a metric γ and external curvature h on a space-like initial surface $S^{(3)}$ embedded in space-time $M^{(4)}$ are used as parameters in the corresponding phase space. These data are not independent. They satisfy Gauss-Codazzi

constraints – highly non-linear PDE, The energy H in the asymptotically flat case is given as an integral of indefinite quadratic form of $\nabla\gamma$ and *h*. Thus, it is not manifestly positive. The important statement that it is nevertheless positive may be proved only by taking into the account the constraints – a formidable problem solved by Yau and Schoen in the late seventy as Atiyah mentions, 'leading in part to Yau's Fields Medal at the Warsaw Congress'." Faddeev failed to see that the so-called 'natural definition of energy' actually excludes the dynamic cases by assuming all the dynamic solutions are bounded [64].

18. The reduction of weight while the temperature increase, is due to the increment of a repulsive gravitational force.
19. G. t' Hooft incorrectly believed that the mass of an electron includes its electric energy. This exposes that he does not understand Newtonian mechanics and also special relativity adequately.
20. Frank A. Wilzcek incorrectly believed that $E = mc^2$ is unconditional [70]. Thus, their proof (Frank. A. Wilczek along with David Gross and H. David Politzer) for asymptotic freedom is actually incomplete.
21. Because this repulsive force is against Maxwell's theory, many disregard this repulsive force of gravity.
22. They failed to understand that the attractive gravitational force is due to current-mass interaction.
23. We assume that force from the current-mass interaction in the sun is comparatively very weak.
24. It is clear that there is much work on astrophysics to be done with a five-dimensional theory.
25. In the next year, the Ph. D. thesis of Ron Shaw [122] was produced with essentially the same content.
26. Pauli [103] and Misner et al. [30] also did not have adequate training in pure mathematics. The misinterpretation of Misner et al. [30] creates the so-called Lorentz invariance, being tested by Chu et al. [123].
27. This is due to Thorne's error. Since Thorne had won a Nobel Prize in 2017, his error could be mistaken as correct.

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By F. F. Mende

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Keywords: *hydrogen bomb, electromagnetic pulse, program «Starfish», program «Program K», scalar-vector potential, Stefan-Boltzmann law, rope trick.*

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Abstract- The United States under the Starfish program blew up a hydrogen bomb with a TNT equivalent 1.4 Mt in space above the Pacific Ocean. This event put a lot of questions before the scientific community. During the explosion, an electrical impulse of very short duration and large amplitude was detected. Modern electrodynamics can not explain this phenomenon. The article attempts to explain this phenomenon on the basis of the concept of the scalar-vector potential developed by the author of the article. A comparison of the calculated data obtained on the basis of this concept and the experimental results obtained during the bomb explosion gave a good agreement.

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I. Introduction

The explosions, which occur in space they shake our imagination of their grandeur. The majorities of stars, concluding their evolution, explode. Supernovas - star, which conclude their evolution in the catastrophic explosive process. Term "supernovas" were named the stars, which flared up much (to the orders) stronger the so-called "new stars". In reality, neither those nor, etc are physically new, always flare up the already existing stars. But in several historical cases flared up those stars, which earlier were before the sky practically or completely visible, that also created the effect of the appearance of a new star. Such explosions are nuclear or thermonuclear and are characterized by the isolation of a colossal quantity of energy in short time. Of the final theory supernova thus far there does not exist. All proposed models are simplified and have the free parameters, which must be tuned for obtaining the necessary picture of explosion. At present in the numerical models it is not possible to consider all physical processes, proceeding in the stars and of the being important for the development flashes.

Still more immense explosions are observed in the center of the galaxies, which to their scales do not go into the comparison even with the explosions of supernovas. So with the explosion in the nucleus of galaxy NGC 3034 from there was rejected a huge quantity of material throughout its mass equal approximately 60 millions of masses of the sun [1]. This of phenomenon does not find its thus far explanation, since they are not known those energy sources, which can lead to so immense an explosion.

In this article the physical phenomena, which accompany artificial nuclear explosions, will be examined.

II. Space Explosions of the Thermonuclear Charges

According to the program "*Starfish*" 9 July 1962 USA exploded in space above Pacific Ocean H-bomb. This event placed before the scientific community many questions. It is earlier into 1957 future Nobel laureate doctor Hans Albrecht Bethe being based on the theory of dipole emission, predicted that with a similar explosion will be observed the electromagnetic pulse (EMI), the strength of field of which on the earth's surface will comprise not more than 100 V/m. Therefore entire measuring equipment, which had to record electromagnetic radiation, was disposed for registering such tensions pour on. But with the explosion of bomb that not expected occurred. But with the explosion of bomb discomfiture occurred, pour on the tension of electrical, beginning from the epicenter of explosion, and further for the elongation of more than 1000 km of it reached several ten thousand volt per meters. (Actual chart area and value of tensions pour on given in Fig. 1. This figure and all given, which will be given in this division, that are concerned tests according to the programs «*Starfish*» and «*Program K*", they are undertaken from the site http://glasstone.blogspot.com/2006/03/emp-radiation-from-nuclear-space.html

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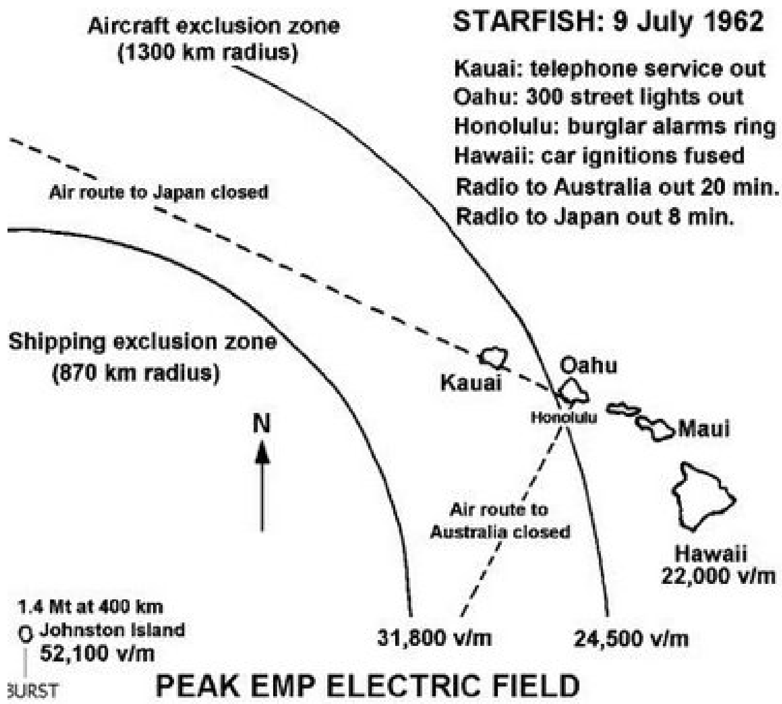

Fig. 1: Map of tests according to the program " *Starfish"*

Unfortunately, in the materials of this reference is not contained information about the polarization of these pour on. But, judging from the fact, that entire equipment was disposed during the measurement of electrical pour on with the vertical polarization, the data about the measured values precisely of the vertical component of electric field are given on the map. Possibility to refine this question give the data, obtained in the USSR during the tests with the code name "*Program K*", when not far from Dzhezkazgan at the height 290 km was exploded H-bomb with the TNT equivalent 300 kt. Actual chart area with the indication of the values of tensions pour on, obtained with this explosion, it is shown in Fig. 2

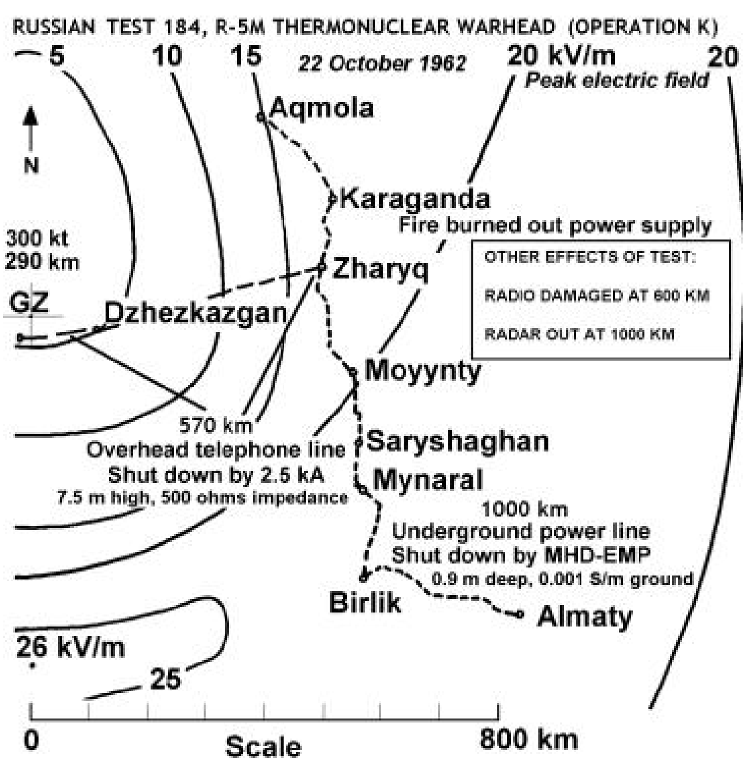

Fig. 2: Map of tests according to the program "*Program K"*

Comparing data with respect to the tensions pour on, given on these two maps, it is possible to see that the values of tensions pour on in Fig. 1 diminish with an increase in the distance from the epicenter of explosion, while on the map, depicted in Fig. 2, these values grow. From this it is possible to draw the conclusion that on the second map are cited the data on the measurement by the horizontal intensity of electrical pour on.

There is a record of the shape of electrical pulse, made at a distance 1300 km from the point of impact (Fig. 3), obtained with the tests according to the program *«Starfish»*. It is evident from the given figure that EMI has not only very large amplitude, but also very short duration.

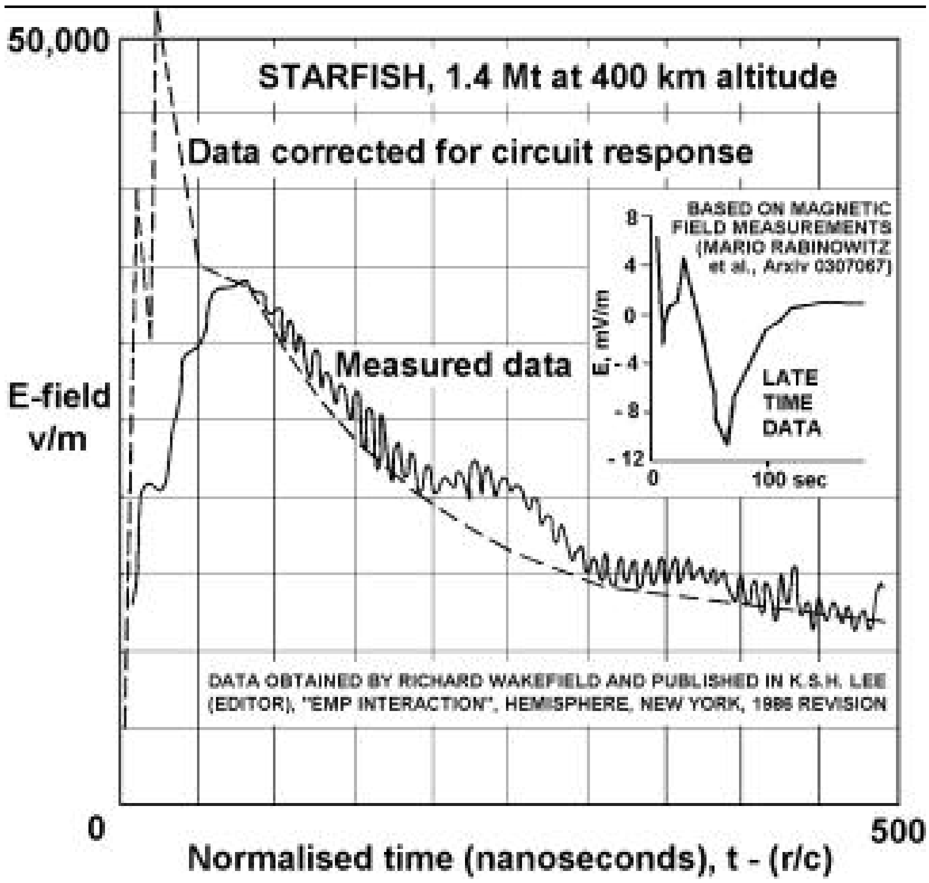

Fig. 3: Experimental dependence of amplitude EMI on the time, obtained with the tests according to the program “ *Starfish”*

Since doctor Bethe's forecast did not justify, it was subsequently advanced a number of the theories, intended to explain experimental data. The first of them was developed by doctor Conrad Longmire in 1963, which examined a question about the formation of the magnetic dipole, formed by the Compton electrons, which revolve around the lines of force of earth's magnetic field.

Louis W. Seiler, *Jr* in which is assumed that the formation EMI is obliged to the relativistic Compton electrons, which the rigid X-radiation knocks out from the molecules of air and which cophasal with gamma-radiation move with the relativistic speeds in the direction of propagation of electromagnetic wave. Neither one nor the other model is reliably accepted or disproved be it cannot, since further nuclear tests in space were ended, and there is no additional experimental data, which could confirm or refute the models examined.

It assumes this model that the process of the pulse shaping is not the property of explosion itself, but is the second effect, connected X-radiation it with the fact that knocks out from the molecules of air Compton electrons. From the last model, which received the greatest acknowledgement, it follows that EMI itself is extended of the ionosphere into the lower layers of the atmosphere, and therefore of its field higher than ionosphere, directly in space itself, they be absent. But, if we with the aid of the theories examined even somehow possible explain the presence of electrical pour on in the visibility range of explosion, then the fact of strong ionospheric disturbances at large distances from the explosion, which it accompanied, to explain difficultly. Thus, after explosion in the course of several ten minutes there is no radio communication with Japan and Australia, and even at a distance into 3200 km from the epicentre of explosion were fixed ionospheric disturbances, which several times exceeded those, which are caused by the most powerful solar flares. Explosion influenced also the automatic spacecraft. Three satellites were immediately disabled by electromagnetic pulse. The charged particles, which were appeared as a result explosion, were seized by the magnetosphere of the Earth, as a result of which their concentration in the artificial Earth radiation belt it increased by orders [2-3]. The action of radiation belts led to the very rapid degradation of solar batteries and electronics in seven more satellites, including in the first commercial telecommunication satellite tele-Star. On the whole explosion derived from system third of the automatic spacecraft, which were being found in low orbits at the moment of explosion.

With the explosion of nuclear charge according to the program "*Program K*", which was realized into the USSR, the radio communication and the radar installations were also blocked at a distance to 1000 km. As a result these tests it was established that the high-altitude nuclear explosions are accompanied by the emission of the powerful pulse, which considerably exceeds in the amplitude the value of the pulse, which occurs with the surface explosions of the same power. It was discovered, that the registration of the consequences of space nuclear explosion was possible at the large (to 10 thousand kilometers) distances from the point of impact.

From the point of view of the existing concepts of classical electrodynamics Compton models cause serious questions. For example, why all Compton electrons must move cophasal with the front of gamma-radiation with the relativistic speed. In Compton electrons the velocity vector has spatial distribution, in connection with this it is not possible to obtain such short of the pulse rise, as it takes place in actuality. In the electrodynamics such mechanisms, which give the possibility to obtain the single-pole pulse of electric field without the three-dimensional separation of charges in this place theoretically be absent. But in the pulse rise time, which is calculated by tens of nanoseconds, to obtain the three-dimensional separation of charges, which will ensure the field strength obtained during the experiment, it is impossible. Compton ionization itself leaves entire system as a whole of electrically neutral.

Is known that the problem of this phenomenon attempted together with his students to solve and academician I. B. Zeldovich [2]. However, in the existing sources there is no information about the fact that this problem was solved by it. Consequently, the everything indicates that within the framework existing classical electrodynamics the results, obtained with the tests according to the program "*Starfish*" and program "*Program K*", cannot be explained thus far.

In what does consist the danger of the forecasts, which does give the model of Compton electrons? Problem in the fact that this model excludes the possibility of the presence pour on pulse in space. It is known that during the tests according to the program "*Starfish*" three satellites, that are found at that time in space not far from the zone of explosion, malfunctioned. It is unknown, there are whether at present precise data apropos of the reasons for these failures. Let us assume that model advanced Louis W. Seiler, *Jr.* is incorrect, and, relying on it as in the past for the predictions Hans A. Bethe, will be produced the sequential explosion of nuclear charge in space, which will put out of action a large quantity of satellites. Moreover this explosion can be both the planned and realized for terrorist purposes. Then be justified already is late.

Let us undertake the attempt, using a concept of scalar- vector potential, to explain obtained experimental data, and let us also show that with the explosion of nuclear charge in space, there there are not fields of electromagnetic pulse (EMI), but pulse electric fields (PEF), in which the magnetic field is absent. The fields PEF in space having much more significant magnitudes, than in the atmosphere and on the earth's surface.

According to the estimations at the initial moment of thermonuclear explosion the temperature of plasmoid can reach several hundred million degrees. At such temperatures the electron gas is no longer degenerate and is subordinated to the distribution of Boltzmann. Let us assume that the temperature of the plasmoid at the initial moment formed with the explosion composes $\sim 10^8$ K, and the total weight of bomb and head part of the rocket, made from metal with the average electron density $\sim 5\times 10^{22}$ 1/sm^3, composes 1000 kg. General a quantity of free electrons in the formed plasma, on the assumption that all atoms will be singly ionized with the specific weight of the metal ~ 8 g/cm^3, will comprise $\sim 5\times10^{27}$. The most probable electron velocity at the temperature indicated let us determine from the relationship:

$$v=\sqrt{\frac{2k_BT}{m}},$$

where k_B - Boltzmann constant, and m - mass of electron.

Now, using for enumerating scalar -vector potential of the moving charge the relationship [3-6]

$$\varphi'_v(r)=\frac{e}{4\pi\varepsilon r}ch\frac{v_\perp}{c}.$$

For enumerating the increase in the scalar potential and taking into account only terms of the expansion $\sim\frac{v^2}{c^2}$, we obtain

$$\Delta\varphi \cong \frac{Nek_B T}{4\pi\varepsilon_0 rmc^2}, \tag{1}$$

where e - electron charge, and r - distance from the burst center to the observation point. We determine from the formula the tension of radial electric field, which corresponds to this increase in the potential:

$$E = \frac{Nek_B T}{4\pi\varepsilon_0 r^2 mc^2} = \frac{\Delta q}{4\pi\varepsilon_0 r^2}, \tag{2}$$

where

$$\Delta q = \frac{Nek_B T}{mc^2} \tag{3}$$

is an equivalent charge of explosion. By this value it is necessary to understand exceeding the charge of electron gas in comparison with its equilibrium value in the metal.

One should say that with the warming-up of plasma the ions also acquire additional speed, however, since their mass considerably more than the mass of electrons, increase in their charges can be disregarded.

In accordance with the formula (2) the tension of the radial electric field in the epicenter of the explosion under specified above options will be $\sim 7 \times 10^5$ V/m at a distance of 870 km from this place it is $\sim 1.5 \times 10^5$ V/m and at a distance 1300 km it is $\sim 6.5 \times 10^4$ V/m. It is evident that the computed values of electrical pour on on the earth's surface they exceed the values, obtained during the tests. The ratio of rasschetnykh values to those measured they comprise: in the epicentre of explosion - 13.5, at a distance 870 km from this place - 4.5, at a distance 1300 km - 2.4. Certainly, are unknown neither the precise initial of the temperature of plasmoid nor mass of bomb and launch vehicle, in which it undermine nor materials, from which are prepared these elements. Correcting these data, it is possible sufficiently simply to obtain values pour on those being approaching experimental values. Greater uneasiness causes that the fact that there is a large noncoincidence of three-dimensional dependences of experimental and calculation data. Let us attempt to explain the reason for such divergences.

Let us first examine the case, when the ionosphere is absent (Fig. 4) For simplification in the task we will consider that the ideally conducting limitless plane represents by the earth's surface. The solution of allocation problem pour on for the charge, which is been located above this plane, well known [7]. The horizontal component of electric field on the surface of this plane is equal to zero, and normal component is equal:

$$E_\perp = \frac{1}{2\pi\varepsilon_0}\frac{zq}{\left(z^2+x^2\right)^{\frac{3}{2}}},$$

where q - magnitude of the charge, z - shortest distance from the charge to the plane, x - distance against the observation points to the point of intersection of vertical line, lowered from the point, where is located charge, to plane itself.

Lower than conducting plane electric fields be absent. This configuration pour on connected with the fact that charge, which is been located above the conducting plane, it induces in it such surface density of charges, which completely compensates horizontal and vertical component of the electric field of charge in the conducting plane and lower than it. The dependence of the area charge from the coordinate x can be determined from the relationship:

$$\sigma(x) = \varepsilon_0 E_\perp = \frac{1}{2\pi}\frac{zq}{\left(z^2+x^2\right)^{\frac{3}{2}}}. \tag{4}$$

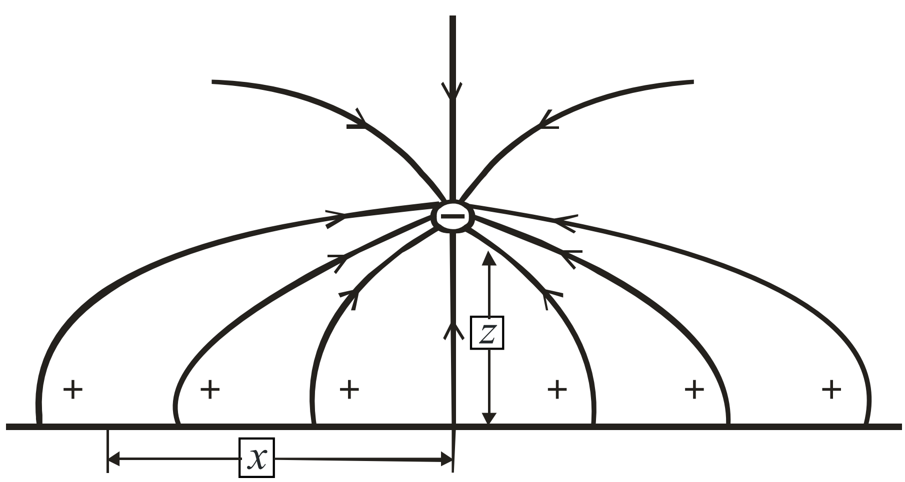

Fig. 4: Negative charge above the limitless conducting plane

If we integrate $\sigma(x)$ with respect to the coordinate x, then we will obtain magnitude of the charge, which is been located above the conducting plane. In such a way as not to pass the electric fields of the charge q through the conducting plane, in it must be contained a quantity of free charges, which give summary charge not less than the charge q. If we periodically draw near and to move away charge from the plane, then in it will arise the periodic horizontal currents, which will create the compensating surface charges. The same effect will be observed, if charge at the particular point can be born and disappear. If at the assigned point above the plane charge suddenly in some time arises, then, so that the fields of charge would not penetrate through the conducting plane, in the same time on the conducting plane the compensating charges, which correspond to relationship must appear (4). This means that the strength of currents, which create the compensating charges, there will be the greater, the greater charge itself and the less the time of its appearance. If we calculate electric fields according to this formula, considering that with $x=0$ the value of the tension of the vertical component of electric field on the surface equally to 5.2 $\times 10^4$ V/m, then at a distance 870 km we will obtain field value of 4×10^3 V/m, and at a distance 1300 km - 1.3×10^3 V/m. It is evident that pour on the values of calculated and obtained experimentally again strongly they are differed from those calculated. This connected with the fact that between the earth's surface and the charge in question exists the ionosphere, which is also the conductor of current, although not very perfect. Let us examine this case (Fig. 5).

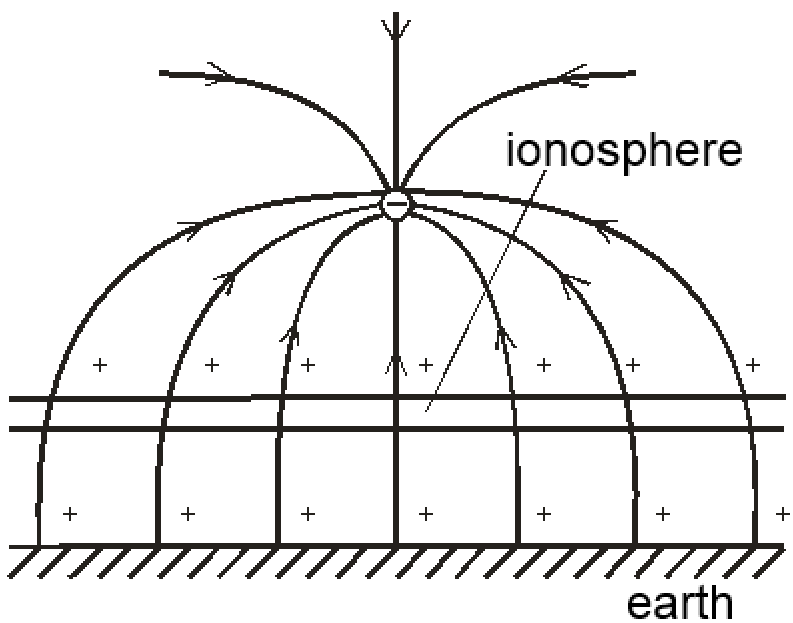

Fig. 5: Negative charge above the earth's surface with the presence of the ionosphere

If charge will appear at the indicated in the figure point, thus it will gather under itself the existing in the ionosphere free charges of opposite sign for compensating those pour on, which it creates in it. However, if a total quantity of free positive charge in the ionosphere will be less than the value of charge itself, then their quantity will not be sufficient for the complete compensation pour on the appearing charge and its fields will penetrate through the ionosphere. In this case the penetrated fields, in view of the screening effect of the ionosphere, can be less than the field above it. Entire this picture can be described only qualitatively, because are accurately known neither thickness of the ionosphere nor degree of its ionization on the height, moreover, such problems are solved only by numerical methods.

The sphericity of the ionosphere also superimposes its special features on the process of the appearance of the compensating surface charges. This process is depicted in Fig. 6.

The tendency of the emergent charge to gather under itself the compensating charges will lead to the longitudinal polarization of the substantial part of the ionosphere. The compensating positive charge will be located in the ionosphere directly in the straight visibility under the charge and here them it will be in the surplus, while beyond the line-of-sight ranges in the surplus they will be negative charges. And entire system charge - the ionosphere - the earth will obtain additional dipole moment. The distribution of induced charge in the ionosphere will depend on the height, at which is located the charge, and also from the position of the sun with respect to the charge, since. The degree of ionization of the ionosphere depends on its position.

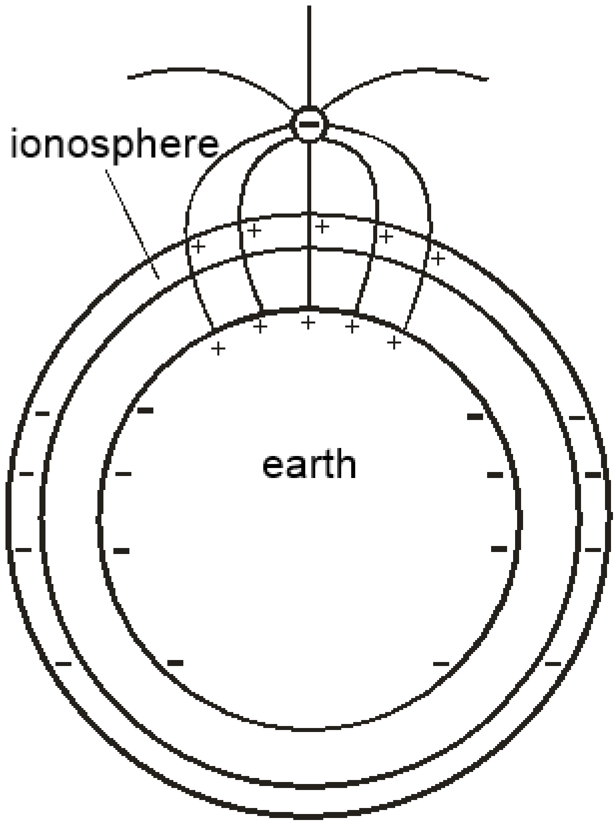

Fig. 6: Neative charge above the earth's surface with the presence of the ionosphere

With the nuclear explosion is synchronous with the electrical radial fields, which are moved from the plasmoid with the speed of light, moves the front X-radiation. This emission will ionize the atmosphere, increasing its conductivity, while this will, in turn, increase the shielding functions of the atmosphere from the penetration into it of the pulses of the subsequent explosions, if such arise. Furthermore, since the negative potential of plasmoid at the initial moment of the explosion of very large, from the cluster will be temporarily rejected some quantity of electrons, which also after a certain time will fall into the ionosphere. The partial neutralization of the electrons, which fell into the ionosphere, will occur, when the positive ions of plasmoid will also reach the ionosphere. But this will concern only those ions, the radial component of speed of which was directed to the side of the ionosphere. The same electrons and ions, whose radial component was directed to the side from it, will leave the limits of the earth's gravity and they will present the similarity of that solar wind, which is the consequence of the evaporation of the solar corona or flashes on the solar surface. Those complex processes, which accompany nuclear explosion, now are only schematically outlined, and is in prospect still extensive work, on the recreation of these processes for the actual conditions. It is obvious that to make this is possible only numerical methods.

The model examined speaks, that nuclear explosion will lead not only to the appearance PEF in the zone of straight visibility, but also to the global ionospheric disturbance. It is known that the explosions according to the program " *Starfish"* and according to the program "*Program K"* led to the presence of large interferences with radio-technical and radar systems at large distances from the epicentre of explosion. Certainly, the electric fields in space, generated by this explosion, have very high values and present the major threat for the automatic spacecraft. The values of the maximum values of the tensions of electric field, depending on distance from ground zero for our specific case, are represented in the Table № 1.

Table № 1

$r(км)$	500	1000	1500	2000	2500	3000
$E(В/м)$	$4{\cdot}10^5$	10^5	$4{,}5{\cdot}10^4$	$2{,}5{\cdot}10^4$	$1{,}6{\cdot}10^4$	$1{,}1{\cdot}10^4$

Now let us return to the horizontal component of electrical pour on the earth's surface, generated with the explosion. It is understandable that these fields represent the tangential component of radial pour on, that go from the point of explosion. Specifically, these fields cause the compensating currents, which create the compensating surface charges. It is possible to calculate the order of the summed currents, which will have radial directivity with respect to the epicentre of explosion. For this let us calculate summary compensating grain surface on the earth's surface, which must be formed with the explosion of nuclear charge. This charge is equal to the charge of plasmoid with the opposite sign

$$q=4\pi\varepsilon_0 r^2 E\ .$$

After conducting calculations according to this formula, on the basis of the actually measured vertical tensions of electrical pour on in the epicentre of explosion (5.2×10^4 V/m), with the distance to the explosion of 400 km of we obtain the charge $\sim 10^6$ pendant. However, the value of charge, calculated according to formula (3) they will compose $\sim 1.2\times10^7$ pendant. This divergence, as it is already said, can be connected with the screening effect of the ionosphere. From the data on the topology PEF, given in Fig. 3, follow that the pulse rise time of electric field is $\sim$ 50 ns. This means that the total current, directed to the

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epicenter of the explosion should be $\sim 10^{12}$ amps. Certainly, this number is somewhat overstated, because the compensating charges are attracted not to one point, which is been the epicentre of explosion, but to the sufficiently extensive region in its environment. But even if this value decreased several orders, previous the strength of compensating currents will be very large. It is now understandable, why on Oahu island, that is been located at a distance of 1300 km of from the epicentre of explosion, burnt 300 street lamps, and near Dzheskazgan in the air telephone line with the extent 570 km of arose the currents $\sim$ 2.5 kA, which burnt in it all safety fuses. Even to the power cable by extent is more than 1000 km, which connects Almaata and Akmola, and the having armored screen from lead, braiding from the steel tape, and located on the depth 0.8 m, such focusings arose, that operated the automata, after opening from the cable power station. Certainly, the pulse of tangential currents, although the less significant than on the earth's surface, will be also in the ionosphere, which will lead to its disturbance on global scales.

Entire process of formation PEF with the explosion of charge in space can be described as follows. At the moment of explosion in the time of the detonation of nuclear charge, which lasts several nanoseconds, is formed dense plasmoid with the temperature in several ten and even hundreds of millions of degrees. This cluster generates the powerful gamma emission, which is extended in different directions from the cluster with the speed of light. Simultaneously is generated the radial electric field, which also is extended in the radial direction from the cluster with the speed of light. Radial electric fields PEF and gamma-radiation reach the ionosphere simultaneously. During its further motion to the side of the earth's surface, if explosive force for this it is sufficient, X-radiation begins to ionize and the layers of the atmosphere, which are been located lower than the ionosphere. The process of the ionization of upper air and the penetrations in them of radial electric field will simultaneously occur. In the ionized layers due to the presence of radial electric field will arise the radial currents, which will lead to the stratification of charges and to the vertical polarization of conducting layers. The processes of the polarization of the atmosphere will last as much time, as will exist radial field, and also conductivity of ionized air. Since the ionosphere will not be able to ensure the charge, necessary for the complete compensation for the radial field of plasmoid, these fields, although in the weakened form, they will continue to be extended in the direction of the earth's surface. Reaching it, electric fields will create powerful radial currents. The process of propagation of X-radiation and radial pour on through the ionosphere it will lead to its additional ionization and polarization, and also to the appearance of a pulse of tangential currents. The pulse of tangential currents in the ionosphere will apply to distances considerably greater than the visibility range of explosion, which will lead to the global ionospheric disturbances.

With some delay in the phase of the ionosphere, electrons are also ejected from the plasma bunch, which will lead to additional perturbations. And if the power of the explosion is such that even the lower layers of the atmosphere will be ionized, then the charge separation, and, consequently, the induced electric charge, due to charge separation, will take place in the whole atmosphere.

Up to that moment, when the flow of rigid gamma emission and ionization of atmosphere cease, the part of the atmosphere, ionized lower than the existing boundary of the ionosphere, will cease to be conductor, and is, therefore, the three-dimensional divided charges will prove to be closed in it. The electrons closed in the atmosphere will as before create some static potential difference, which will slowly relax to the extent of the presence of the residual conductivity of the atmosphere. It should be noted that the polarity of this field will be opposite to the polarity of initial PEF, that also is observed in actuality. This means that the radial electric field, observed on the earth's surface, will be first directed from the earth toward the epicentre of explosion, but at some moment of time it will change its polarity. Specifically, this behavior of electric field is observed on the graph, depicted in the upper as right to angle Fig. 3

Becomes clear and that, why after space nuclear explosion an even longer time is observed the residual glow of the atmosphere under the point of impact. This glow is obliged to those electrons, which during the first stage development PEF were displaced of the ionosphere into the denser layers of the atmosphere, and then, after the termination of the ionizing effect of gamma emission, they remained closed in the little conducting atmosphere, continuing to ionize it.

Now let us be turned to Fig. 3 Since the value of radial field in accordance with relationship (2) is proportional to the work of a quantity of free electrons to the temperature of plasma, the like to this graph it is possible to judge the knocking processes of nuclear charge and the subsequent cooling of plasmoid. From the figure one can see that the most active process of formation PEF lasts in all $\sim$ 100 ns. In this case even X-rays, which are extended with the speed of light, will have time to leave from the burst center in all on 30 m. In the figure there are two dependences. Solid line designated the curve, photographed from the oscilloscope face, dotted line presents the real shape of pulse, obtained by working by the photographed curve taking into account the parameters of the input circuits of oscillograph. In the initial stage of real dependence for the elongation strand 50 ns are visible two sequential peaks. The first peak presents nuclear blast, which ignites thermonuclear charge, the second peak presents the knocking process of thermonuclear fuel. The rapid decrease, which characterizes the process of cooling cluster, further goes. It is evident that it occurs very rapidly. Naturally to assume that this is that period, when basic energy losses are connected with the radiant losses caused by the rigid X-radiation. On the dependence, depicted on the graph, located in the upper by right to angle Fig. 3, are depicted processes in the time interval calculated by seconds after explosion. It is evident that the intensity of these processes is insignificant, however, characteristic property it is that that the field strength changes its sign.

The carried out analysis attests to the fact that the appearance EMI it is necessary to consider as the rapidly elapsing generation of new negative single-pole charge at the moment of the detonation of nuclear charge and its subsequent slower disappearance during cooling of plasma.

Thus, the appearance PEF with the nuclear explosion are the properties of explosion itself, but not second phenomena. Its properties and characteristics can be explained within the framework to the concept of scalar- vector potential. Studying topology PEF it is possible to study knocking processes with the nuclear explosion, moreover this method is remote. Studying topology PEF on the earth's surface, it is possible to judge also the subsequent processes of polarization and depolarization of the ionosphere, atmosphere and earth's surface. With the explosion in the atmosphere very process of formation PEF and its development are connected with the presence of the atmosphere, and also by the presence of conductivity on the earth's surface and this will also superimpose its special features on shaping pour on PEF.

Now should be made one observation apropos of term itself the electromagnetic pulse (EMI), utilized in the literary sources. From this name should be excluded the word magnetic, since. this process presents the propagation only of radial electrical pour on, and in this case magnetic fields be absent. It is another matter that electric fields can direct currents in the conducting environments, and these currents will generate magnetic fields, but this already second phenomenon.

Would seem, everything very well converges, however, there is one basic problem, which is not thus far examined, it concerns energy balance with the explosion. If we consider that one ton of trotyl is equivalent 4.6×10^{9} J, then with the explosion of bomb with the TNT equivalent 1,4 Mt. are separated 6.44 $\times10^{15}$ J. If we consider that the time of detonation is equal to 50 ns, then explosive force composes $\sim1.3\times10^{23}$ W. Let us say for an example that the power of the radiation of the Sun $\sim3.9\times10^{26}$ W. Let us examine a question, where how, in so short a time, can be the intake, isolated with this explosion.

In accordance with Stephan equation Boltzmann the power, radiated by the heated surface, is proportional to the fourth degree of its temperature:

$$P=\sigma s T^{4},$$

where $\sigma=5.67\cdot10^{-8}\ \dfrac{W}{м^{2}K^{4}}$ - the Stefan-Boltzmann constant and S - area of radiating surface.

If we take the initial temperature of the plasmoid $\sim10^{8}$ K, then with its initial diameter 1 m (in this case the surface area of cluster it is ~3 m^{2} entire explosive energy will be radiated in the time $\sim$ 0.4 ns. But if we take the initial temperature $\sim10^{7}$, then this time will be already $\sim$ 400 ns. Thus, one should assume that the initial temperature of plasmoid to be located somewhere between the undertaken values. Wavelength, on which will be radiated a maximum quantity of energy, is determined by the Wiens law

$$\lambda_{\max}=\frac{0,28975}{T}\ \frac{sm}{K}$$

If we substitute here the value of the temperature of 5×10^{7} K, then we will obtain the wavelength on the order 6 Å, which corresponds to rigid X-radiation. Thus, in the period of the most active isolation of explosive energy explosion itself will be invisible in the visible part of the spectrum. Its temperature will begin to fall in proportion to cooling cluster and $\lambda_{\max}$ will begin to be shifted into the visible part of the spectrum. In this case can be observed the interesting phenomenon, when the temperature of cluster will fall, and the visible brightness - grow.

But the mechanism of losses examined is not only. Since with the temperature of cluster are unambiguously connected its electric fields, immediately after detonation they will be maximum, and then with a temperature drop of cluster they will begin to decrease proportional to temperature. However, the energy, necessary for their creation, will fall not as rapidly as energy necessary for creating the X-radiation.

Besides these losses will be still loss to the thermionic emission of electrons from the plasmoid. The velocity of the electrons, which will leave cluster considerably less than pour on the speed of electrical since. it corresponds to the temperature of cluster; therefore the front of these electrons will substantially be late relative to the fronts of X-radiation and radial electric field. And only after thermionic electrons will leave cluster, the basic reserve of energy of nuclear explosion will be exhausted. Will remain only ions with some quantity of compensating electrons, which will fly away in the radial direction from the point of impact. This remained relict of nuclear explosion will present ball lightning.

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Appears one additional important question about which a quantity of electrons it will leave plasmoid. In order to answer it, let us examine the condition of the electrically neutral of plasma. At that moment when metal is converted into the plasma, occurs not only the passage of substance from one state of aggregation to another, but also changes the statistics of the description of electron gas. In the solid state statistician Fermi-Dirac's this, while in the state of plasma - statistician Boltzmann's this. When electron gas was located in the steadfast conductor, then in the state of electrically neutral to each ion it was fallen along one free electron. Let us determine from the point of view of the concept of scalar- vector potential, what relationship must be observed between the electrons and the ions in the plasma so that it would also remain electrically neutral. Before solid became plasma, the electron density and ions was identical and, therefore, the absolute values of their charges were equal

$$eN_e = eN_p\,,$$

After the transformation of substance into the plasma general equivalent electron charge increased, to the value, determined by relationship (3), and in ions it remained practically before. Now already for observing the electroneutrality must be observed the relationship:

$$N_{e(pl)}\left(1+\frac{k_B T}{m_e c^2}\right)=N_p\,,$$

where $N_{e(pl)}$ - equilibrium quantity of electrons in the plasma.

Is evident that this equilibrium quantity is less than to the passage of substance into the state of plasma. Difference composes

$$\Delta N=N_p\left(1-\frac{1}{1+\frac{k_B T}{m_e c^2}}\right). \tag{5}$$

For example, at a temperature ~10 the value, which stands in the brackets, will compose approximately 0.13. This means that at the temperature indicated, for retaining the electrically neutral of plasma, 13% of a total initial quantity of electrons had to it leave. We will call this effect the effect of temporarily excess electrons. Word “are temporarily " used by in the sense that temporary they appear as long as plasma is hot. In this connection clear to become that, from where, for example, on the surface of the sun appear powerful magnetic fields, especially when at it appear spots. These fields are induced by those currents, which overflow between the regions of plasma, which have a different temperature.

We in sufficient detail examined the behavior of the static charge above the conducting plane. But in actuality there is not a static charge, but a charge, which lives only several hundred nanoseconds. Therefore the processes of short-term generation and disappearance of charge are differed from those, which are examined. The carried out analysis was directed toward that so that it is better to understand the kinematics of process itself.

If in the origin of coordinates is located the charge $Q(t)$, depending on time, then the electric fields, created by it in the surrounding space, can be found from the relationship:

$$\varphi(r,t)=\frac{Q(t)\left(t-\frac{r}{c}\right)}{4\pi\varepsilon r} \tag{6}$$

to which correspond the being late longitudinal electric fields:

$$E(r,t)=\frac{Q(t)\left(t-\frac{r}{c}\right)}{4\pi\varepsilon r^2}. \tag{7}$$

In accordance with relationships (6, 7) the short-lived charge generates so short-term a pulse of longitudinal electrical pour on, which in the space are extended with the speed of light and is formed the spherical layer, whose thickness is equal to the lifetime of charge, multiplied by the speed of light. If we consider that for our case the time of life of charge composes the half-width of pulse PEF (somewhere about 150 ns), then the thickness of this layer will be about 45 m. The spherical layer, having first reached the ionosphere, and then the earth will induce there the same radial currents, as if the static charge appeared and, having existed 150 ns, disappeared.

The effect of superfluous electrons leads to another phenomenon. As it was already said, when a charge explodes in space, its considerable energy is expended to create a flux of hard x-ray radiation, whose front after the explosion propagates in radial directions with respect to the charge. Getting in the atmosphere, this front it ionizes and warms up. But, if ionization occurs and warming-up, then excess electrons immediately appear, and in the region of ionization appears the negative static charge, on both sides which appear the static electric fields, which begin to be extended both in the direction of the earth and to the side of the outer space. In the direction of the earth these fields are added to the fields, created by the charge of explosion, strengthening them. However, according to the relation to the outer space occurs its

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kind the reflection from the ionosphere of the front of the X-radiation of in the form stimulated by this emission radial electric field. And these are is one additional factor, which generates PEF in the outer space, but this already second effect. However, since, energy of the X-radiation of nuclear explosion is very great, this second effect can be significant. All the fact is that of ionization itself is still insufficient for the formation PEF, in addition to this is necessary the warming-up of plasma itself. Therefore one should assume that the front of X-radiation not only ionizes plasma, but still it it razogrevaet. In addition to this to the warming-up of the formed plasma contribute those radial electric fields, which are extended with the front of X-radiation since they cophasal create radial currents.

Following this concept possible to assume that with the solar flares, when a significant quantity of additional X-radiation, which irradiates the ionosphere, is separated, in it additional excess charges will also appear and its additional warming-up will occur. This means that already, approximately, eight minutes after the flash (time necessary, so that the X-rays would reach the Earth) will begin ionospheric disturbances and, in particular, additional vertical components of electric field will appear on the earth's surface.

The mechanism examined gives the possibility to explain those magnetic fields, which appear on the surface of the sun with the formation on it of dark spots. A difference in the temperature of plasma in the individual sections of solar surface leads to formation between these sections of the potential difference, because of which charges to overflow of the more heated regions to those less heated.

As was already said, analyzing the topology of pulse PEF, it is possible to judge about the temperature of plasma and the processes of proceeding in it. This method can be used also for diagnostics of other forms of plasma. For plasma itself there is no difference whatever in by what form of its energy they heat, is important only quantity of free electrons, i.e., the degree of ionization, which depends on the final temperature of plasma. Laser warming-up is considered as the promising method of its warming-up for realizing of thermonuclear fusion. In this case the samples under investigation undergo the action of powerful laser pulse. Model in short time is converted into the high-temperature plasma, i.e., there is a certain similarity of the behavior of plasma with the nuclear explosion. Therefore completely obvious is the fact that application in this case of a method of electric field thermokinetic spectroscopy will make possible to remotely diagnose the processes of warming-up and subsequent cooling of this plasma. For these purposes it suffices to surround sample under investigation by two conducting screens and to connect between them high-speed to oscillograph with the high input resistance. External screen in this case should be grounded. At the moment of the warming-up of plasma by laser beam will arise PEF. Moreover a potential difference between the screens will arise much earlier than the material particles of plasma they will reach the walls of the first screen. Studying the topology of the recorded pulse, it is possible to judge the temporary energy processes of the warming-up of plasma. It is not difficult to calculate the expected potential difference between the screens depending on the temperature and quantities of free charge carriers in the heated plasma. After using relationships (5) and (7), for the case, when $k_B T << mc^2$ we obtain:

$$U = \frac{Nek_B T}{4\pi\varepsilon_0 mc^2}\left(\frac{1}{r_1^2} - \frac{1}{r_2^2}\right),$$

where r_1 and r_2 - radii of external and internal screens respectively, and N - quantity of free electrons in the heated plasma.

The fact of the presence of excess electrons should be considered, also, with realizing of controlled thermonuclear fusion, since this phenomenon must influence also the stability of plasma with its warming-up.

III. Rope Trick

It should be noted that despite the fact that nuclear explosions are studied already sufficiently long ago, however, until now, not all components of the development of this process obtained its explanation. Such processes include the so-called cable tricks (rope trick), which investigated John Malik.

In Fig. 7 and Fig. 8 are represented the photographs of cable it is special effect. These photographs removed American photographer Harold Edgerton by automatic camera, which is been located at a distance of 11.2 km of from the epicentre of explosion with the periodicity of survey 100 ms.

In Fig. 7 is presented the initial phase of the development of the cloud of the explosion of charge, located on the metallic tower with the ropes from the wire cables. Already it is evident on the initial phase of explosion that in the upper part of the cloud of explosion are three spinous formations.

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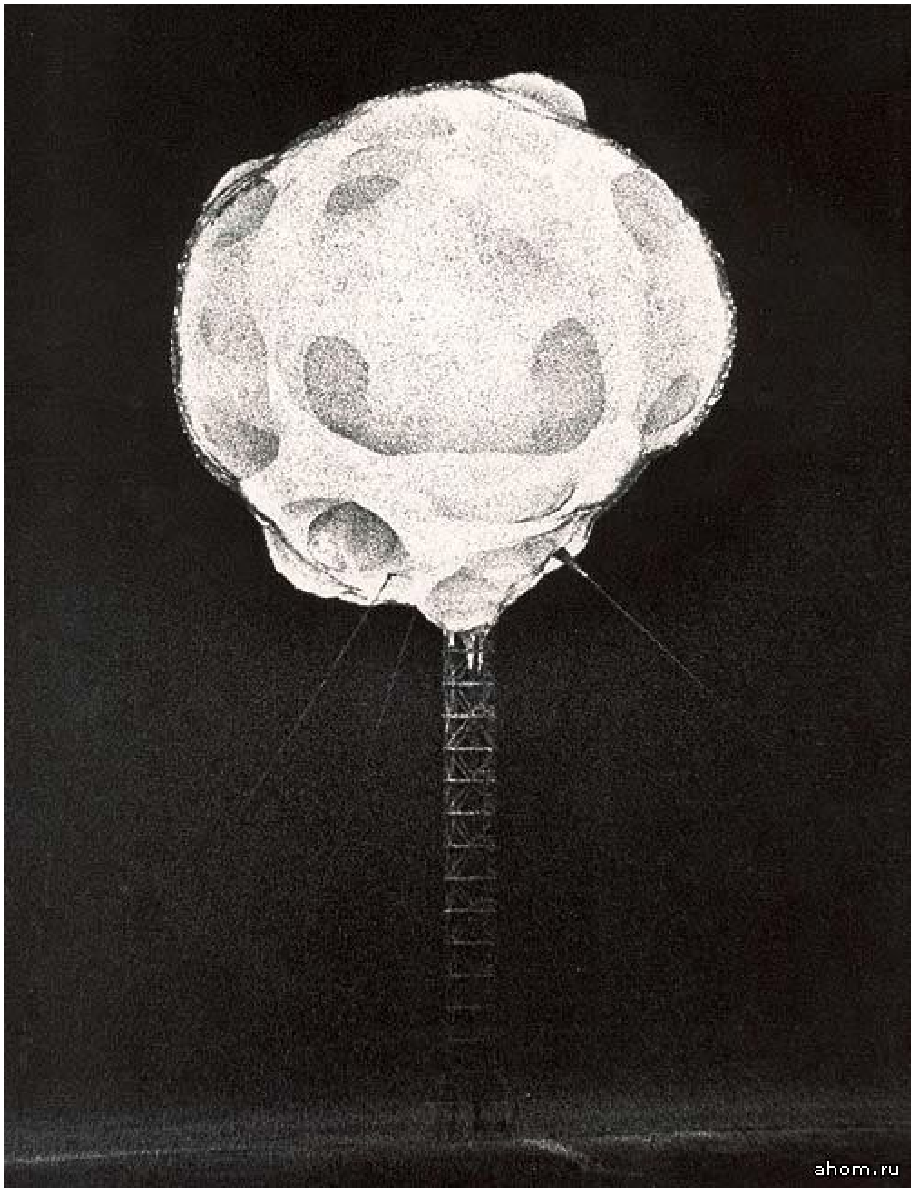

Fig. 7: Initial phase of the development of the cloud of explosion

The same shafts is especially well visible in the upper photograph (Fig. 8) Towers in this photograph already barely it remained, but it is evident that the shaft of large diameter, which exits to the earth, pierces it. Smaller two shafts are extended in the direction of the stretching ropes.

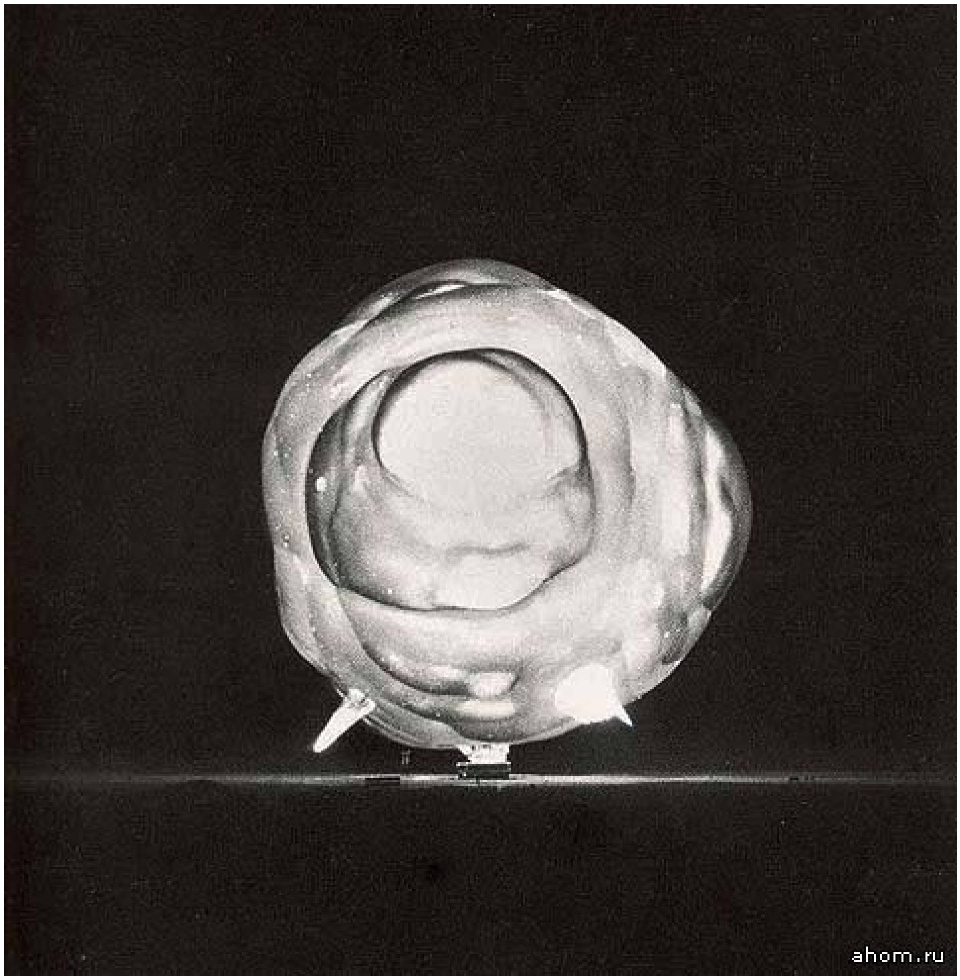

Fig. 8: Subsequent phases of the development of the cloud of explosion. Recording frequency 100 ms

In the photographs is evident that the diameter of shaft grows with an increase in the volume of the cloud of explosion. Especially good this is evident in the lower photograph Fig. 8, when the cloud of explosion already touched the earth. The shaft, located in the lower left side of the cloud of explosion, which exits to the earth, has already considerably larger diameter, than in the upper photograph.

This phenomenon attempt to explain by the fact that powerful gamma-radiation of the cloud of explosion melts ropes, converting them into the plasma. It even attempted to bring the reflecting coatings to the ropes, which decreased, and in certain cases even liquidated this phenomenon. But this idea is not very productive, since the ropes of stretchings go practically in parallel to light rays; therefore they cannot be heated strongly by emission. is certain that that the ropes and tower are guiding elements for the appearance of shafts, it is clearly evident in upper Fig 8. Moreover, this photograph finally removes version about the fact that the ropes warm up by the emission of the cloud of explosion. It is evident in the photograph that the luminosity of shafts is higher than in cloud itself, and means their temperature also higher. But, if they warm up by the emission of cloud itself, then their temperature cannot be higher than its temperature. Consequently, must be some additional sources of the warming-up of ropes.

Even the more impressive photograph of the formation of the cloud of explosion and shafts is shown in Fig. 9.

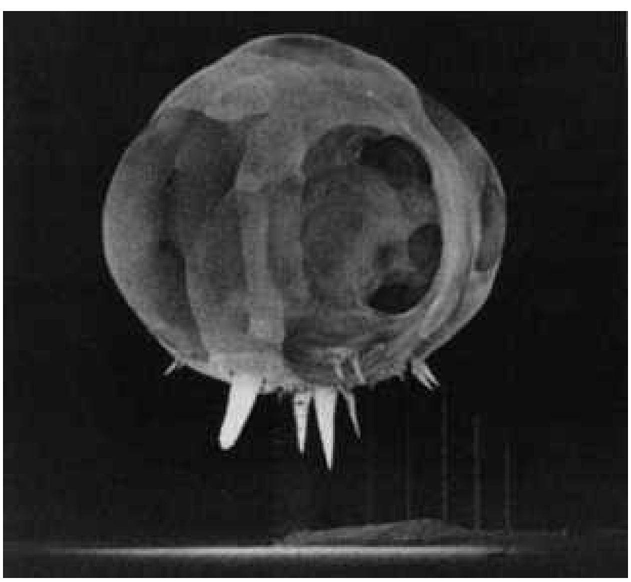

Fig. 9: Cloud species of explosion after 1 ms after the detonation of nuclear charge, time of exposure 1 s.

In the photograph is distinctly evident that the temperature of shafts is much higher than the temperature of the cloud of explosion. Their large quantity is connected, apparently with existence of the additional stretchings of the tower, where explosion was accomplished.

It is evident in the photographs that all visible shafts directly proceed from the cloud of explosion. Therefore follows to assume that the warming-up of ropes it is connected with the advent of the equivalent charge of the explosion, which as along the lightning conductor departs through the ropes to the earth, warm up them. Since the part of the rope closest to the plasmoid is hottest, specific resistance in its this part is more than in the remaining parts of the rope. Therefore a basic voltage drop will precisely fall in this section, and, therefore, and to be melted it will begin from this place. Moreover, those sections of rope and tower itself, which are converted into the plasma, also add some quantity of excess electrons, which must be somewhere rejected. Therefore Rope trick phenomenon is connected with the appearance of the equivalent charge of the explosion, which through the ropes and tower departs to the earth.

The appearance of the induced equivalent charge of explosion, and it, is as shown higher, it has very high value, it will melt not only the ropes of stretchings and tower. Very high currents will be induced on the earth's surface radial with respect to the epicentre of explosion, and also in the conducting elements of those located above the earth's surface and buried into the earth, which presents the specific danger with the ground-based or air nuclear explosion.

In the confirmation of the fact that the excess electrons are formed upon transfer from solid state to the state of plasma, let us lead one additional phenomenon, which is connected with the explosion of H-bombs, not received its thus far explanation. During the formation of the cloud of explosion from it to the side of the earth they beat lightning.

The Lightning they were photographed with the explosion of H-bomb by power into 10 Mt, which was produced in 1952 in the atoll Eniwetok. The discharges of lightning branched out upward from the surface of sea. When the expanding fireball reached that place, where before this the discharges (visible flashes by this time they disappeared), were visible, twisting channels again seemed against its background. The charge, which gave birth to lightning, judging by everything, was formed very rapidly, but the reasons for its formation remain obscure to the these rapids. Actually this phenomenon, until now, did not obtain its explanation, but from the point of view of the processes of those examined above this phenomenon has simple explanation. With the expansion of the cloud of explosion occurs the ionization and the warming-up of the large masses of air, with which the molecules convert from the neutral state to the state of plasma, that also leads to the formation of excess electrons. When the cloud of explosion does not have straight electrical contact with the earth, the surplus of charges leads to the formation of lightning.

IV. Conclusion

The United States under the Starfish program blew up a hydrogen bomb with a TNT equivalent 1.4 Mt in space above the Pacific Ocean. This event put a lot of questions before the scientific community. During the explosion, an electrical impulse of very short duration and large amplitude was detected. Modern electrodynamics can not explain this phenomenon. The article attempts to explain this phenomenon on the basis of the concept of the scalar-vector potential developed by the author of the article. A comparison of the calculated data obtained on the basis of this concept and the experimental results obtained during the bomb explosion gave a good agreement.

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Chaos-Imaginary Ostensibility- Orthogonality

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Abstract- Thermo-dynamics, classical and quantum mechanics describe how Nature "lives" in time. Both abstract static fields used in the fundamentals of physics: electric and gravitational, and describe the "life" of their substructure, and "breathe - live" when moving their "sources" in time. So in TIMELESS there are no forms of "LIFE", how far or how deeply we would not have looked.

There is no our biological life, originally formed in the form of prigogine dissipative structures, but which later gave the palm to chemical structures, not in semi-animal dissipative social structures. There is no "life" without the Time and the Conscious sphere of knowledge, which was originally formed in the form of sections of Science and Art, but now give priority to computer-micro-nano-electronic structures.

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CHAOSIMAGINARYOSTENSIBILITYORTHOGONALITY

Strictly as per the compliance and regulations of:

Chaos –Imaginary Ostensibility– Orthogonality

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Abstract- Thermo-dynamics, classical and quantum mechanics describe how Nature "lives" in time. Both abstract static fields used in the fundamentals of physics: electric and gravitational, and describe the "life" of their substructure, and "breathe - live" when moving their "sources" in time. So in TIMELESS there are no forms of "LIFE", how far or how deeply we would not have looked.

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But as long as we did not give in to computer structures in rationality (in the intellect they have already given way), we use the "key" of rationality (understanding that we are not an exception to the time dependence — a self-consistent task) to identify the particular time coordinate feature, whose presence ensures the existence of life, but absence - time has stopped - means death.

Elementary Dynamic "Point" - the point of Life of Nature, its abstract model is the Harmonic Oscillator. This model passes through all of physics and allows you to closely "see" the used Imagination of Time to distinguish it from other orthogonal (simply independent, but not polar) coordinates. And, as shown by the analysis of this model, its real Imagination is the "imaginary" properties and they are determined by the leakage of WHERE (to uncertainty - in the future) of the energy that forces FROM WHERE (from nowhere - from the past) to force. And this determines the special orthogonality of the time coordinate of the rest, spatial. And this IMPORTANCE was also reflected in the mathematical writing of the Harmonic Oscillator, and as a result, in Einstein's Theory of Relativity.

I. Preamble

How did we live up to such a life that Faraday and Lomonosov, Mendeleev and Einsteins did not, and Bill Gates in computers, Ilon Mask on a pair with Dima Rogozin in technology, Trump and Putin in economics !?

The answer to this question lies on the surface, in science itself, where, as in all of society, philistine priorities have become higher than scientific ones.

And, as a result, academic titles/awards became nothing more than a decoration for the society/ government, and within the scientific environment only a hierarchical step. And in a degraded *scientific environment!* it became permissible to use the technology of porn sites for the Nobel Prize.

And, as a result, the same innovations, or more simply, money is invested not in fundamentally new ideas / developments, but in the same money, in the area of production, where yesterday's science is used and nothing more than a colorful wrapper.

And, as a result, the same innovations, or more simply, money is invested not in fundamentally new ideas / developments, but in the same money, in the area of production, where yesterday's science is used and nothing more than a colorful wrapper.

It is clear that in this situation it is necessary to treat, first of all, the science itself. And treat according to science, i.e. in the body of science itself, in the Scientific Head itself. And, as they say: Do you want to do well, do it yourself. But without a certain push it is difficult to understand if you will not become similar to those who are adapted for money = obsolete science and feel whether you have a moral right to this "treatment". The impetus for me was the appeal to RBC (Russian Business Consulting) correspondents with a request to explain: What is a NANO? Before contacting me, they asked the Nobel Laureate Zhores Alferov with this question. And having listened to his two-hour lecture, they did not understand: NANO is a new physics or a new method of money laundering? And when I managed to explain to them what the essence of NANO-physics was, and they, after placing my answers in the article, received the Pulitzer Prize for it, they asked me to write a number of other popular science articles on the NOR website (Nanotechnology Society of Russia). Write, asked, so that it was clear even to academicians. And since the disease has gone deep into the body of science itself in a hundred years, in formulating topical scientific problems and solving them, it was necessary to "cut to the quick" - to write about essentially pseudoscientific "scientific discoveries", introduced, at best, in devices that are already written off.

And these articles-solutions on NOR have become not only an additional education for many scientists (already about 300 thousand views), and not only in Russia, but also self-education for me. So, in contrast to the low-level popularization of outdated science, I tried to do, in the popular, but quite professional, form of the course EDUCATION of a future science.

Here is the next step of the EDUCATION-FORMATION OF SCIENCE presented in this article.

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II. Dynamics of Chaos in Nature, In Society and Science

If you take the point of view that is not inflamed by a specific theory of the mind, but build reasoning with an "eye on" Reality, with an eye on available physical experiments, then the main ANOMALY of the thermodynamic description of the universe is Thermal Death. The death of the immortal Universe goes into the category of "singularities" fashionable for "theorists of all kinds", which (like the Big Bang Theory), as has already been written more than once, in Reality are just analytical "extensions" of mental simulations and formulas beyond their applicability. And Thermal Death is just a similar asymptotics of thermostatics (in the universe as a whole, and not in the movement of individual "molecules"). And based on reality, we see that the thermostat itself is only a special case of a thermal theory that takes into account time, that is, thermodynamics proper. But, in order to fully realize this with reference to the entire Universe, it took Prigogine's look at NANO [1] to look at fast and visible "eye" violations at the level of almost molecules and at the local level "in the sky", in macroscopic thermodynamics of slow processes Strict scientific calculations -the justifications of local thermodynamics, even the Nobel laureate Ilya Prigogine, have been in disgrace for a long time. The noted book is published by a graduate student only after his death. And he set forth his vision of Time and published it in a popular form [2].

To some extent, such "popular creativity" seems to be the "inevitable fate" of true scientific research. And true scientific discoveries in REALITY. After all, even a "vivid example" of Dirac, who "received" a positron at the tip of a pen, is the realization of the REALITY of the second character of an electron-type particle charge. And his "tip of the pen" - the possession of the mathematical operators of Heviside simply elevated him over the philistine reality and could not dismiss him. Grisha Perelman's possession of the mathematical technique of computation forced the "mathematical mafia" not to dismiss the end-to-end solution he found, in which only fragments were available to the understanding of the "Separate Mathematical Clans" [3]. Gathering together the whole "chaos of clan mathematical representations," Grisha was able to see the general pattern of REALITY. And in this regard, the artistic creativity of the scientist Ivan Efremov gave just a different "support" for his scientific awareness of REALITY - the scientific validity of his judgments in an artistic book accessible to the philistines, including those bred in science.

But purely philistine ideas now lie at the heart of both the clan theoretical and clan experimental bans in science itself. And in order to rise above them, strictly scientifically, it is enough to carefully analyze the basics and understand what science and technology and society as a whole have come to in a definite direction in a dead end. And false, basically, philistine "discoveries" of the graphene type lead science to a dead end even deeper, and false technical "achievements" of Ilona Mask only inhibit the creation of fundamentally new technology. But in reality, the fundamentally new in the current crisis state of science is making its way with difficulty. And there are lots of examples, starting with the creation by an enthusiast who has spent the whole legacy for the sake of creating a BOEING aircraft. And, in this regard, I am, of course, pleased with the operational attempts at "theoretical" development in popular articles of ideas from the articles "Newton's Coulomb Laws" [4, 5] and experimental attempts to build aircraft based on the ideas of the article "Physics of Flight" [6] and even on the basis of ideas from the articles "Electrostatic propulsion" [7].

Therefore, I will continue to spend my time not only on the rigorous scientific processing of the dozens of folders I have accumulated with experimental data and incomplete calculations with bringing them to scientific publications, but on their popular presentation. A rigorous scientific analysis and scientific publications I limit only to a deeper consideration of basic ELEMENTS.This is the main idea reflected in the title of the article itself as a result of the comprehension (contradiction) of the Elementary Model of the Elementary Harmonic Oscillator. Briefly about its "IMAGINARY OSTENSIBILITY" (in the physical term imaginary quantity, the English imaginary - fictitious is opposed to the Russian hue imaginary - unreal)will be discussed in the next paragraph, and I will try to publish their strict description in the scientific article "Parametric interaction of normal modes in C & BN".

And so, returning to REAL non-equilibrium thermodynamics, Mankind, the unreasonable organization of intelligent people, called Civilization, was proud of its achievements and victories (mostly over its own kind), owes its origin to "non-equilibrium processes," processes in time. The fact that Ilya Prigogine "saw" at the local level is in many ways just a manifestation of what was described by Vlasov in the Theory of Many Particles [8], where the formation of galaxies was considered as the main example. Although Vlasov touched local processes like solitons. But Prigogine's attentive glance "in depth" clearly demonstrated the logarithmic relativity of the structure of Nature on different scales [9], and supplemented this structure with new laws - dissipative structures existing on the scale of the universe, but clearly visible on local scales.

Here, as the "sun cloud" cooled, both the Sun itself and the planets formed, and the region that was optimal for the emergence of organic life migrated from the distant planet to the nearby Sun. In this region, which slowly migrates in space (along a radius), a small-scale dissipative structure has formed – life (according to non-equilibrium thermodynamics, which is consistent with the initial gigantism of animals, the Earth was wrapped up with a cloud of asteroids). Everything is strictly according to the laws of inanimate Nature, which develops in time. So, in principle, LIFE itself, its occurrence does not introduce any paradox into our perception. Moreover, it gives a deeper understanding of “disequilibrium” and our Sphere of Conscious Knowledge [10]. Limiting the expansion of the sphere of conscious knowledge in time means nothing more than the "thermal" death of Civilization. And the Science, which is now degenerated into the Knowledge Industry, with this death, due to the destruction of the Collective Intelligence, is involved.

There is only a “small” nuance that falls out of this collective nonequilibrium thermodynamic process - REASONABILITY, originally laid in each individual in defiance of ANY THERMODYNAMICS. But it is also “compensated” by the unreasonableness of the organization of society, so much so that it returns Civilization to the bosom of inanimate Nature. This paradox now in SCIENCE is manifested in its pure form: SCIENCE - the Collective Intelligence of Mankind needs the Reasonable development of the Individual and has itself produced Education, but in its organization and its life activity it is oriented towards the philistine Values that dominate BUSINESS. And it levels and Education, and innate reasonableness. Art, however, also falling out of inanimate Nature, orienting itself mainly on emotions, judging from the whole History of Civilization, can only maintain the balance of Good and Evil [11]. In addition, the flourishing of Art apparently already behind - it is closely intertwined with computer games.

So almost all manifestations of the "vital activity" of Civilization strictly correspond to non-equilibrium thermodynamics. Take at least the cumulative constantly “expanding” amount of money that government governments would supposedly regulate. In such monetary pseudo-economic activity of governments, local adjustments (in space and in time) as in communicating vessels lead to opposite effects outside the local area. And the total, integral effect is strictly according to nonequilibrium thermodynamics. So all the "local rationality" of governments has a strictly local characteristic: "Here and Now." But if a mentally rational individual can overcome space-time as far as desired (this “overcoming” will most likely be erroneous, if the use of ideas beyond the boundaries of the sphere of conscious knowledge associated with real experiments occurs), then an UNREASONABLE organization of people in the form of modern civilization mortal - its cycle - “lifetime” is set by the parameters of non-equilibrium thermodynamics.

And the saddest thing is that now the Sphere of Conscious Knowledge behaves in full accordance with the non-equilibrium thermodynamics of non-living particles. Although the Sphere of Conscious Knowledge is much wider, naturally, the philistine ideas of individuals, and its rationality is mainly determined by individual rationality, since science, as the structure of an unreasonable society also turns out (especially in a crisis period as it is now) organized unreasonably. And to overcome this all deadening tendency by purely bureaucratic means is not possible, which is well illustrated by the example of poor Russia [12]. Neither the scientific mafia, nor the state mafia at all does not care / is interested in the death of civilization as a result of the liquidation of Collective Intelligence. Although both of them, I know, are now looking into my articles in order to get enough for decoration of the scientific nature of “clever words”. But I do not write for them unreasonable, but for those whom the normal, naturally inherent in man Reasonableness will move to a lesson in the Sphere of Knowledge, and to a reasonable lesson.

So, I repeat, the sphere of conscious knowledge is not limited to narrow-minded ideas and organoleptic - with the help of instruments we have learned how to “see” and measure very small and very large objects and, based on experimental vision, build not only local theories (which are more correctly called working interpretations to systematize the data), but also the Fundamental Laws allowing to peep, in principle, for any “event horizons” (and not exactly the opposite - not to look where it’s not supposed to). But if the modern, “horizon boundary” reached in space, and in breadth, and in depth, is well defined, then with time, which enters as the main parameter into any dynamics, from molecule oscillations, to the emergence and development of life, the situation is more complicated. We can track / measure only the past and, based on the laws obtained in the past and on the measured instantaneous derivatives, in the present, build analytical continuations of the laws in the future.

But we have another “tool” - INVARIANCE, which, if used correctly, allows us to “look into” the future. This is precisely the manifestation of rationality, action (and in the layman and thought) not on the basis of animals, simplified reflexes, but thoughts on the basis of the Fundamental Laws (up to the limit of their applicability [13]). And in this regard, all sorts of "time compression", especially as compression to a point (the "theory" of the Big Bang), are no more than incorrect interpretations of models that have a limited range of applicability in time. Inaccurate in principle, since the incomprehensible connection between changes in the properties of matter in time is replaced by time itself. It is like compressing the spring in space to be replaced by stretching the space (which, technically, in principle, it can be useful to use in calculations). So, for example, we came to the Aborigines living according to the traditions of the past millennium, and on the basis of studying their behavior, we also talk about our ancestors in Europe, but we do not move into any past except for thought in time. So, on the one hand, Time plays the role

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of both normal in the universal sense and normal in terms of the orthogonal, independent coordinates of the "geometric" space in which we live and draw a picture of Nature. On the other hand, we live in a racing train, and this must be correctly taken into account in our constructions. It is necessary to take into account, among other things, the psychological aspect (as, for example, the principle of Schrödinger's uncertainty in quantum mechanics). Here, formally, purely mathematically, the "time wasting where is it!", In contrast to the spatial coordinates, was associated with atomicity, which I will look at later in the mental POINT.

So that we understand that, behind the formally used formulas with the imaginary value of Time, depending on Time, we do not see, and it took more careful consideration of the dynamics of the REAL POINT - Elementary (and not very) Harmonic Oscillator. It was necessary to understand what in reality the imaginary means and what it is orthogonal to. The fact that any thought, idea, including the one reflected in the title, is orthogonal to unreasonableness, I think it is not necessary to prove.

III. Imaginations" of the Dynamic Point - Harmonic Oscillator

The POINT of this article is rooted in real, but "anomalous" experimental results — detection of the spectral "anomalous" NON-MISSION(non-transmission) band at orthogonal modes. This, the wave leakage in "nowhere", into orthogonal (forbidden) oscillations, is actually devoted to a purely scientific article "Parametric interaction of normal modes in C & BN" that is being prepared for a physical journal. Here, before analyzing the complex solutions of the Mathieu formula, I again, as I used to do in life, looked into the original ELEMENTARY POINT.

The fact that the harmonic oscillator POINT (dynamic) in both our classical and our quantum representations and their mathematical descriptions can be seen from any alphabetical letters on physics. But Lenin's ideas about matter: "The electron is also inexhaustible as an atom" strictly correspond to mathematical ideas: between the two points of the numerical axis you can always place a new one (and you also need to supplement rational numbers with irrational ones). So, if once I was surprised by the mistake of the leading figure Ziman [14] in the Quantum Point (and not just me - the correcting quantum description of phonons and accepted for publication in Phys.Rev., My article was made IMPRESSIVE - they were forbidden to print. So I It was made REAL after many years, published in the book [15]), now I look at the discoveries at the POINT as "Refinement and Addition of Basic Physical Models", the publication of which in the form of the second book "delayed" the abundance of new points.

The non-attenuating harmonic oscillator is an idealized model:

$$y''[t]+\Omega^2 y[t]=0 \qquad (1)$$

It has a single resonant frequency Ω, which corresponds to the spectrum described by the delta function. Its single perturbation leads to INFINITE in time $t\to\infty$ harmonic oscillations $A\cdot\mathrm{Sin}[\Omega\cdot t]_{/A=const}$, and a long harmonic effect on the resonant frequency leads to INFINITE increase in the amplitude of oscillations $A[t]_{/t\to\infty}\to\infty$. Naturally, these INFINITY are violated, which means that it is impossible to use this idealized model in reality, including the impossibility to investigate it.

That is why the use of this idealized model in the fundamentals of quantum mechanics (as basic) is complemented by the Heisenberg uncertainty principle (the probabilistic nature of quantum mechanical solutions). In fact, this means that a separate electromagnetic quantum is a train of waves, having a certain finite length and a non-zero frequency band, and an increase in a narrow emission band, coupled with an increase in the length of the train, is coherent radiation. Similar conditions are imposed on both the electron wave and the minimum width of the allowed electron level.

The above idealized model in a veiled (IMPRESSIVE) way (already) concerns the IMPRESSION of Time - if zero attenuation is imagined as striving to zero small but finite attenuation, then we get quasi-chaotic walks of the oscillation phase in time. But in the analysis we will not rely on IMAGED images, but will only start from REALITY - from the FINAL magnitude of the attenuation of the Harmonic Oscillator γ and at the FINAL magnitude of the harmonic measurement effect on the Oscillator. At the same time, for clarity, without any loss of generality, the resonant frequency of the Oscillator and the amplitude of the measuring action are set equal to unity:

$$y''[t]+\gamma\cdot y'[t]+1\cdot y[t]=1\cdot\mathrm{Sin}(\omega\cdot t) \qquad (2)$$

Thus, the imaginary "imaginary" remained with us only in infinite Time, and all the resulting real "imaginary" solutions of equation (2), as well as the real parts of solutions, are directly related to the real, measured parameters of the Harmonic Oscillator with Damping.

With the traditional method of solving the differential equation (2), the use of which we confine in this analysis, the mathematical imagination (complexity) is introduced not in Time, but in the form allowing to single out the time independent factor of the solution by substitution:

$$y[\omega,t] = A_y e^{i(\omega t+\phi[\omega])} \quad (3)$$

Substitution (3) allows reducing differential equation (2) to an algebraic equation and obtaining its complex solution (private, but in principle, qualitatively reflecting the main features):

$$y[\omega,t] = \frac{1}{1+i\gamma\omega-\omega^2}\,\mathrm{Sin}[\omega t] \quad (4)$$

Actual *Re* and imaginary *Im* parts (terms) of this solution (given - specific, resonant frequency and amplitude of harmonic influence are equal 1) at different levels of attenuation are shown in Fig.1 and Fig.2.

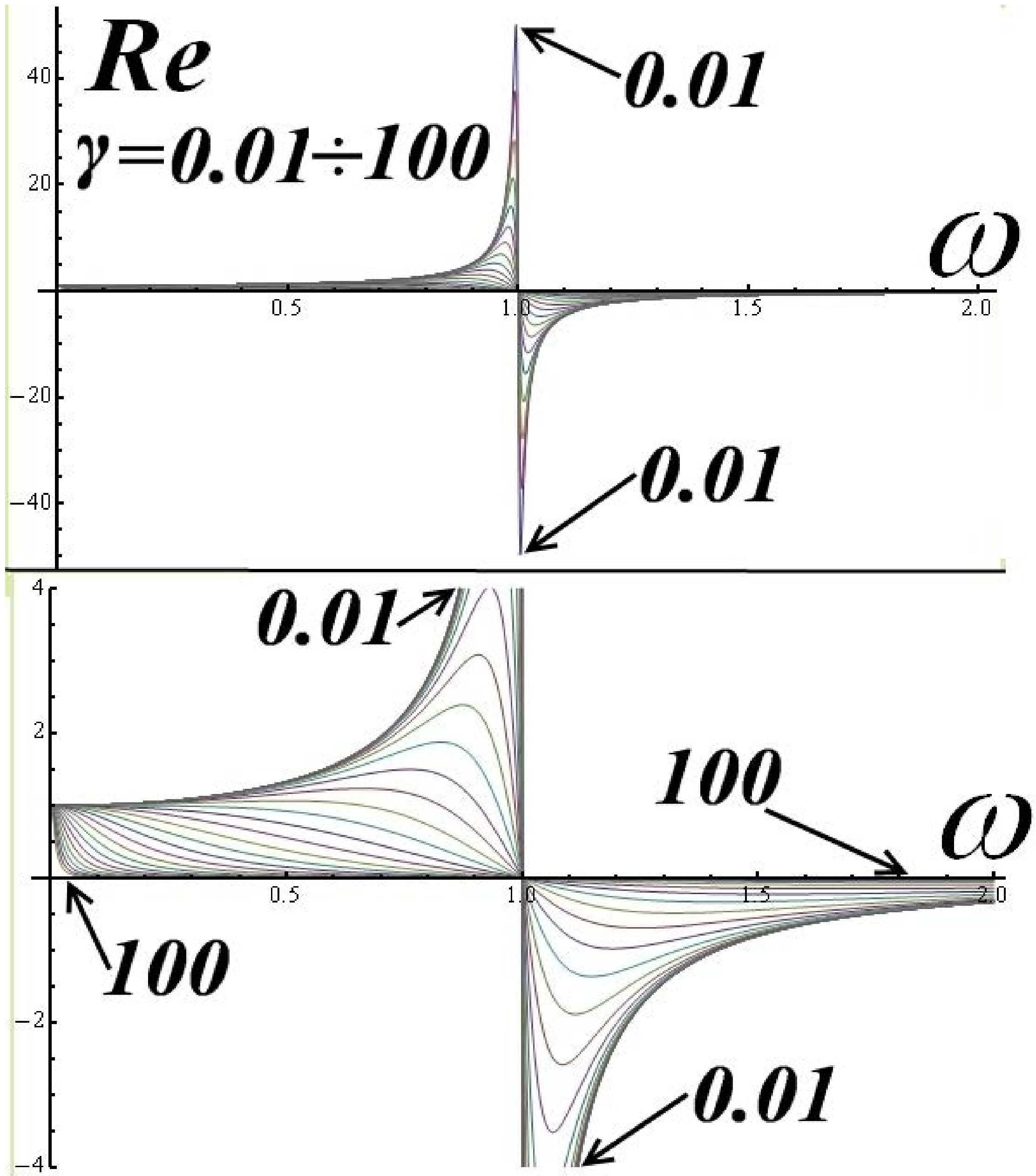

Fig. 1: Reducing the height and frequency of the positive maximum and its tendency to unity for a constant value of the specific displacement with increasing attenuation

The dependence shown in Fig. 1 is a real "reality", since agrees well with the real part of the impedance of any resonant oscillations and is manifested in the reflection spectra. Including optical, it is consistent with the real part of the dielectric constant both for dielectrics and for metals, if we consider that the plasma resonant frequency is zero, then the frequency dependence of the dielectric constant and its reduction to minus infinity at zero frequencies is completely are consistent with the right, negative wing of the dependence shown in Fig. 1.

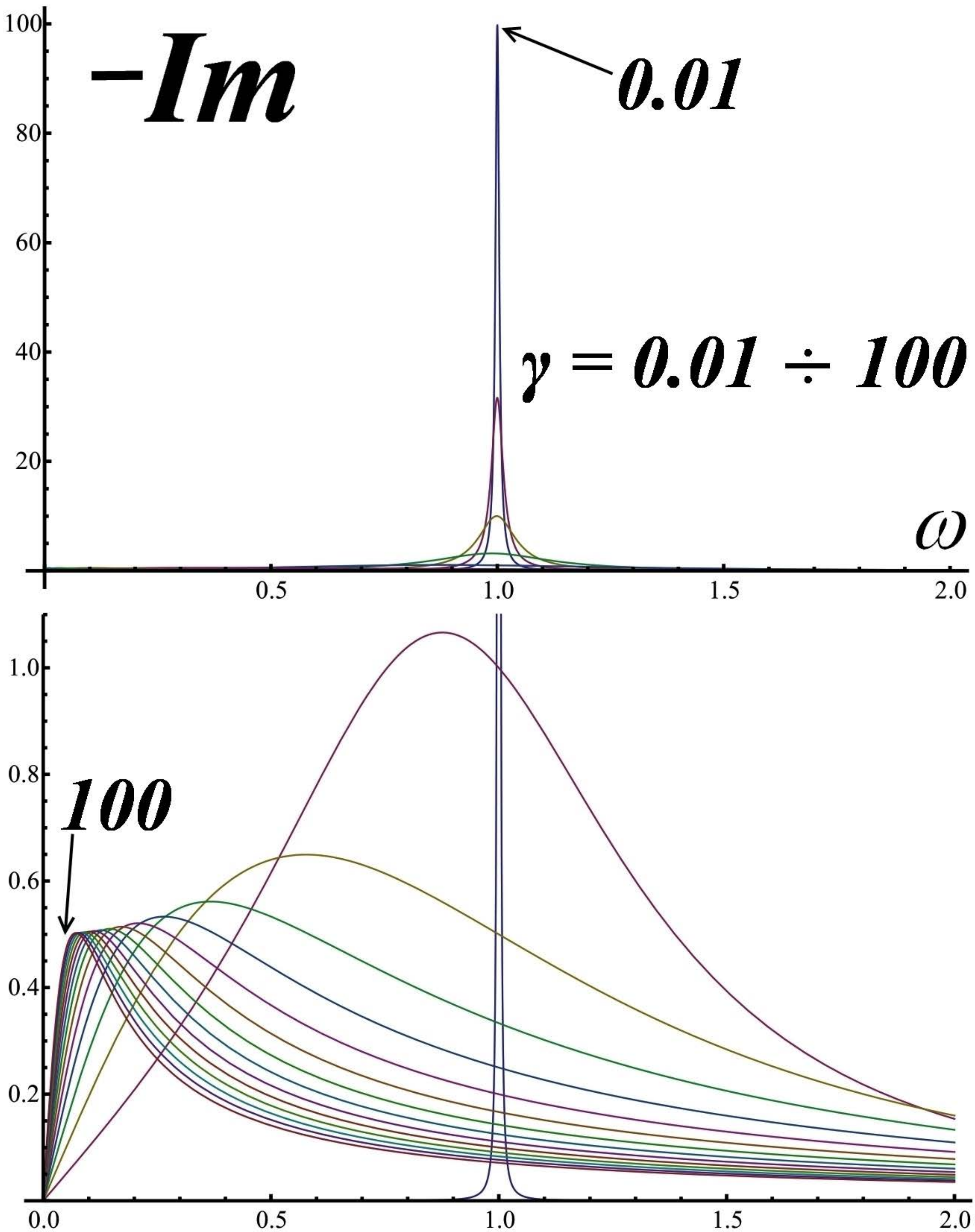

Fig. 2: Decreases the amplitude and frequency of the maximum negative impedance with increasing attenuation

The dependence shown in Fig. 2 is real "imaginary", since its exponent directly corresponds to the spectrum of attenuation of the amplitude of the driving oscillations (absorption spectrum - Fig. 3).

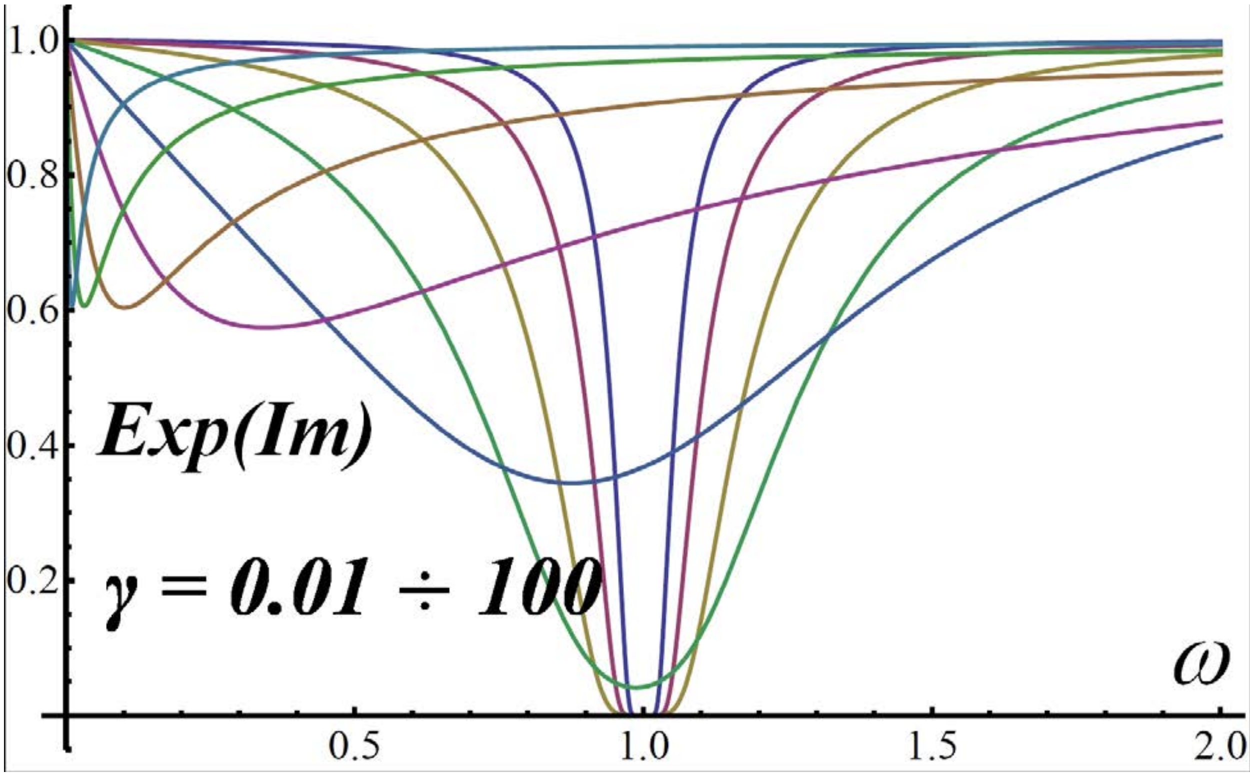

Fig. 3: Attenuation by the Harmonic Oscillator of the amplitude of the forcing oscillations at its different attenuation

The given harmonic formula (4) and the graphs of the spectral dependences of the components of its solution presented in Figures 1 ÷ 3 well describe the real oscillations of both macroscopic and microscopic objects, and even atoms-ions, from mechanical-acoustic-electric oscillations, then plasma-lattice- spin. Such a high INVARIANCE of this abstract model makes it an ELEMENT of dynamics, which, in each of the above cases, is only "weighed down" by the corresponding coefficients relating to the measured values of characteristic parameters and forces. But I will not be distracted by the specific rewriting of the real and imaginary parts of the solution for the harmonic oscillator in, for example, the real and imaginary parts of the dielectric constant (although there is something to be corrected in their standard records). I will return again to the analysis of this invariant "dynamic point" itself.

Imagination of the real part of the amplitude of oscillations near the resonant frequency (Fig. 1) is apparent, since the absolute value of the amplitude *Abs* does not change during the passage of resonance (Fig. 4), and the phase *Arg/π-* from in-phase at low frequencies to antiphase at frequencies higher than the resonance(fig.5).

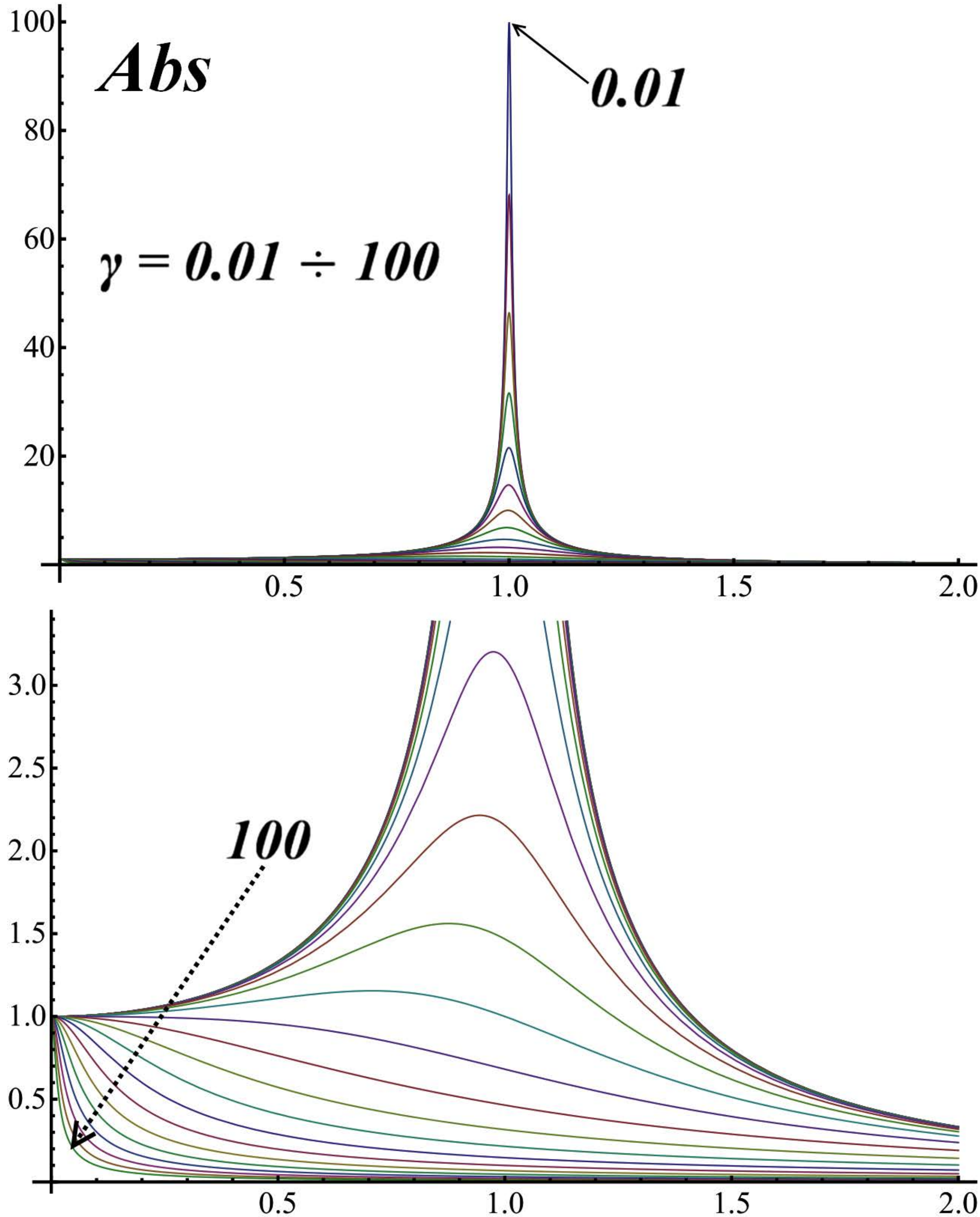

Fig. 4: The dependence on the oscillation frequency of a single force that forces the absolute magnitude of the amplitude of the oscillations of the Harmonic Oscillator at different attenuations

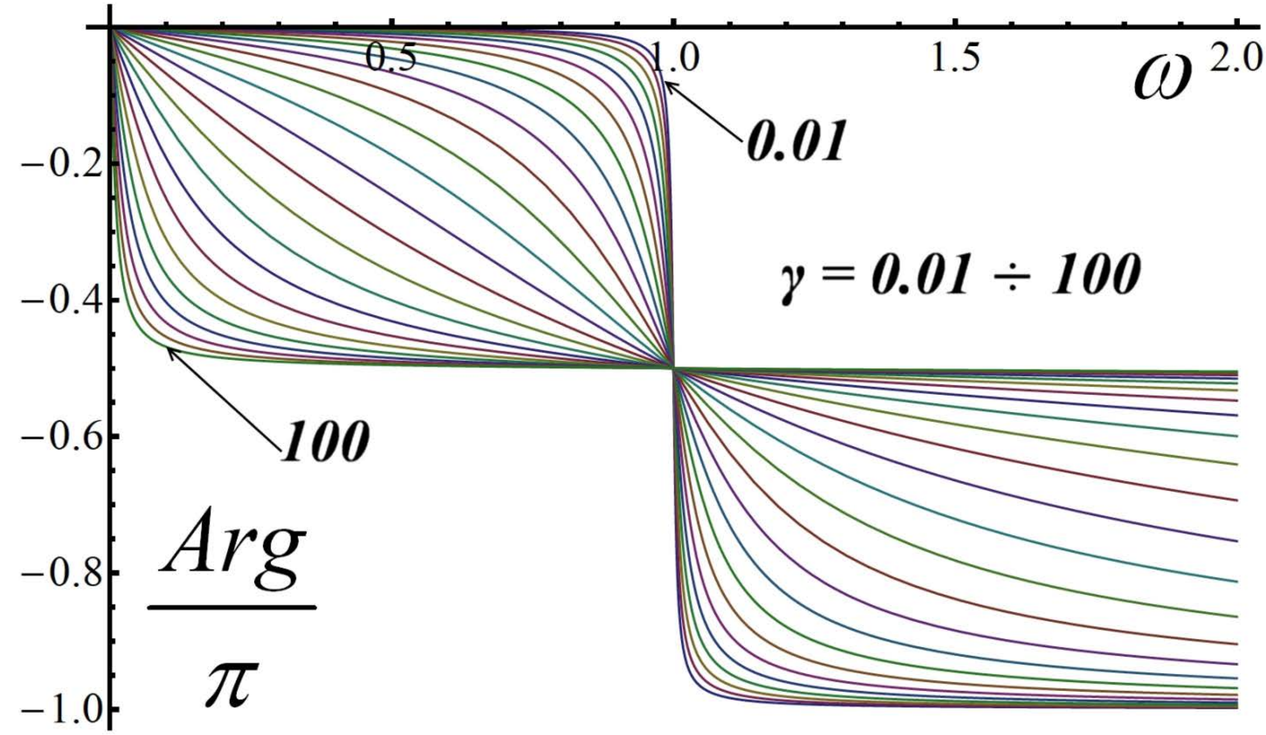

Fig. 5: Dependence on the oscillation frequency of the forcing unit shear force in the phase of the forced oscillations of the Harmonic oscillator at different dampings

Naturally, from decomposition of a complex number into terms or factors, it does not change at all, which reflects the Kramers-Kronig relation for optical constants, and the justification by referring to the causality principle can be read and vice versa - the causal relationship is that they are different same.

IV. Conclusion

And so, as the analysis showed, the real Imagination is not Time, but the time dependence of some properties of the Elementary Harmonic Oscillator. This real Imagination means nothing more than the "leakage" in time of the excitation energy and is described by the introduction of an imaginary unit into the equations. Those the real Imagination is the very dissipation of energy that Ilya Prigogine considered.

Moreover, the analysis of a slightly non-elementary harmonic oscillator shows that, strictly speaking, one imaginary unit for describing its motion is indispensable - instead of complex numbers one should use quaternions, since there may be several weakly coupled or strictly independent "channels of leakage" of the excitation energy (like the disproportion of purely geometric in crystals [15]).

And the real Imagination of Time itself, the real difference between normal (in the sense of independent) coordinate Time from geometric coordinates in the originality of the values of this polar coordinate - invariance in time is real, according to the causality principle, the repeatability of certain real processes in the future and unreal, mental, imaginary repeatability in the past processes occurring now. And about the future, and about the past, we can only speak in terms of probability.

So the real Imagination of Time is that it is in itself unobservable neither in the past nor in the future. If we imagine that the light picture from our Earth has flown around the floor of the universe and returned to us, then we will see WHAT happened with us a long time ago, but not THAT Time itself. But the formal equating of Time to one of the additional geometric coordinates, the Imaginary of Time itself is thrown out of consideration, which leads to scientific errors [16], unraveling which you see that "common anomalies" are from primitive, non-elementary analysis of the Laws of Nature [17, 18].

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On Refinement of Certain Laws of Classical Electrodynamic

By F. F Mende

Abstract- The problems considered refer to the material equations of electric- and magnetoelectric induction. Some contradictions found in fundamental studies on classical electrodynamics have been explained. The notion "magnetoelectric induction" has been introduced, which permits symmetrical writing of the induction laws. It is shown that the results of the special theory of relativity can be obtained from these laws through the Galilean transformations. The permittivity and permeability of materials media are shown to be independent of frequency. The notions "magnetoelectrokinetic and electromagneto potential waves" and "kinetic capacity" have been introduced. It is shown that along with the longitudinal Langmuir resonance, the transverse resonance is possible in nonmagnetized plasma, and both the resonances are degenerate. A new notion "scalar-vector potential" is introduced, which permits solution of all present-day problems of classical electrodynamics. The use of the scalar-vector potential makes the magnetic field notion unnecessary.

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Abstract- The problems considered refer to the material equations of electric- and magnetoelectric induction. Some contradictions found in fundamental studies on classical electrodynamics have been explained. The notion "magnetoelectric induction" has been introduced, which permits symmetrical writing of the induction laws. It is shown that the results of the special theory of relativity can be obtained from these laws through the Galilean transformations. The permittivity and permeability of materials media are shown to be independent of frequency. The notions "magnetoelectrokinetic and electromagneto potential waves" and "kinetic capacity" have been introduced. It is shown that along with the longitudinal Langmuir resonance, the transverse resonance is possible in nonmagnetized plasma, and both the resonances are degenerate. A new notion "scalar-vector potential" is introduced, which permits solution of all present-day problems of classical electrodynamics. The use of the scalar-vector potential makes the magnetic field notion unnecessary.

I. Introduction

Until now, some problems of classical electrodynamics involving the laws of electromagnetic induction have been interpreted in a dual or even contraversal way.

As an example, let us consider how the homopolar operation is explained in different works. In [1] this is done using the Faraday low specified for the "discontinuous motion" case. In [2] the rule of flow is rejected and the operation of the homopolar generator is explained on the basis of the Lorentz force acting upon charges.

The contradictory approaches are most evident in Feynman's work [2] (see page 53): the rule of flow states that the contour e.m.f. is equal to the opposite-sign rate of change in the magnetic flux through the contour when the flux varies either with the changing field or due to the motion of the contour (or to both). Two options – "the contour moves" or "the field changes" are indistinguishable within the rule. Nevertheless, we use these two completely different laws to explain the rule for the two cases: $\left[\vec{V}\times\vec{B}\right]$ for the "moving contour" and $\nabla\times\vec{E}=-\frac{\partial\vec{B}}{\partial t}$ for the "changing field". And further on: There is hardly another case in physics when a simple and accurate general law has to be interpreted in terms of two different phenomena. Normally, such beautiful generalization should be based on a unified fundamental principle. Such principle is absent in our case. The interpretation of the Faraday law in [2] is also commonly accepted: Faraday's observation led to the discovery of a new law relating electric and magnetic fields: the electric field is generated in the region where the magnetic field varies with time. There is however an exception to this rule too, though the above studies do not mention it. However, as soon as the current through such a solenoid is changed, an electric field is excited externally. The exception seem to be too numerous. The situation really causes concern when such noted physicists as Tamm and Feynman have no common approach to this seemingly simple question.

It is knowing [3] that classical electrodynamics fails to explain the phenomenon of phase aberration. As applied to propagation of light, the phenomenon can be explained only in terms of the special theory of relativity (STR). However, the Maxwell equations are invariant with respect to the covariant STR transformations, and there is therefore every reason to hope that they can furnish the required explanation of the phenomenon.

It is well known that electric and magnetic inductivities of material media can depend on frequency, i.e. they can exhibit dispersion. But even Maxwell himself, who was the author of the basic

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equations of electrodynamics, believed that ε and μ were frequency-independent fundamental constants.

How the idea of ε and μ-dispersion appeared and evolved is illustrated vividly in the monograph of well-known specialists in physics of plasma [4]: while working at the equations of electrodynamics of material, media, G. Maxwell looked upon electric and magnetic inductivities as constants (that is why this approach was so lasting). Much later, at the beginning of the XX century, G. Heavisidr and R.Wull put forward their explanation for phenomena of optical dispersion (in particular rainbow) in which electric and magnetic inductivities came as functions of frequency. Quite recently, in the mid-50ies of the last century, physicists arrived at the conclusion that these parameters were dependent not only on the frequency but on the wave vector as well. That was a revolutionary breakaway from the current concepts. The importance of the problem is clearly illustrated by what happened at a seminar held by L. D. Landau in 1954, where he interrupted A. L. Akhiezer reporting on the subject: “Nonsense, the refractive index cannot be a function of the refractive index”. Note, this was said by L. D. Landau, an outstanding physicist of our time.

What is the actual situation? Running ahead, I can admit that Maxwell was right: both ε and μ are frequency – independent constants characterizing one or another material medium. Since dispersion of electric and magnetic inductivities of material media is one of the basic problems of the present – day physics and electrodynamics, the system of views on these questions has to be radically altered again (for the second time!).

In this context the challenge of this study was to provide a comprehensive answer to the above questions and thus to arrive at a unified and unambiguous standpoint. This will certainly require a revision of the relevant interpretations in many fundamental works.

II. Equations of Electromagnetic Induction in Moving Coordinates

The Maxwell equations do not permit us to write down the fields in moving coordinates proceeding from the known fields measured in the stationary coordinates. Generally, this can be done through the Lorentz transformations but they so not follow from classical electrodynamics. In a homopolar generator, the electric fields are measured in the stationary coordinates but they are actually excited in the elements which move relative to the stationary coordinate system. Therefore, the principle of the homopolar generator operation can be described correctly only in the framework of the special theory of relativity (STR). This brings up the question: Can classical electrodynamics furnish correct results for the fields in a moving coordinate system, or at least offer an acceptable approximation? If so, what form will the equations of electromagnetic induction have?

The Lorentz force is

$$\vec{F}' = e\,\vec{E} + e\left[\vec{V} \times \vec{B}\right]. \qquad (1.1)$$

It bears the name of Lorentz it follows from his transformations which permit writing the fields in the moving coordinates if the fields in the stationary coordinates are known. Henceforward, the fields and forces generated in a moving coordinate system will be indicated with primed symbols.

The clues of how to write the fields in moving coordinates if they are known in the stationary system are available even in the Faraday law. Let us specify the form of the Faraday law:

$$\oint \vec{E}' d\,\vec{l}' = -\frac{d\,\Phi_B}{d\,t}. \qquad (1.2)$$

The specified law, or, more precisely, its specified form, means that $\vec{E}$ and $d\vec{l}$ should be primed if the contour integral is sought for in moving coordinates and unprimed for stationary coordinates. In the latter case the right-hand side of Eq. (1.2) should contain a partial derivative with respect to time which fact is generally not mentioned in literature.

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The total derivative with respect to time in Eq. (1.2) implies that the final result for the contour e.m.f. is independent of the variation mode of the flux. In other words, the flux can change either purely with time variations of $\vec{B}$ or because the system, in which $\oint \vec{E}' d\vec{l}'$ is measured, is moving in the spatially varying field $\vec{B}$. In Eq. (1.2)

$$\Phi_B = \int \vec{B}\, d\,\vec{S}', \tag{1.3}$$

where the magnetic induction $\vec{B} = \mu \vec{H}$ is measured in the stationary coordinates and the element $d\,\vec{S}'$ in the moving coordinates.

Taking into account Eq. (1.3), we can find from Eq. (1.2)

$$\oint \vec{E}' d\,\vec{l}' = -\frac{d}{d\,t}\int \vec{B}\, d\,\vec{S}'. \tag{1.4}$$

Since $\frac{d}{d\,t} = \frac{\partial}{\partial\,t} + \vec{V}\,grad$, we can write

$$\oint \vec{E}' d\,\vec{l}' = -\int \frac{\partial\,\vec{B}}{\partial\,t}\, d\,\vec{S} - \int \left[\vec{B}\times\vec{V}\right] d\,\vec{l}' - \int \vec{V}\,div\,\vec{B}\, d\,\vec{S}'. \tag{1.5}$$

In this case contour integral is taken over the contour $d\,\vec{l}'$, covering the space $d\,\vec{S}'$. Henceforward, we assume the validity of the Galilean transformations, i.e. $d\,\vec{l}' = d\,\vec{l}$ and $d\,\vec{S}' = d\,\vec{S}$. Eq. (1.5) furnishes the well-known result:

$$\vec{E}' = \vec{E} + \left[\vec{V}\times\vec{B}\right], \tag{1.6}$$

which suggests that the motion in the magnetic field excites an additional electric field described by the final term in Eq. (1.6). Note that Eq. (1.6) is obtained from the slightly specified Faraday law and not from the Lorentz transformations.

According to Eq. (1.6), a charge moving in the magnetic field is influenced by a force perpendicular to the direction of the motion. However, the physical nature of this force has never been considered. This brings confusion into the explanation of the homopolar generator operation and does not permit us to explain the electric fields outside an infinitely long solenoid on the basis of the Maxwell equations.

To clear up the physical origin of the final term in Eq. (1.6), let us write $\vec{B}$ and $\vec{E}$ in terms of the magnetic vector potential $\vec{A}_B$:

$$\vec{B} = rot\,\vec{A}_B, \qquad \vec{E} = -\frac{\partial\,\vec{A}_B}{\partial\,t}. \tag{1.7}$$

Then, Eq. (1.6) can be re-written as

$$\vec{E}' = -\frac{\partial\,\vec{A}_B}{\partial\,t} + \left[\vec{V}\times rot\,\vec{A}_B\right], \tag{1.8}$$

and further:

$$\vec{E}' = -\frac{\partial \vec{A}_B}{\partial t} - (\vec{V}\,\nabla)\vec{A}_B + grad\,(\vec{V}\,\vec{A}_B). \tag{1.9}$$

The first two terms in the right-hand side of Eq. (1.9) can be considered as the total derivative of the vector potential with respect to time:

$$\vec{E}' = -\frac{d\,\vec{A}_B}{d\,t} + grad\,(\vec{V}\,\vec{A}_B). \tag{1.10}$$

As seen in Eq. (1.9), the field strength, and hence the force acting upon a charge consists of three components.

The first component describes the pure time variations of the magnetic vector potential. The second term in the right-hand side of Eq. (1.9) is evidently connected with the changes in the vector potential caused by the motion of a charge in the spatially varying field of this potential. The origin of the last term in the right-hand side of Eq. (1.9) is quite different. It is connected with the potential forces because the potential energy of a charge moving in the potential field $\vec{A}_B$ at the velocity $\vec{V}$ is equal to $e\,(\vec{V}\,\vec{A}_B)$. The magnitude $e\;grad\,(\vec{V}\,\vec{A}_B)$ describes the force just as the scalar potential gradient does.

Using Eq. (1.9), we can explain physically all the strength components of the electronic field excited in the moving and stationary cooperates. If our concern is with the electric fields outside a long solenoid, where the no magnetic field, the first term in the right-hand side of Eq. (1.9) come into play. In the case of a homopolar generator, the force acting upon a charge is determined by the last two terms in the right-hand side of Eq.(1.9), both of them contributing equally.

It is therefore incorrect to look upon the homopolar generator as the exception to the flow rule because, as we saw above, this rule allows for all the three components. Using the rotor in both sides of Eq. (1.10) and taking into account $rot\;grad \equiv 0$, we obtain

$$rot\,\vec{E}' = -\frac{d\,\vec{B}}{d\,t}. \tag{1.11}$$

If motion is absent, Eq. (1.11) turns into Maxwell equation (1.2). Equation (1.11) is certainly less informative than Eq. (1.2): because of $rot\;grad \equiv 0$, it does not include the forces defined in terms of $e\;grad\,(\vec{V}\,\vec{A}_B)$. It is therefore more reasonable to use Eq. (1.2) if we want to allow for all components of the electric fields acting upon a charge both in the stationary and in the moving coordinates.

As a preliminary conclusion, we may state that the Faraday Law, Eq. (1.2), when examined closely, explains clearly all features of the homopolar generator operation, and this operation principle is a consequence, rather than an exception, of the flow rule, Eq. (1.2). Feynman's statement that $[\vec{V} \times \vec{B}]$ for the "moving contour" and $\nabla\times\vec{E} = -\frac{\partial \vec{B}}{\partial t}$ for the "varying field" are absolutely different laws is contrary to fact. The Faraday law is just the sole unified fundamental principle which Feynman declared to be missing. Let us clear up another Feynman's interpretation. Faraday's observation in fact led him to discovery of a new law relating electric and magnetic fields in the region where the magnetic field varies with time and thus generates the electric field. This correlation is essentially true but not complete. As shown above, the electric field can also be excited where there is no magnetic field, namely, outside an infinitely long solenoid. A more complete formulation follows from Eq.

(1.9) and the relationship $\vec{E} = -\dfrac{d\ \vec{A}_B}{d\ t}$ is more general than $rot\ \vec{E} = -\dfrac{\partial\ \vec{B}}{\partial\ t}$.

This suggests that a moving or stationary charge interacts with the field of the magnetic vector potential rather than with the magnetic field. The knowledge of this potential and its evolution can only permit us to calculate all the force components acting upon charges. The magnetic field is merely a spatial derivative of the vector field.

As follows from the above consideration, it is more appropriate to write the Lotentz force in terms of the magnetic vector potential

$$\vec{F}' = e\ \vec{E} + e\ [\vec{V} \times rot\ \vec{A}_B] = e\ \vec{E} - (\vec{V}\nabla)\vec{A}_B + grad(\vec{V}\ \vec{A}_B), \tag{1.12}$$

which visualizes the complete structure of the force.

The Faraday law, Eq. (1.2) is referred to as the law of electromagnetic induction because it shows how varying magnetic fields can generate electric fields. However, classical electrodynamics contains no law of magnetoelectric induction showing how magnetic fields can be excited by varying electric fields. This aspect of classical electrodynamics evolved along a different pathway. First, the law

$$\oint \vec{H}\ d\ \vec{l} = I, \tag{1.13}$$

was known, in which I was the current crossing the area of the integration contour. In the differential from Eq. (1.13) becomes

$$rot\ \vec{H} = \vec{j}_\sigma, \tag{1.14}$$

where $\vec{j}_\sigma$ is the conduction current density.

Maxwell supplemented Eq. (1.14) with displacement current

$$rot\ \vec{H} = \vec{j}_\sigma + \frac{\partial\ \vec{D}}{\partial\ t}. \tag{1.15}$$

However, if Faraday had performed measurement in varying electric induction fluxes, he would have inferred the following law

$$\oint \vec{H}' d\ \vec{l}\,' = \frac{d\ \Phi_D}{d\ t}, \tag{1.16}$$

where $\Phi_D = \int \vec{D}\, d\ S'$ is the electric induction flux. Then

$$\oint \vec{H}' d\ \vec{l}\,' = \int \frac{\partial\ \vec{D}}{\partial\ t} d\ \vec{S} + \oint [\vec{D} \times \vec{V}] d\ \vec{l}\,' + \int \vec{V}\ div\ \vec{D}\ d\ \vec{S}'. \tag{1.17}$$

Unlike $div\ \vec{B} = 0$ in magnetic fields, electric fields are characterized by $div\ \vec{D} = \rho$ and the last term in the right-hand side of Eq. (1.17) describes the conduction current *I*, i.e. the Ampere law follows from Eq. (1.16). Eq. (1.17) gives

$$\vec{H} = [\vec{D} \times \vec{V}], \tag{1.18}$$

which was earlier obtainable only from the Lorentz transformation.

Moreover, as was shown convincingly in [2], Eq. (1.18) also leads out of the Biot-Savart law if magnetic fields are calculated from the electric fields excited by moving charges. In this case the last term in the right-hand side of Eq. (1.17) can be omitted and the induction laws become completely symmetrical.

$$\oint \vec{E}' d\vec{l}' = -\int \frac{\partial \vec{B}}{\partial t} dS - \oint [\vec{B} \times \vec{V}] d\vec{l}' \quad ,$$

$$\oint \vec{H}' d\vec{l}' = \int \frac{\partial \vec{D}}{\partial t} dS + \oint [\vec{D} \times \vec{V}] d\vec{l}' \quad . \tag{1.19}$$

$$E' = \vec{E} + [\vec{V} \times \vec{B}] \quad ,$$

$$H' = \vec{H} - [\vec{V} \times \vec{D}] \quad . \tag{1.20}$$

Earlier, Eqs. (1.20) were only obtainable from the covariant Lorentz transformations, i.e. in the framework of special theory of relativity (STR). Thus, the STR results accy rate to the $\sim \frac{V}{c}$ terms can be derived from the induction laws through the Galilean transformations. The STR results accurate to the $\frac{V^2}{c^2}$ terms can be obtained through transformation of Eq (1.19). At first, however, we shall introduce another vector potential which is not used in classical electrodynamics. Let us assume for vortex fields [5] that

where $\vec{A}_D$ is the electric vector potential. It then follows from Eq. (1.19) that

$$\vec{D} = rot\ \vec{A}_D \ , \tag{1 21}$$

$$\vec{H}' = \frac{\partial \vec{A}_D}{\partial t} + [\vec{V}\nabla]\vec{A}_D - grad\,[\vec{V}\vec{A}_D] \ , \tag{1.22}$$

or

$$\vec{H}' = \frac{\partial \vec{A}_D}{\partial t} - [\vec{V} \times rot\ \vec{A}_D] \ , \tag{1.23}$$

or

$$\vec{H}' = \frac{d\vec{A}_D}{dt} - grad\,[\vec{V}\vec{A}_D] \ . \tag{1.24}$$

These equations present the law of magnetoelectric induction written in terms of the electric vector potential.

To illustrate the importance of the introduction of the electric vector potential, we come back to an infinitely long solenoid. The situation is much the same, and the only change is that the vectors $\vec{B}$ are replaced with the vectors $\vec{D}$. Such situation is quite realistic: it occurs when the space between the flat capacitor plates is filled with high electric inductivities. In this case the displacement flux is almost entirely inside the dielectric. The attempt to calculate the magnetic field outside the space occupied by the dielectric (where $\vec{D} \cong 0$) runs into the same problem that existed for the calculation beyond the fields $\vec{E}$ of an infinitely long solenoid. The introduction of the electric vector potential permits a correct solution of this problem. This however brings up the question of priority: what is primary and what is secondary? The electric vector potential is no doubt primary because electric vortex fields are excited only where the rotor of such potential is non-zero.

As follows from Eqs. (1.20), if the reference systems move relative to each other, the fields $\vec{E}$ and $\vec{H}$ are mutually connected, i.e. the movement in the fields $\vec{H}$ induces the fields $\vec{E}$ and vice versa. But new consequences appear, which were not considered in classical electrodynamics. For illustration, let us analyze two parallel conducting plates with the electric field $\vec{E}$ in between. In this case the surface charge ρ_S per unit area of each plate is εE. If the other reference system is made to move parallel to the plates in the field E at the velocity ΔV, this motion will generate an additional field $\Delta H = \Delta V \varepsilon E$. If a third reference system starts to move at the velocity ΔV, within the above moving system, this motion in the field ΔH will generate $\Delta E = \mu\varepsilon\Delta V^2 E$, which is another contribution to the field E. The field E' thus becomes stronger in the moving system than it is in the stationary one. It is reasonable to suppose that the surface charge at the plates of the initial system has increased by $\mu\varepsilon^2\Delta V^2 E$ as well.

This technique of field calculation was described in [6]. If we put $\vec{E}_{||}$ and $\vec{H}_{||}$ for the field components parallel to the velocity direction and $\vec{E}_{\perp}$ and $\vec{H}_{\perp}$ for the perpendicular components, the final fields at the velocity V can be written as

$$\vec{E}'_{||} = \vec{E}_{||},$$

$$\vec{E}'_{\perp} = \vec{E}_{\perp}\mathrm{ch}\frac{V}{c} + \frac{Z_0}{V}[\vec{V}\times\vec{H}_{\perp}]\mathrm{sh}\frac{V}{c},$$

$$\vec{H}'_{||} = \vec{H}_{||}, \tag{1.25}$$

$$\vec{H}'_{\perp} = \vec{H}_{\perp}\mathrm{ch}\frac{V}{c} - \frac{1}{Z_0 V}[\vec{V}\times\vec{E}_{\perp}]\mathrm{sh}\frac{V}{c},$$

where $Z_0 = \sqrt{\frac{\mu}{\varepsilon}}$ is the space impedance, $c = \sqrt{\frac{1}{\mu\varepsilon}}$ is the velocity of light in the medium under consideration.

The results of these transformations coincide with the STR data with the accuracy to the $\sim\frac{V^2}{c^2}$ terms. The higher-order corrections do not coincide. It should be noted that until now experimental tests of the special theory of relativity have not gone beyond the $\sim\frac{V^2}{c^2}$ accuracy.

As an example, let us analyze how Eqs. (1.25) can account for the phenomenon of phase aberration which was inexplicable in classical electrodynamics.

Assume that there are plane wave components H_Z and E_X, and the primed system is moving along the x-axis at the velocity V_X. The field components with in the primed coordinates can be written as

$$E_X{}' = E_X,$$
$$E_Y{}' = H_Z sh\frac{Vx}{c},$$
$$H_Z{}' = H_Z ch\frac{V_X}{c}. \tag{1.27}$$

The total field E in the moving system is

$$E' = \left[\left(E_X{}'\right)^2 + \left(E_Y{}'\right)^2\right]^{1/2} = E_X\, ch\,\frac{V_X}{c}\;. \tag{1.28}$$

Hence, the Poynting vector no longer follows the direction of the *y*-axis. It is in the *xy*-plane and tilted about the *y*-axis at an angle determined by Eqs. (1.27). The ratio between the absolute values of the vectors *E* and *H* is the same in both the systems. This is just what is known as phase aberration in classical electrodynamics.

III. Is There Any Dispersion of Electric and Magnetic Inductivities in Material Media?

It is noted in the introduction that dispersion of electric and magnetic inductivities of material media is a commonly accepted idea. The idea is however not correct.

To explain this statement and to gain a better understanding of the physical essence of the problem, we start with a simple example showing how electric lumped-parameter circuits can be described. As we can see below, this example is directly concerned with the problem of our interest and will give us a better insight into the physical picture of the electrodynamic processes in material media.

In a parallel resonance circuit including a capacitor *C* and an inductance coil *L*, the applied voltage *U* and the total current I_Σ through the circuit are related as

$$I_\Sigma = I_C + I_L = C\frac{dU}{dt} + \frac{1}{L}\int U\,dt\;, \tag{2.1}$$

where $I_C = C\dfrac{dU}{dt}$ is the current through the capacitor, $I_L = \dfrac{1}{L}\int U\,dt$ is the current through the inductance coil. For the harmonic voltage $U = U_0 \sin \omega t$

$$I_\Sigma = \left(\omega\,C - \frac{1}{\omega\,L}\right)U_0 \cos\,\omega\,t\;. \tag{2.2}$$

The term in brackets is the total susceptance σ_x of the circuit, which consists of the capacitive σ_c and inductive σ_L components

$$\sigma_x = \sigma_c + \sigma_L = \omega\,C - \frac{1}{\omega\,L}\;. \tag{2.3}$$

Eq. (2.2) can be re-written as

$$I_\Sigma = \omega\,C\left(1 - \frac{\omega_0^2}{\omega^2}\right)U_0 \cos\,\omega\,t\,, \tag{2.4}$$

where $\omega_0^2 = \dfrac{1}{LC}$ is the resonance frequency of a parallel circuit.

From the mathematical (i.e. other than physical) standpoint, we may assume a circuit that has only a capacitor and no inductance coil. Its frequency – dependent capacitance is

$$C^*(\omega) = C\left(1 - \frac{\omega_0^2}{\omega}\right) . \tag{2.5}$$

Another approach is possible, which is correct too.

Eq. (2.2) can be re-written as

$$I_\Sigma = -\frac{\left(\dfrac{\omega^2}{\omega_0^2} - 1\right)}{\omega\, L} U_0 \cos\, \omega\, t . \tag{2.6}$$

In this case the circuit is assumed to include only an inductance coil and no capacitor. Its frequency – dependent inductance is

$$L^*(\omega) = \frac{L}{\left(\dfrac{\omega^2}{\omega_0^2} - 1\right)} . \tag{2.7}$$

Using the notion of Eqs. (2.5) and (2.7), we can write

$$I_\Sigma = \omega\, C^*(\omega) U_0 \cos\, \omega\, t , \tag{2.8}$$

or

$$I_\Sigma = -\frac{1}{\omega\, L^*(\omega)} U_0 \cos\, \omega\, t . \tag{2.9}$$

Eqs (2.8) and (2.9) are equivalent and each of them provides a complete mathematical description of the circuit. From the physical point of view, $C^*(\omega)$ and $L^*(\omega)$ do not represent capacitance and inductance though they have the corresponding dimensions. Their physical sense is as follows:

$$C^*(\omega) = \frac{\sigma_X}{\omega} , \tag{2.10}$$

i.e. $C^*(\omega)$ is the total susceptance of this circuit divided by frequency:

$$L^*(\omega) = \frac{1}{\omega\, \sigma_X} , \tag{2.11}$$

and $L^*(\omega)$ is the inverse value of the product of the total susceptance and the frequency.

Amount $C^*(\omega)$ is constricted mathematically so that it includes C and L simultaneously. The same is true for $L^*(\omega)$.

We shall not consider here any other cases, e.g., series or more complex circuits. It is however important to note that applying the above method, any circuit consisting of the reactive components C and L can be described either through frequency – dependent inductance or frequency – dependent capacitance.

But this is only a mathematical description of real circuits with constant – value reactive elements. It is well known that the energy stored in the capacitor and inductance coil can be found as

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$$W_C = \frac{1}{2} C\,U^2 \quad , \tag{2.12}$$

$$W_L = \frac{1}{2} L\,I^2 \quad . \tag{2.13}$$

But what can be done if we have $C^*(\omega)$ and $L^*(\omega)$? There is no way of substituting them into Eqs. (2.12) and (2.13) because they can be both positive and negative. It can be shown readily that the energy stored in the circuit analyzed is

$$W_\Sigma = \frac{1}{2} \times \frac{d\,\sigma_X}{d\,\omega} U^2 \quad , \tag{2.14}$$

or

$$W_\Sigma = \frac{1}{2} \times \frac{d\lfloor \omega\, C^*(\omega) \rfloor}{d\,\omega} U^2 \quad , \tag{2.15}$$

or

$$W_\Sigma = \frac{1}{2} \times \frac{d\left(\frac{1}{\omega\, L^*(\omega)} \right)}{d\,\omega} U^2 \quad . \tag{2.16}$$

Having written Eqs. (2.14), (2.15) or (2.16) in greater detail, we arrive at the same result:

$$W_\Sigma = \frac{1}{2} C\,U^2 + \frac{1}{2} L\,I^2 , \tag{2.17}$$

where U is the voltage at the capacitor and I is the current through the inductance coil. Below we consider the physical meaning jog the magnitudes $\varepsilon(\omega)$ and $\mu(\omega)$ for material media.

a) Plasma Media

A superconductor is a perfect plasma medium in which charge carriers (electrons) can move without friction. In this case the equation of motion is

$$m \frac{d\,\vec{V}}{d\,t} = e\,\vec{E} \quad , \tag{2.18}$$

where m and e are the electron mass and charge, respectively; $\vec{E}$ is the electric field strength, $\vec{V}$ is the velocity. Taking into account the current density

$$\vec{j} = n\,e\,\vec{V}, \tag{2.19}$$

we can obtain from Eq. (2.18)

$$\vec{j}_L = \frac{n\,e^2}{m} \int \vec{E}\,d\,t \quad . \tag{2.20}$$

In Eqs. (2.19) and (2.20) n is the specific charge density. Introducing the notion

$$L_k = \frac{m}{n\,e^2} \quad , \tag{2.21}$$

we can write

$$\vec{j}_L = \frac{1}{L_k}\int \vec{E}\, d\, t \, . \tag{2.22}$$

Here L_k is the kinetic inductivity of the medium. Its existence is based on the fact that a charge carrier has a mass and hence it possesses inertia properties.

For harmonic fields we have $\vec{E}=\vec{E}_0 \sin \omega t$ and Eq. (2.22) becomes

$$\vec{j}_L = -\frac{1}{\omega L_k} E_0 \cos\omega t \, . \tag{2.23}$$

Eqs. (2.22) and (2.23) show that $\vec{j}_L$ is the current through the inductance coil.

In this case the Maxwell equations take the following form

$$rot\,\vec{E} = -\mu_0 \frac{\partial \vec{H}}{\partial t},$$

$$rot\,\vec{H} = \vec{j}_C + \vec{j}_L = \varepsilon_0 \frac{\partial \vec{E}}{\partial t} + \frac{1}{L_k}\int \vec{E}\, d\, t, \tag{2.24}$$

where ε_0 and μ_0 are the electric and magnetic inductivities in vacuum, $\vec{j}_C$ and $\vec{j}_L$ are the displacement and conduction currents, respectively. As was shown above, $\vec{j}_L$ is the inductive current.

Eq. (2.24) gives

$$rot\,rot\,\vec{H} + \mu_0\varepsilon_0 \frac{\partial^2 \vec{H}}{\partial t^2} + \frac{\mu_0}{L_k}\vec{H} = 0 \, . \tag{2.25}$$

For time-independent fields, Eq. (2.25) transforms into the London equation

$$rot\,rot\,\vec{H} + \frac{\mu_0}{L_k}\vec{H} = 0 \, , \tag{2.26}$$

where $\lambda_L^2 = \frac{L_k}{\mu_0}$ is the London depth of penetration.

As Eq. (2.24) shows, the inductivities of plasma (both electric and magnetic) are frequency – independent and equal to the corresponding parameters for vacuum. Besides, such plasma has another fundamental material characteristic – kinetic inductivity.

Eqs. (2.24) hold for both constant and variable fields. For harmonic fields $\vec{E}=\vec{E}_0 \sin \omega t$, Eq. (2.24) gives

$$rot\,\vec{H} = \left(\varepsilon_0\omega - \frac{1}{L_k\omega}\right)\vec{E}_0 \cos \omega t \, . \tag{2.27}$$

Taking the bracketed value as the specific susceptance σ_x of plasma, we can write

$$rot\,\vec{H} = \sigma_X \vec{E}_0 \cos\,\omega\,t\,, \tag{2.28}$$

where

$$\sigma_X = \varepsilon_0\omega - \frac{1}{\omega\,L_k} = \varepsilon_0\omega\left(1 - \frac{\omega_\rho^2}{\omega^2}\right) = \omega\,\varepsilon^*(\omega)\,, \tag{2.29}$$

and $\varepsilon^*(\omega) = \varepsilon_0\left(1 - \frac{\varpi_\rho^2}{\omega}\right)$, where $\omega_\rho^2 = \frac{1}{\varepsilon_0 L_k}$ is the plasma frequency.

Now Eq. (2.28) can be re-written as

$$rot\,\vec{H} = \omega\,\varepsilon_0\left(1 - \frac{\omega_\rho^2}{\omega^2}\right)\vec{E}_0 \cos\,\omega\,t\,, \tag{2.30}$$

or

$$rot\,\vec{H} = \omega\,\varepsilon^*(\omega)\vec{E}_0 \cos\,\omega\,t\,. \tag{2.31}$$

The $\varepsilon^*(\omega)$ –parameter is conventionally called the frequency-dependent electric inductivity of plasma. In reality however this magnitude includes simultaneously the electric inductivity of vacuum aid the kinetic inductivity of plasma. It can be found as

$$\varepsilon^*(\omega) = \frac{\sigma_X}{\omega}\,. \tag{2.32}$$

It is evident that there is another way of writing σ_X

$$\sigma_X = \varepsilon_0\omega - \frac{1}{\omega\,L_k} = \frac{1}{\omega\,L_k}\left(\frac{\omega^2}{\omega_\rho^2} - 1\right) = \frac{1}{\omega\,L_k{}^*}, \tag{2.33}$$

where

$$L_k{}^*(\omega) = \frac{L_k}{\left(\frac{\omega^2}{\omega_\rho^2} - 1\right)} = \frac{1}{\sigma_X\omega}\,. \tag{2.34}$$

$L_k{}^*(\omega)$ written this way includes both ε_0 and L_k.

Eqs. (2.29) and (2.33) are equivalent, and it is safe to say that plasma is characterized by the frequency-dependent kinetic inductance $L_k{}^*(\omega)$ rather than by the frequency-dependent electric inductivity $\varepsilon^*(\omega)$.

Eq. (2.27) can be re-written using the parameters $\varepsilon^*(\omega)$ and $L_k{}^*(\omega)$

$$rot\,\vec{H} = \omega\,\varepsilon^*(\omega)\vec{E}_0 \cos\,\omega\,t\,, \tag{2.35}$$

or

$$rot\,\vec{H} = \frac{1}{\omega\,L_k{}^*(\omega)}\vec{E}_0 \cos\,\omega\,t\,. \tag{2.36}$$

Eqs. (2.35) and (2.36) are equivalent.Thus, the parameter $\varepsilon^*(\omega)$ is not an electric inductivity though it has its dimensions. The same can be said about $L_k{}^*(\omega)$.

We can see readily that

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$$\varepsilon^*(\omega) = \frac{\sigma_X}{\omega} \quad , \tag{2.37}$$

$$L_k^*(\omega) = \frac{1}{\sigma_X \omega} \quad . \tag{2.38}$$

These relations describe the physical meaning of *ε*(ω)* and L_k**(ω)*.

Of course, the parameters *ε*(ω)* and L_k**(ω)* are hardly usable for calculating energy by the following equations

$$W_E = \frac{1}{2}\varepsilon\, E_0^2 \tag{2.39}$$

and

$$W_j = \frac{1}{2}L_k\, j_0^2 \,. \tag{2.40}$$

For this purpose the Eq. (2.15)-type fotmula was devised in [7]:

$$W = \frac{1}{2}\times\frac{d\left[\omega\ \varepsilon^*(\omega)\right]}{d\ \omega}E_0^2 \quad . \tag{2.41}$$

Using Eq. (2.41), we can obtain

$$W_\Sigma = \frac{1}{2}\varepsilon_0 E_0^2 + \frac{1}{2}\times\frac{1}{\omega^2 L_k}E_0^2 = \frac{1}{2}\varepsilon_0 E_0^2 + \frac{1}{2}L_k\, j_0^2 \,. \tag{2.42}$$

The same result is obtainable from

$$W = \frac{1}{2}\times\frac{d\left[\dfrac{1}{\omega\ L_k^*(\omega)}\right]}{d\ \omega}E_0^2 \,. \tag{2.43}$$

As in the case of a parallel circuit, either of the parameters *ε*(ω)* and L_k**(ω)*, similarly to *C*(ω)* and *L*(ω)*, characterize completely the electrodynamic properties of plasma. The case

$$\varepsilon^*(\omega) = 0$$

$$L_k^*(\omega) = \infty \tag{2.44}$$

corresponds to the resonance of current.It is shown below that under certain conditions this resonance can be transverse with respect to the direction of electromagnetic waves.

It is known that the Langmuir resonance is longitudinal. No other resonances have ever been detected in nonmagnetized plasma. Nevertheless, transverse resonance is also possible in such plasma, and its frequency coincides with that of the Langmuir resonance. To understand the origin of the transverse resonance, let us consider a long line consisting of two perfectly conducting planes (see Fig. 2.1). First, we examine this line in vacuum.

If a d.c. voltage (U) source is connected to an open line the energy stored in its electric field is

$$W_{E\Sigma} = \frac{1}{2}\varepsilon_0 E^2 a\ b\ z = \frac{1}{2}C_{E\Sigma}U^2, \tag{2.45}$$

where $E = \dfrac{U}{a}$ is the electric field strength in the line, and

$$C_{E\Sigma} = \varepsilon_0 \frac{b\,z}{a} \tag{2.46}$$

is the total line capacitance. $C_E = \varepsilon_0 \dfrac{b}{a}$ is the linear capacitance and ε_0 is electric inductivities of the medium (plasma) in SI units (F/m).

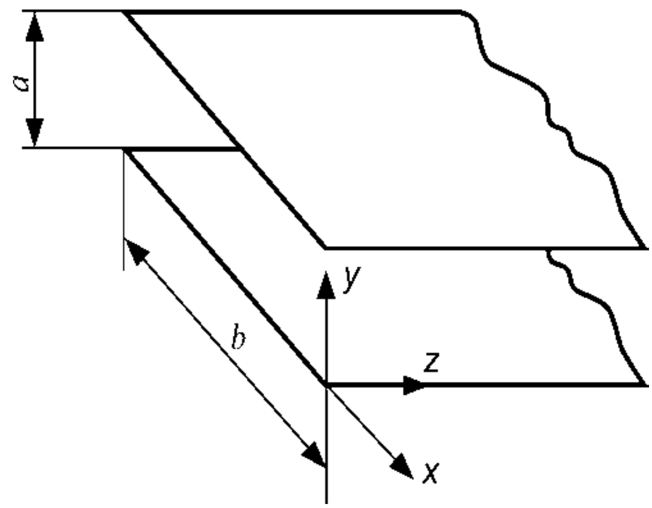

Fig. 2.1: Two-conductor line consisting of two perfectly conducting planes

The specific potential energy of the electric field is

$$W_E = \frac{1}{2}\varepsilon_0\, E^2 \; . \tag{2.47}$$

If the line is short-circuited at the distance *z* from its start and connected to a d.c. current (*I*) source, the energy stored in the magnetic field of the line is

$$W_{H\Sigma} = \frac{1}{2}\mu_0\, H^2 a\, b\, z = \frac{1}{2} L_{H\Sigma}\, I^2 \; . \tag{2.48}$$

Since $H = \dfrac{I}{b}$, we can write

$$L_{H\Sigma} = \mu_0 \frac{a\,z}{b}, \tag{2.49}$$

where $L_{H\Sigma}$ is the total inductance of the line $L_H = \mu_0 \dfrac{a}{b}$ is linear inductance and μ_0 is the inductivity of the medium (vacuum) in SI (H/m).

The specific energy of the magnetic field is

$$W_H = \frac{1}{2}\mu_0\, H^2 \; . \tag{2.50}$$

To make the results obtained more illustrative, henceforward, the method of equivalent circuits will be used along with mathematical description. It is seen that $C_{E\Sigma}$ and $L_{H\Sigma}$ increase with growing *z*. The line segment *dz* can therefore be regarded as an equivalent circuit (Fig. 2.2a).

If plasma in which charge carriers can move free of friction is placed within the open line and then the current I, is passed through it, the charge carriers moving at a certain velocity start storing kinetic energy. Since the current density is

$$j = \frac{I}{b\,z} = n\,e\,V, \tag{2.51}$$

the total kinetic energy of all moving charges is

$$W_{k\Sigma} = \frac{1}{2} \times \frac{m}{n\,e^2} a\,b\,z\;j^2 = \frac{1}{2} \times \frac{m}{n\,e^2} \frac{a}{b\,z} I^2 \ . \tag{2.52}$$

On the other hand,

$$W_{k\Sigma} = \frac{1}{2} L_{k\Sigma} I^2 \ , \tag{2.53}$$

where $L_{k\Sigma}$ is the total kinetic inductance of the line. Hence,

$$L_{k\Sigma} = \frac{m}{n\,e^2} \times \frac{a}{b\,z} \ . \tag{2.54}$$

Thus, the magnitude

$$L_k = \frac{m}{n\,e^2} \tag{2.55}$$

corresponding kinetic inductivity of the medium.

Earlier, we introduced this magnitude by another way (see Eq. (2.21)).Eq. (2.55) corresponds to case of uniformly distributed d.c. current.

As we can see from Eq. (2.54), $L_{H\Sigma}$, unlike $C_{E\Sigma}$ and $L_{k\Sigma}$, decreases when z grows. This is clear physically because the number of parallel-connected inductive elements increases with growing z. The equivalent circuit of the line with nondissipative plasma is shown in Fig. 2.26. The line itself is equivalent to a parallel lumped circuit:

$$C = \frac{\varepsilon_0 b\,z}{a} \ \text{and}\ L = \frac{L_k\,a}{b\,z} . \tag{2.56}$$

It is however obvious from calculation that the resonance frequency is absolutely independent of whatever dimension. Indeed,

$$\omega_\rho^2 = \frac{1}{C\,L} = \frac{1}{\varepsilon_0 L_k} = \frac{n\,e^2}{\varepsilon_0 m} \ . \tag{2.57}$$

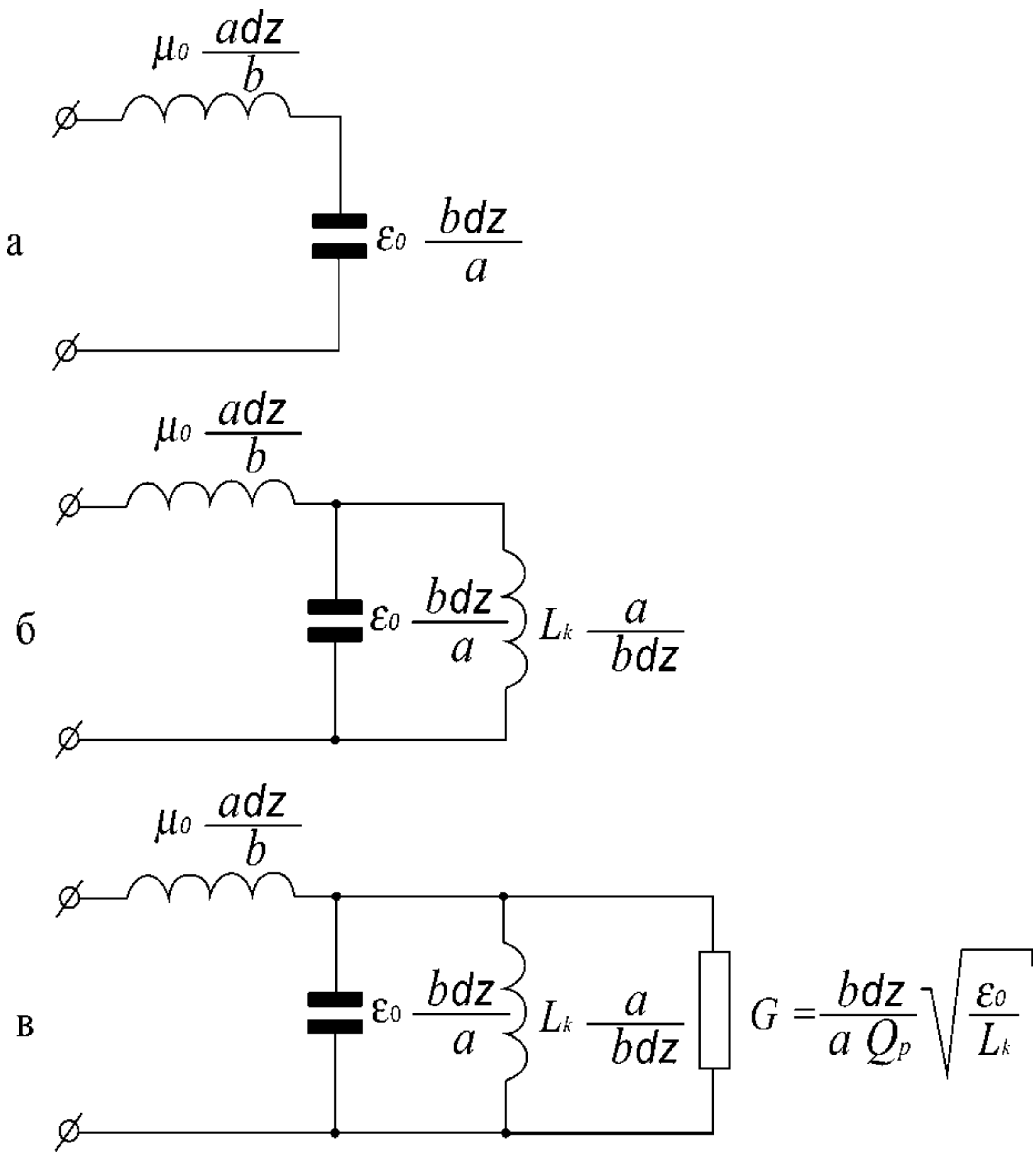

Fig. 2.2: a. Equivalent circuit of the two-conductor line segment;
б. Equivalent circuit of the two-conductor line containing
в. Equivalent circuit of the two-conductor line segment containing dissipa tive plasma.

This brings us to a very interesting result: the resonance frequency of the macroscopic resonator is independent of its size. It may seem that we are dealing here with the Langmuir resonance because the obtained frequency corresponds exactly to that of the Langmuir resonance. We however know that the Langmuir resonance characterizes longitudinal waves. The wave propagating in the phase velocity in the z-direction is equal to infinity and the wave vector is $\vec{k}_z = 0$, which corresponds to the solution of Eqs. (2.24) for a line of pre-assigned configuration (Fig. 2.1). Eqs. (2.25) give a well-known result. The wave number is

$$k_z^2 = \frac{\omega^2}{c^2}\left(1 - \frac{\omega_\rho^2}{\omega^2}\right) . \tag{2.58}$$

The group and phase velocities are

$$V_g^2 = c^2\left(1 - \frac{\omega_\rho^2}{\omega^2}\right) , \tag{2.59}$$

$$V_F^2 = \frac{c^2}{\left(1 - \frac{\omega_\rho^2}{\omega^2}\right)} , \tag{2.60}$$

where $c = \left(\frac{1}{\mu_0 \, \varepsilon_0}\right)^{1/2}$ is the velocity of light in vacuum.

For the plasma under consideration, the phase velocity of the electromagnetic wave is equal to infinity. Hence, the distribution of the fields and currents over the line is uniform at each instant of time and independent of the *z*-coordinate. This implies that, on the one hand, the inductance $L_{H\Sigma}$ has no effect on the electrodynamic processes in the line and, on the other hand, any two planes can be used instead of conducting planes to confine plasma above and below.

Eqs. (2.58) , (2.59) and (2.60) indicate that we have transverse resonance with an infinite *Q*-factor. The fact of transverse resonance, i.e. different from the Langmuir resonance, is most obvious when the *Q*-factor is not equal to infinity. Then $k_z \neq 0$ and the transverse wave is propagating in the line along the direction perpendicular to the movement of charge carriers. True, we started our analysis with plasma confined within two planes of a long line, but we have thus found that the presence of such resonance is entirely independent of the line size, i.e. this resonance can exist in an infinite medium. Moreover, in infinite plasma transverse resonance can coexist with the Langmuir resonance characterizing longitudinal waves. Since the frequencies of these resonances coincide, both of them are degenerate. Earlier, the possibility of transverse resonance was not considered. To approach the problem more comprehensively, let us analyze the energy processes in loss-free plasma.

The characteristic resistance of plasma determining the relation between the transverse components of electric and magnetic fields can be found from

$$Z = \frac{E_y}{H_x} = \frac{\mu_0 \, \omega}{k_z} = Z_0\left(1 - \frac{\omega_\rho^2}{\omega^2}\right)^{-1/2} , \tag{2.61}$$

where $Z_0 = \sqrt{\frac{\mu_0}{\varepsilon_0}}$ is the characteristic resistance in vacuum.

The obtained value of *Z* is typical for transverse electromagnetic waves in waveguides. When $\omega \to \omega_\rho$, $Z \to \infty$, and $H_x \to 0$. At $\omega > \omega_\rho$, both the electric and magnetic field components are present in plasma. The specific energy of the fields is

$$W_{E,H} = \frac{1}{2}\varepsilon_0 \, E_{0y}^2 + \frac{1}{2}\mu_0 \, H_{0x}^2 . \tag{2.62}$$

Thus, the energy accumulated in the magnetic field is $\left(1-\frac{\omega_\rho^2}{\omega^2}\right)$ times lower than that in the electric field. This traditional electrodynamic analysis is however not complete because it disregards one more energy component – the kinetic energy of charge carriers. It turns out that in addition to the electric and magnetic waves carrying electric and magnetic energy, there is one more wave in plasma – the kinetic wave carrying the kinetic energy of charge carriers. The specific energy of this wave is

$$W_k=\frac{1}{2}L_k\,j_0^2=\frac{1}{2}\times\frac{1}{\omega^2\,L_k}E_0^2=\frac{1}{2}\varepsilon_0\,\frac{\omega_\rho^2}{\omega^2}E_0^2\ . \tag{2.63}$$

The total specific energy thus amounts to

$$W_{E,H,j}=\frac{1}{2}\varepsilon_0\,E_{0y}^2\ +\frac{1}{2}\mu_0\,H_{0x}^2\ +\frac{1}{2}L_k\,j_0^2\ . \tag{2.64}$$

Hence, to find the total specific energy accumulated in unit volume of plasma, it is not sufficient to allow only for the fields E and H.

At the point $\omega = \omega_\rho$

$$W_H = 0$$
$$W_E = W_k\ , \tag{2.65}$$

i.e. there is no magnetic field in the plasma, and the plasma is a macroscopic electromechanical cavity resonator of frequency ω_ρ.

At $\omega > \omega_\rho$ the wave propagating in plasma carries three types of energy – magnetic, electric and kinetic. Such wave can therefore be-called magnetoelectrokinetic. The kinetic wave is a current-density wave $\vec{j}=\frac{1}{L_k}\int\vec{E}\ d\ t$. It is shifted by π/2 with respect to the electric wave.

Up to now we have considered a physically unfeasible case with no losses in plasma, which corresponds to infinite *Q*-factor of the plasma resonator. If losses occur, no matter what physical processes caused them, the *Q*-factor of the plasma resonator is a final quantity. For this case the Maxwell equations become

$$rot\,\vec{E}=-\mu_0\frac{\partial\,\vec{H}}{\partial\,t},$$
$$rot\,\vec{H}=\sigma_{p.ef}\,\vec{E}+\varepsilon_0\frac{\partial\,\vec{E}}{\partial\,t}+\frac{1}{L_k}\int\vec{E}\ d\ t. \tag{2.66}$$

The term $\sigma_{p.ef}\vec{E}$ allows for the loss, and the index ef near the active conductivity emphasizes that we are interested in the fact of loss and do not care of its mechanism. Nevertheless, even though we do not try to analyze the physical mechanism of loss, we should be able at least to measure $\sigma_{p.ef}$.

For this purpose, we choose a line segment of the length z_0 which is much shorter than the wavelength in dissipative plasma. This segment is equivalent to a circuit with the following lumped parameters

$$C=\varepsilon_0\frac{b\ z_0}{a}, \tag{2.67}$$

$$L = L_k \frac{d}{b\, z_0}, \tag{2.68}$$

$$G = \sigma_{\rho.ef} \frac{b\, z_0}{a}, \tag{2.69}$$

where G is the conductance parallel to C and L.
The conductance G and the Q-factor of this circuit are related as

$$G = \frac{1}{Q_\rho} \sqrt{\frac{C}{L}} \; . \tag{2.70}$$

Taking into account Eqs. (2.67) – (2.69), we obtain from Eq. (2.70)

$$\sigma_{\rho.ef} = \frac{1}{Q_\rho} \sqrt{\frac{\varepsilon_0}{L_k}} \; . \tag{2.71}$$

Thus, $\sigma_{p.ef}$. can be found by measuring the basic Q-factor of the plasma resonator.Using Eqs. (2.71) and (2.66), we obtain

$$\begin{aligned} rot\, \vec{E} &= -\mu_0 \frac{\partial \vec{H}}{\partial t} \quad , \\ rot\, \vec{H} &= \frac{1}{Q_\rho} \sqrt{\frac{\varepsilon_0}{L_k}} \vec{E} + \varepsilon_0 \frac{\partial \vec{E}}{\partial t} + \frac{1}{L_k} \int \vec{E}\, d\, t \quad . \end{aligned} \tag{2.72}$$

The equivalent circuit of this line containing dissipative plasma is shown in Fig. 2.2b.

Let us consider the solution of Eqs. (2.72) at the point $\omega = \omega_p$. Since

$$\varepsilon_0 \frac{\partial \vec{E}}{\partial t} + \frac{1}{L_k} \int \vec{E}\, d\, t = 0 . \tag{2.73}$$

We obtain

$$\begin{aligned} rot\, \vec{E} &= -\mu_0 \frac{\partial \vec{H}}{\partial t} \quad , \\ rot\, \vec{H} &= \frac{1}{Q_P} \sqrt{\frac{\varepsilon_0}{L_k}} \vec{E}. \end{aligned} \tag{2.74}$$

The solution of these equations is well known. If there is interface between vacuum and the medium described by Eqs. (2.74), the surface impedance of the medium is

$$Z = \frac{E_{tg}}{H_{tg}} = \sqrt{\frac{\omega_p \mu_0}{2\sigma_{p.ef.}}} (1+i) \quad , \tag{2.75}$$

where $\sigma_{p.ef} = \dfrac{1}{Q_p} \sqrt{\dfrac{\varepsilon_0}{L_k}}.$

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There is of course some uncertainty in this approach because the surface impedance is dependent on the type of the field-current relation (local or non-local). Although the approach is simplified, the qualitative results are quite adequate. True, a more rigorous solution is possible.

The wave propagating deep inside the medium decreases by the law $e^{-\frac{z}{\delta_{ef}}} \times e^{-i\frac{z}{\delta_{ef}}}$. In this case the phase velocity is

$$V_F = \omega \, \sigma_{p.ef} \, , \tag{2.76}$$

where $\delta_{p.ef}^{2} = \dfrac{2}{\mu_0 \omega_p \sigma_{p.ef}}$ is the effective depth of field penetration in the plasma. The above relations characterize the wave process in plasma. For good conductors we usually have $\dfrac{\sigma_{ef}}{\omega \, \varepsilon_0} >> 1$. In such a medium the wavelength is

$$\lambda_g = 2\pi\delta \, . \tag{2.77}$$

I.e. much shorter than the free-space wavelength. Further on we concentrate on the case $\lambda_g >> \lambda_0$ at the point $\omega = \omega_p$, i.e. $V_F \big|_{\omega = \omega p} >> c$.

b) Discussion of Results

We have found that ε (ω) is not dielectric inductivity permittivity. Instead, it includes two frequency-independent parameters ε_0 and L_k. What is the reason for the physical misunderstanding of the parameter ε (ω)? This occurs first of all because for the case of plasma the $\dfrac{1}{L_k}\int \vec{E} \, d \, t$ - type term is not explicitly present in the second Maxwell equation.

There is however another reason for this serious mistake in the present-day physics [7] as an example. This study states that there is no difference between dielectrics and conductors at very high frequencies. On this basis the authors suggest the existence of a polarization vector in conducting media and this vector is introduced from the relation

$$\vec{P} = \Sigma \; e \, \vec{r}_m = n \; e \, \vec{r}_m \; , \tag{2.78}$$

where n is the charge carrier density, $\vec{r}_m$ is the current charge displacement. This approach is physically erroneous because only bound charges can polarize and form electric dipoles when the external field overcoming the attraction force of the bound charges accumulates extra electrostatic energy in the dipoles. In conductors the charges are not bound and their displacement would not produce any extra electrostatic energy. This is especially obvious if we employ the induction technique to induce current (i.e. to displace charges) in a ring conductor. In this case there is no restoring force to act upon the charges, hence, no electric polarization is possible. In [7] the polarization vector found from Eq. (2.78) is introduced into the electric induction of conducting media

$$\vec{D} = \varepsilon_0 \; \vec{E} + \vec{P}, \tag{2.79}$$

where the vector $\vec{P}$ of a metal is obtained from Eq. (2.78), which is wrong.

Since

$$\vec{r}_m = -\frac{e^2}{m\,\omega^2}\vec{E} \quad , \tag{2.80}$$

for free carriers, then

$$\vec{P}^*(\omega) = -\frac{n\,e^2}{m\,\omega^2}\vec{E} \quad , \tag{2.81}$$

for plasma, and

$$\vec{D}^*(\omega) = \varepsilon_0\,\vec{E} + \vec{P}^*(\omega) = \varepsilon_0\left(1 - \frac{\omega_p^2}{\omega^2}\right)\vec{E} \quad . \tag{2.82}$$

Thus, the total accumulated energy is

$$W_\Sigma = \frac{1}{2}\varepsilon_0\,E^2 + \frac{1}{2}\times\frac{1}{L_k\,\omega^2}E^2 \quad . \tag{2.83}$$

However, the second term in the right-hand side of Eq. (2.83) is the kinetic energy (in contrast to dielectrics for which this term is the potential energy). Hence, the electric induction vector *D*(ω)* does not correspond to the physical definition of the electric induction vector.

The physical meaning of the introduced vector $\vec{P}^*(\omega)$ is clear from

$$\vec{P}^*(\omega) = \frac{\sigma_L}{\omega}\vec{E} = \frac{1}{L_k\,\omega^2}\vec{E} \quad . \tag{2.84}$$

The interpretation of $\varepsilon(\omega)$ as frequency-dependent inductivity has been harmful for correct understanding of the real physical picture (especially in the educational processes). Besides, it has drawn away the researchers attention from some physical phenomena in plasma, which first of all include the transverse plasma resonance and three energy components of the magnetoelectrokinetic wave propagating in plasma.

Below, the practical aspects of the results obtained are analyzed, which promise new data and refinement of the current views.

c) Practical Aspects

Plasma can be used first of all to construct a macroscopic single-frequency cavity for development of a new class of electrokinetic plasma lasers. Such cavity can also operate as a band-pass filter.

At high enough Q_P the magnetic field energy near the transverse resonance is considerably lower than the kinetic energy of the current carriers and the electrostatic field energy. Besides, under certain conditions the phase velocity can much exceed the velocity of light. Therefore, if we want to excite the transverse plasma resonance, we can put

$$rot\,\vec{E} \cong 0,$$

$$\frac{1}{Q_p}\sqrt{\frac{\varepsilon_0}{L_k}}\vec{E} + \varepsilon_0\frac{\partial\,\vec{E}}{\partial\,t} + \frac{1}{L_k}\int\vec{E}\,d\,t = \vec{j}_{CT}, \tag{2.85}$$

where $\vec{j}_{CT}$ is the extrinsic current density.

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Integrating Eq. (2.84) over time and dividing it by ε_0 obtain

$$\omega_p^2 \vec{E} + \frac{\omega_p}{Q_p} \times \frac{\partial \vec{E}}{\partial t} + \frac{\partial^2 \vec{E}}{\partial t^2} = \frac{1}{\varepsilon_0} \times \frac{\partial \vec{j}_{CT}}{\partial t}. \tag{2.86}$$

Integrating Eq. (2.86) over the surface normal to the vector $\vec{E}$ and taking $\Phi_E = \int \vec{E}\, d\vec{S}$, we have

$$\omega_p^2 \Phi_E + \frac{\omega_p}{Q_p} \times \frac{\partial \Phi_E}{\partial t} + \frac{\partial^2 \Phi_E}{\partial t^2} = \frac{1}{\varepsilon_0} \times \frac{\partial I_{CT}}{\partial t}, \tag{2.87}$$

where I_{CT} is the extrinsic current.

Eq. (2.87) is the harmonic oscillator equation whose right-hand side is typical of two-level lasers [8]. If there is no excitation source, we have a "cold". Laser cavity in which the oscillation damping follows the exponential law

$$\Phi_E(t) = \Phi_E(0) e^{i\omega_P t} \times e^{-\frac{\omega_P}{2Q_P} t}, \tag{2.88}$$

i.e. the macroscopic electric flow $\Phi_E(t)$ oscillates at the frequency ω_p. The relaxation time can be round as

$$\tau = \frac{2Q_P}{\omega_P}. \tag{2.89}$$

If this cavity is excited by extrinsic currents, the cavity will operate as a band-pass filter with the pass band $\Delta\omega = \frac{\omega_p}{2Q_p}$.

Transverse plasma resonance offers another important application – it can be used to heat plasma. High-level electric fields and, hence, high change-carrier energies can be obtained in the plasma resonator if its *Q*-factor is high, which is achievable at low concentrations of plasma. Such cavity has the advantage that the charges attain the highest velocities far from cold planes. Using such charges for nuclear fusion, we can keep the process far from the cold elements of the resonator.

Such plasma resonator can be matched easily to the communication line. Indeed, the equivalent resistance of the resonator at the point $\omega = \omega_p$ is

$$\mathrm{R}_{\text{экв}} = \frac{1}{G} = \frac{a\, Q_P}{b\, z} \sqrt{\frac{L_k}{\varepsilon_0}}. \tag{2.90}$$

The communication lines of sizes a_L and b_L should be connected to the cavity either through a smooth junction or in a stepwise manner. If $b = b_L$, the matching requirement is

$$\frac{a_L}{b_L} \sqrt{\frac{\mu_0}{\varepsilon_0}} = \frac{a\, Q_p}{b\, z_0} \sqrt{\frac{L_k}{\varepsilon_0}}, \tag{2.91}$$

$$\frac{a\, Q_p}{a_L z_0} \sqrt{\frac{L_k}{\mu_0}} = 1. \tag{2.92}$$

It should be remembered that the choice of the resonator length z_0 must comply with the requirement $z_0 << \lambda_g \big|_{\omega = \omega p}$.

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Development of devices based on plasma resonator can require coordination of the resonator and free space. In this case the following condition is important:

$$\sqrt{\frac{\mu_0}{\varepsilon_0}} = \frac{a\,Q_p}{b\,z_0}\sqrt{\frac{L_k}{\varepsilon_0}}\ , \tag{2.93}$$

or

$$\frac{a\,Q_p}{b\,z_0}\sqrt{\frac{L_k}{\mu_0}} = 1\ . \tag{2.94}$$

Such plasma resonators can be excited with d.c. current, as is the case with a monotron microwave oscillator [9]. It is known that a microwave diode (the plasma resonator in our case) with the transit angle of ~5/2π develops negative resistance and tends to self-excitation. The requirement of the transit angle equal to 5/2π correlates with the following d.c. voltage applied to the resonator:

$$U_0 = \frac{0{,}32a^2\,\omega_p^2\,m\,c^2}{4\pi^2\,e} = \frac{0{,}32a^2\,n\,e}{4\pi^2\,\varepsilon_0^2\,\mu_0}, \tag{2.95}$$

where a is the distance between the plates in the line.

It is quite probable that this effect is responsible for the electromagnetic oscillations in semiconductive lasers.

d) Dielectric Media

Applied fields cause polarization of bound charges in dielectrics. The polarization takes some energy from the field source, and the dielectric accumulates extra electrostatic energy. The extent of displacement of the polarized charges from the equilibrium is dependent on the electric field and the coefficient of elasticity β, characterizing the elasticity of the charge bonds. These parameters are related as

$$-\omega^2\,\vec{r}_m + \frac{\beta}{m}\vec{r}_m = \frac{e}{m}\vec{E}, \tag{2.96}$$

where $\vec{r}_m$ is the charge displacement from the equilibrium. Putting ω_0 for the resonance frequency of the bound charges and taking into account that $\omega_0 = \beta/m$ we obtain from Eq. (2.96)

$$\vec{r}_m = -\frac{e\vec{E}}{m\,(\omega^2 - \omega_o^2)}\ . \tag{2.97}$$

The polarization vector becomes

$$\vec{P}_m{}^* = -\frac{n\,e^2}{m}\times\frac{1}{(\omega^2-\omega_0^2)}\vec{E}. \tag{2.98}$$

Since

$$\vec{P} = \varepsilon_0\,(\varepsilon - 1)\,\vec{E}, \tag{2.99}$$

we obtain

$$\varepsilon'_\partial\,{}^*(\omega) = 1 - \frac{n\,e^2}{\varepsilon_0\,m}\times\frac{1}{\omega^2-\omega_0^2}. \tag{2.100}$$

The quantity $\varepsilon_{\partial}^{'}*(\omega)$ is commonly called the relative frequency dependably lectric inductivity. Its absolute value can be found as

$$\varepsilon_{\partial}*(\omega)=\varepsilon_0(1-\frac{n\,e^2}{\varepsilon_0 m}\times\frac{1}{\omega^2-\omega_0^2}). \tag{2.101}$$

Once again, we arrive at the frequency-dependent dielectric permitlivity. Let us take a closer look at the quantity $\varepsilon_{\partial}*(\omega)$. As before, we introduce $L_{k\,\partial}=\frac{m}{n\,e^2}$ and $\omega_{p.\partial}=\frac{1}{L_{k\,\partial}\varepsilon_0}$ and see immediately that the vibrating charges of the dielectric have masses and thus possess inertia properties. As a result, their kinetic inductivity would make itself evident too. Eq. (2.101) can be re-written as

$$\varepsilon_{\partial}*(\omega)=\varepsilon_0(1-\frac{\omega_{p\,\partial}^2}{\omega^2-\omega_0^2}). \tag{2.102}$$

It is appropriate to examine two limiting cases: $\omega >> \omega_0$ and $\omega << \omega_0$.

If $\omega >> \omega_0$,

$$\varepsilon_{\partial}*(\omega)=\varepsilon_0(1-\frac{\omega_{p\,\partial}^2}{\omega^2}) \;, \tag{2.103}$$

and the dielectric behaves just like plasma. This case has prompted the idea that at high frequencies there is no difference between dielectrics and plasma. The idea served as a basis for introducing the polarization vector in conductors [7]. The difference however exists and it is of fundamental importance. In dielectrics, because of inertia, the amplitude of charge vibrations is very small at high frequencies and so is the polarization vector. The polarization vector is always zero in conductors.

For $\omega << \omega_0$,

$$\varepsilon_{\partial}*(\omega)=\varepsilon_0(1+\frac{\omega_{p\,\partial}^2}{\omega_0^2}) \;, \tag{2.104}$$

and the permittivity of the dielectric is independent of frequency. It is $(1+\frac{\omega_{p\,\partial}^2}{\omega_0^2})$ times higher than in vacuum. This result is quite clear. At $\omega >> \omega_0$ the inertia properties areinactive and permittivity approaches its value in the static field.

The equivalent circuits corresponding to these two cases are shown in Figs. 2.3a and b. It is seen that in the whole range of frequencies the equivalent circuit of the dielectric acts as a series oscillatory circuit parallel-connected to the capacitor operating due to the electric inductivity ε_0 of vacuum (see Fig. 2.3b). The resonance frequency of this series circuit is obviously obtainable from

$$\omega_{\partial}^2=\frac{1}{L_k\,\varepsilon_0\left(\dfrac{\omega_{p\,\partial}^2}{\omega_0^2}\right)} \;. \tag{2.105}$$

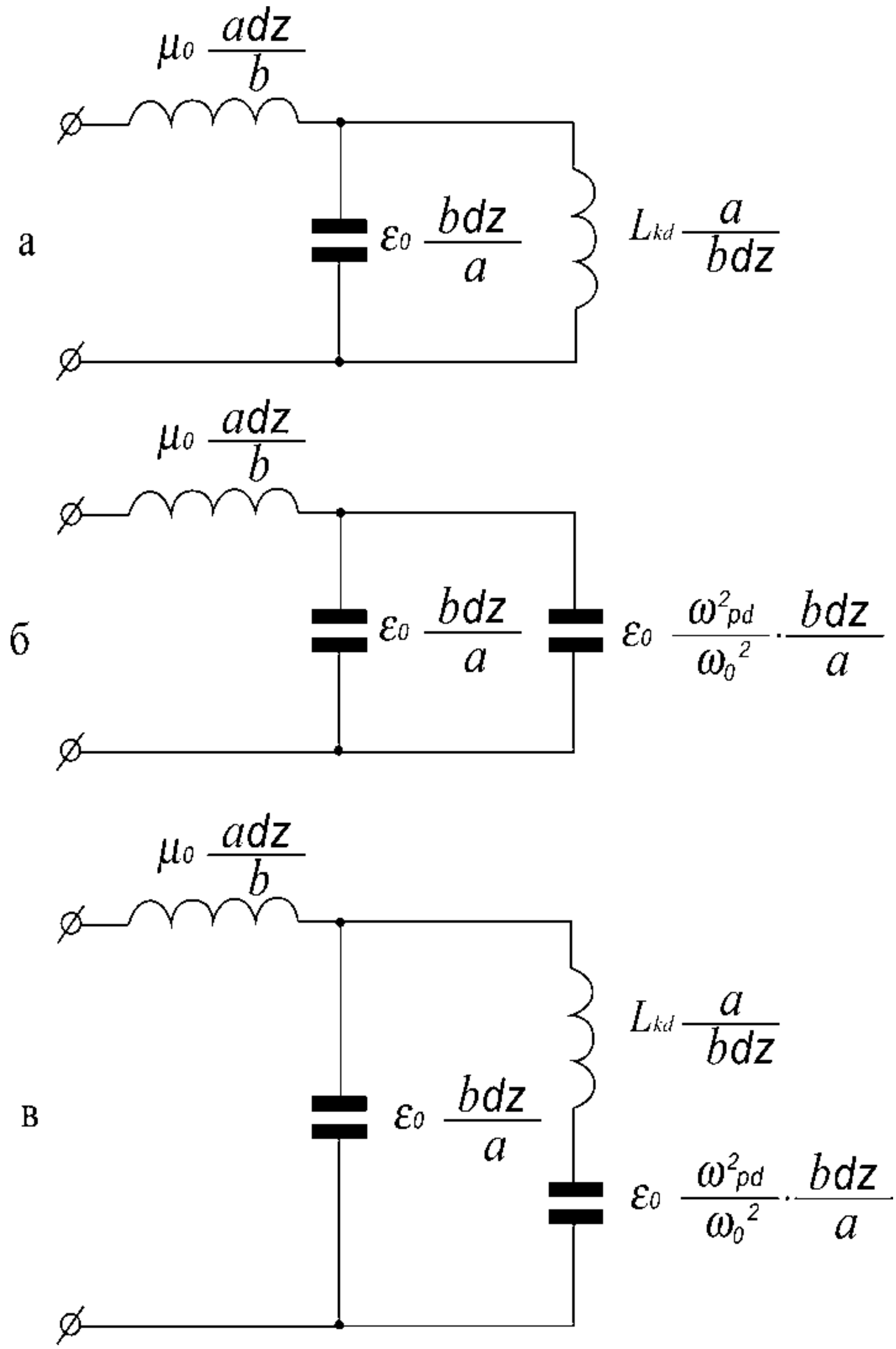

Fig. 2.3: Equivalent circuit of two-conductor line segment with a dielectric: а - $\omega >> \omega_0$; б – $\omega << \omega_0$; в – the whole frequency range.

Lake in the case of plasma, ω_0^2 is independent of the line size, i.e. we have a macroscopic resonator whose frequency is only true when there are no bonds between individual pairs of bound charges. Like for plasma, $\varepsilon_\partial{}^*(\omega)$ is specific susceptance of the dielectric divided by frequency. However, unlike plasma, this parameter contains three frequency-independent components: ε_0, $L_{k\partial}$ and the static permittivity of the dielectric $\varepsilon_0 \dfrac{\omega_{p\partial}^2}{\omega_0^2}$. In the dielectric, resonance occurs when $\varepsilon_\partial{}^*(\omega) \to -\infty$.

Three waves-magnetic, electric and kinetic-propagate in it too. Each of them carries its own type of energy. It not is not problematic to calculate them but we omit this here to save room.

e) Magnetic Media

The resonance phenomena in plasma and dielectrics are characterized by repeated electrostatic-kinetic and kinetic-electrostatic transformations of the charge motion energy during oscillations. This can be described as an electrokinetic process, and devices based on it (lasers, masers, filters, etc.) can be classified as electrokinetic units. However, another type of resonance is also possible, namely, magnetic resonance. Within the current concepts of frequency-dependent permeability, it is easy to show that such dependence is related to magnetic resonance. For example, let us consider ferromagnetic resonance. A ferrite magnetized by applying a stationary field H_0 parallel to the *z*-axis will act as an anisotropic magnet in relation to the variable external field. The complex permeability of this medium has the form of a tensor [10]:

$$\mu = \begin{pmatrix} \mu_T{}^*(\omega) & -i\alpha & 0 \\ i\alpha & \mu_T{}^*(\omega) & 0 \\ 0 & 0 & \mu_L \end{pmatrix}, \qquad (2.106)$$

where

$$\mu_T{}^*(\omega) = 1 - \frac{\Omega\,|\gamma|\,M_0}{\mu_0(\omega^2-\Omega^2)}, \qquad \alpha = \frac{\omega\,|\gamma|\,M_0}{\mu_0(\omega^2-\Omega^2)}, \qquad \mu_L = 1, \qquad (2.107)$$

$$\Omega = |\gamma|\,H_0. \qquad (2.108)$$

Being the natural professional frequency, and

$$M_0 = \mu_0(\mu-1)H_0 \qquad (2.109)$$

is the medium magnetization.

Taking into account Eqs. (2.108) and (2.109) for $\mu_T{}^*(\omega)$, we can write

$$\mu_T{}^*(\omega) = 1 - \frac{\Omega^2(\mu-1)}{\omega^2-\Omega^2}. \qquad (2.110)$$

Assuming that the electromagnetic wave propagates along the *x*-axis and there are H_y and H_z components, the first Maxwell equation becomes

$$rot\,\vec{E} = \frac{\partial\,\vec{E}_Z}{\partial\,x} = \mu_0\mu_T\,\frac{\partial\,\vec{H}_y}{\partial\,t}\;. \tag{2.111}$$

Taking into account Eq. (2.110), we obtain

$$rot\,\vec{E} = \mu_0\left[1 - \frac{\Omega^2(\mu-1)}{\omega^2-\Omega^2}\right]\frac{\partial\,\vec{H}_y}{\partial\,t}\;. \tag{2.112}$$

For ω>>Ω

$$rot\,\vec{E} = \mu_0\left[1 - \frac{\Omega^2(\mu-1)}{\omega^2}\right]\frac{\partial\,\vec{H}_y}{\partial\,t}\;. \tag{2.113}$$

Assumeng $\vec{H}_y = \vec{H}_{y0}\,sin\,\omega t$ and taking into account that

$$\frac{\partial\,\vec{H}_y}{\partial\,t} = -\omega^2\int \vec{H}_y\,d\,t\;. \tag{2.114}$$

Eq. (2.113) gives

$$rot\,\vec{E} = \mu_0\frac{\partial\,\vec{H}_y}{\partial\,t} + \mu_0\,\Omega^2(\mu-1)\int \vec{H}_y\,d\,t\;, \tag{2.115}$$

or

$$rot\,\vec{E} = \mu_0\frac{\partial\,\vec{H}_y}{\partial\,t} + \frac{1}{C_k}\int \vec{H}_y\,d\,t\;. \tag{2.116}$$

For ω<< Ω

$$rot\,\vec{E} = \mu_0\mu\frac{\partial\,\vec{H}_y}{\partial\,t}\;. \tag{2.117}$$

The quantity

$$C_k = \frac{1}{\mu_0\,\Omega^2(\mu-1)} \tag{2.118}$$

can be described as kinetic capacitance. What is its physical meaning? If the direction of the magnet-icmoment does not coincide with that of the external magnetic field, the vector of the moment starts precessional motion at the frequency Ω about the magnetic field vector. The magnetic moment $\vec{m}$ has the potential energy $U_m = -\vec{m}\times\vec{B}$. Like in a charged condenser, U_m is the potential energy because the precessional motion is inertialess (even though it is mechanical) and it stops immediately when the magnetic field is lifted. In the magnetic field the processional motion lasts until the accumulated potential energy is exhausted and the vector of the magnetic moment becomes parallel to the vector $\vec{H}_0$. The equivalent circuit for this case is shown in Magnetic resonance occurs at the point ω=Ω and $\mu_T^*(\omega) \to -\infty$. It is seen that the resonance frequency of the macroscopic magnetic resonator is independent of the line size and equals Ω.

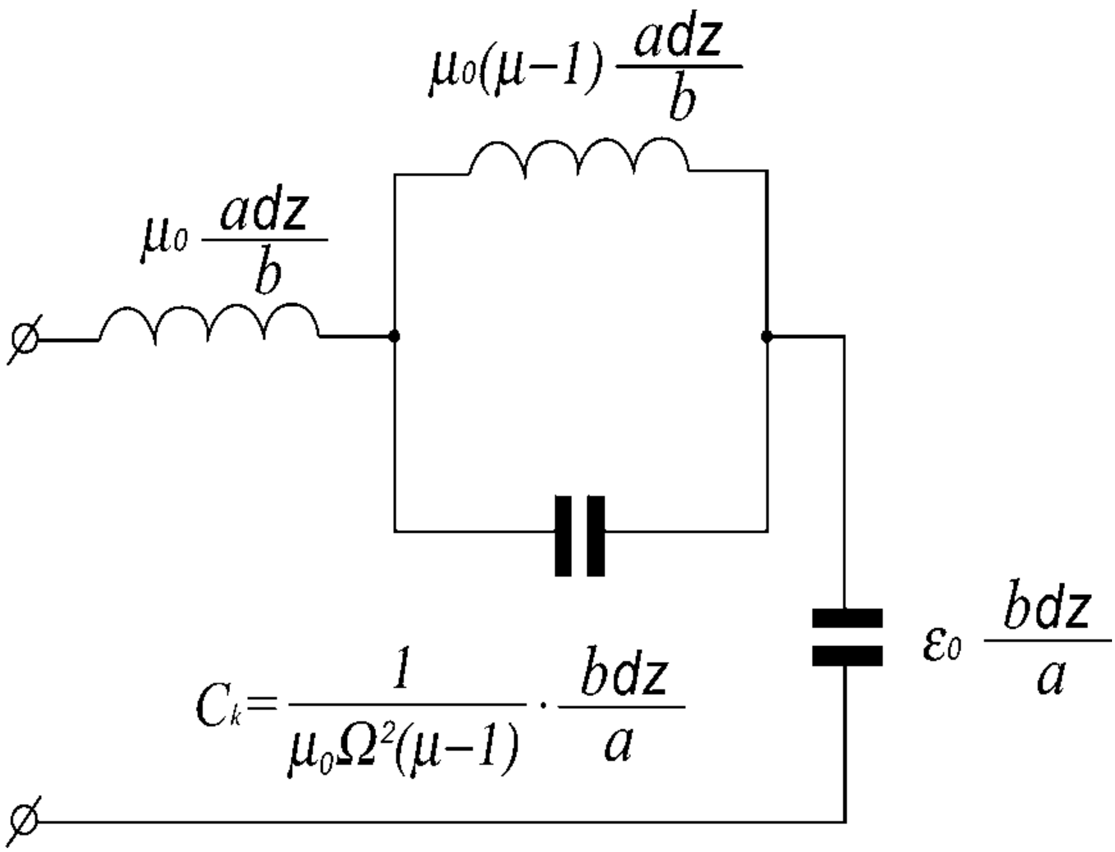

Fig. 2.4: Equivalent circuit of two-conductor line including a magnet

Thus, the parameter

$$\mu_H{}^*(\omega)=\mu_0\left[1-\frac{\Omega^2(\mu-1)}{\omega^2-\Omega^2}\right] \tag{2.119}$$

is not a frequency-dependent permeability. According to the equivalent circuit in Fig. 2.4, it includes μ_0, μ and C_k.

It is easy to show that three waves propagate in this case-electric, magnetic and a wave carrying potential energy of the precessional motion of the magnetic moments about the vector $\vec{H}_0$. The systems in which these types of waves are used can also be described as electromagnetopotential devices.

Conclusions

Thus, it has been found that along with the fundamental parameters $\varepsilon\varepsilon_0$ and $\mu\mu_0$ characterizing the electric and magnetic energy accumulated and transferred in the medium, there are two more basic material parameters L_k and C_k. They characterize kinetic and potential energy that can be accumulated and transferred in material media. L_k was sometimes used to describe certain physical phenomena, for example, in superconductors [11], C_k has never been known to exist. These four fundamental parameters $\varepsilon\varepsilon_0$, $\mu\mu_0$, L_k and C_k clarify the physical picture of the wave and resonance processes in material media in applied electromagnetic fields. Previously, only electromagnetic waves were thought to propagate and transfer energy in material media. It is clear now that the concept was not complete. In fact, magnetoelectrokinetic, or electromagnetopotential waves travel in material media. The resonances in these media also have specific features. Unlike closed planes with electromagnetic resonance and energy exchange between electric and magnetic fields, material media have two types of resonance – electrokinetic and magnetopotential. Under the electrokinetic resonsnce the energy of the electric field changes to kinetic energy. In the case of magnetopotential resonance the potential energy accumulated during the precessional motion can escape outside at the precession frequency.

The notions of permittivity and permeability dispersion thus become physically groundless though $\varepsilon*(\omega)$ and $\mu*(\omega)$ are handy for a mathematical description of the processes in material media. We should however remember their true meaning especially where educational processes are involved.

IV. Magnetic Field Problem

As follows from the transformations in Eq. (1.25) if two charges move at the relative velocity $\vec{V}$, their interaction is determined not only by the absolute values of the charges but by the relative motion velocity as well. The new value of the interaction force is found as [12]

$$\vec{F} = \frac{g_1\, g_2\, ch\,\frac{V_\perp}{c}}{4\pi\,\varepsilon} \times \frac{\vec{r}_{12}}{r_{12}^3}\,, \tag{3.1}$$

where $\vec{r}_{12}$ is the vector connecting the charges, $V_\perp$ is the component of the velocity $\vec{V}$, normal to the vector $\vec{r}_{12}$.

If opposite-sign charges are engaged in the relative motion, their attraction increases. If the charges have the same signs, their repulsion enhances. For $\vec{V} = 0$, Eq. (3.1) becomes the Coulomb law .

Using Eq. (3.1), a mew value of the potential $\varphi(r)$ can be introduced at the point, where the charge g_2 is located, assuming that g_2 is immobile and only g_1 executes the relative motion

$$\varphi(r) = \frac{g_1\, ch\,\frac{V_\perp}{c}}{4\pi\,\varepsilon\, r}\,. \tag{3.2}$$

We can denote this potential as “scalar-vector”, because its value is dependent not only on the charge involved but on the value and the direction of its velocity as well. The potential energy of the charge interaction is

$$W = \frac{g_1\, g_2\, ch\,\frac{V_\perp}{c}}{4\pi\,\varepsilon\, r}\,. \tag{3.3}$$

Eqs. (3.1), (3.2) and (3.3) apparently account for the change in the value of the moving charges.

Using these equations, it is possible to calculate the force of the conductor-current interactions and allow, through superposition, for the interaction forces of all moving and immobile charges in the conductors. We thus obtain all currently existing laws of electromagneticm.

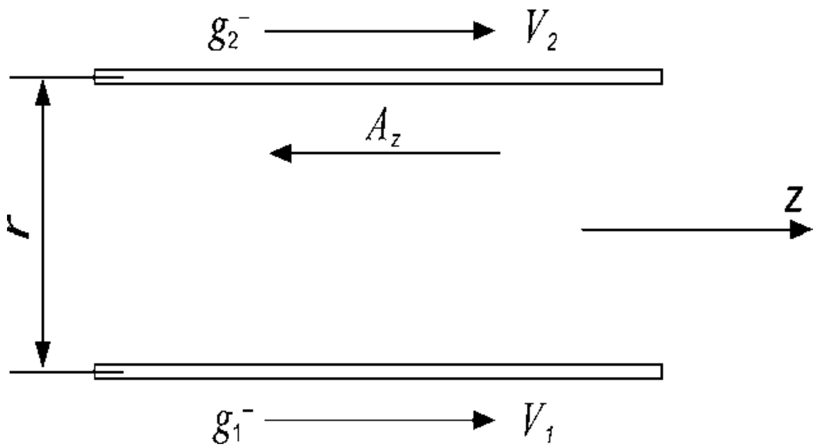

Fig. 3.1: Schematic view of force interaction between current-carreging conductors of a two-conductor line in terms of the present-day model

Let us examine the force, interaction of two z-spaced conductors (Fig. 3.1) assuming that the electron velocities in the conductors are V_1 and V_2. The moving charge values per unit length of the conductors are g_1 and g_2.

In terms of the present-day theory of electromagnetism, the forces of the interaction of the conductors can be found by two methods.

1. One of the conductors (e.g., the lower one) generates the magnetic field *H(r)* in the location of the first conductor. This field is

$$H(r) = \frac{g_1 V_1}{2\pi\, r} . \tag{3.4}$$

The field E' is excited in the coordinate system moving together with the charges of the upper conductor:

$$E' = \left[\vec{V} \times \vec{B}\right] = V_2\, \mu\, H(r) . \tag{3.5}$$

I.e. the charges moving in the upper conductor experience the Lorentz force. This force per unit length of the conductor is

$$F = \frac{\mu\, g_1 V_1\, g_2 V_2}{2\pi\, r} = \frac{I_1\, I_2}{2\pi\, \varepsilon\, c^2\, r} . \tag{3.6}$$

Eq. (3.6) can be obtained in a different way. Assume that the lower conductor excites a vector potential in the region of the upper conductor. The z–component of the vector potential is

$$A_Z = -\frac{g_1 V_1 \ln r}{2\pi\, \varepsilon\, c^2} = -\frac{I_1 \ln r}{2\pi\, \varepsilon\, c^2} . \tag{3.7}$$

The potential energy per unit length of the upper conductor carrying the current I_2 in the field of the vector potential A_Z is

$$W = I_2 A_z = -\frac{I_1\, I_2 \ln r}{2\pi\ \varepsilon\ c^2} \quad . \tag{3.8}$$

Since the force is the derivative of the potential energy with respect to the opposite-sign coordinate, it is written as

$$F = -\frac{\partial\, W}{\partial\ r} = \frac{I_1\, I_2}{2\pi\ \varepsilon\ c^2 r} \quad . \tag{3.9}$$

Both the approaches show that the interaction force of two conductors is the result of the interaction of moving charges: some of them excite fields, the others interact with them. The immobile charges representing the lattice do not participate in the interaction in this scheme. But the forces of the magnetic interaction between the conductors act just on the lattice. Classical electrodynamics does mot explain how the moving charges experiencing this force can transfer it to the lattice.

The above models of iteration are in unsolvable conflict, and experts in classical electrodynamics prefer to pass it over in silence. The conflict is connected with estimation of the interaction force of two parallel-moving charges. Within the above models such two charges should be attracted. Indeed, the induction *B* caused by the moving charge g_1 at the distance r is

$$B = \frac{g_1\, V}{2\pi\ \varepsilon\ c^2 r^2} \quad . \tag{3.10}$$

If another charge g_2 moves at the same velocity *V* in the same direction at the distance r from the first charge, the induction *B* at the location of g_2 produces the force attracting g_1 and g_2.

$$F = \frac{g_1\, g_2 V^2}{4\pi\ \varepsilon\ c^2 r^2} \, . \tag{3.11}$$

An immovable observer would expect these charges to experience attraction along with the Coulomb repulsion. For an observer moving together with the charges there is only the Coulomb repulsion and no attraction. Neither classical electrodynamics not the special theory of relativity can solve the problem. Physically, the introduction of magnetic fields reflects certain experimental facts, but so far we can hardly understand where these fields come from.

In 1976 it was reported in a serious experimental study that a charge appeared on a short-circuited superconducting solenoid when the current in it was attenuating. The results of [13] suggest that the value of the charge is dependent on its velocity, which is first of all in contradiction with the charge conservation law. The author of this study has also investigated this problem [6, 12, 14] (see below). It is useful to analyze here the interaction of current-carrying systems in terms of Eqs. (3.1), (3.2) and (3.3) [12, 14].

We come back again to the interaction of two thin conductors with charges moving at the velocities V_1 and V_2 (Fig. 3.2).

g_1^+, g_2^+ and g_1^-, g_2^- are the immobile and moving charges, respectively, pre unit length of the conductors. g_1^+ and g_2^+ refer to the positively charged lattice in the lower and upper conductors, respectively. Before the charges start moving, both the conductors are assumed to be neutral electrically, i.e. they contain the same number of positive and negative charges.

Each conductor has two systems of unlike charges with the specific densities g_1^+, g_1^- and g_2^+, g_2^- . The charges neutralize each other electrically. To make the analysis of the interaction forces more convenient, in Fig. 3.2 the systems are separated along the *z*-axis. The negative-sign subsystems (electrons) have velocities V_1 and V_2. The force of the interaction between the lower and upper con-

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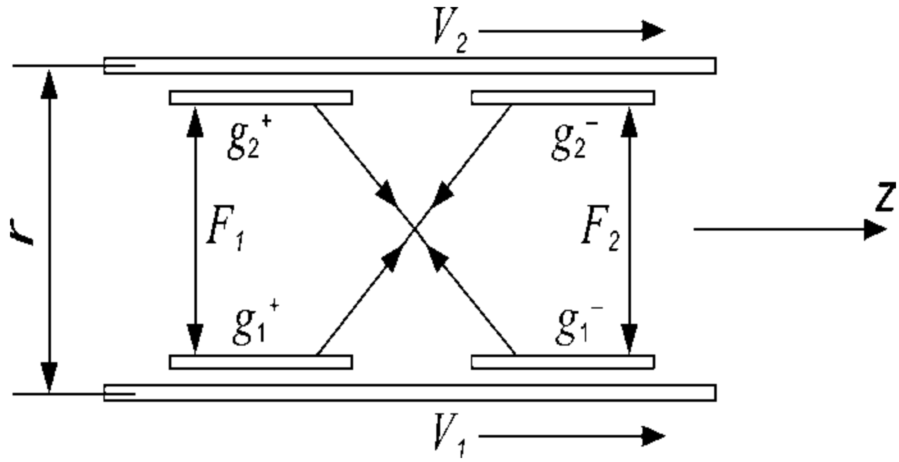

Fig. 3.2: Schematic view of force interaction between current-carrying wires of a two-conductor line. The lattice is charged positively

ductors can be considered as a sum of four forces specified in Fig. 3.2 (the direction is shown by arrows). The attraction forces F_3 and F_4 are positive, and the repulsion forces F_1 and F_2 are negative.

According to Eq. (3.1), the forces between the individual charge subsystems (Fig. 3.2) are

$$F_1 = -\frac{g_1^+ g_2^+}{2\pi\ \varepsilon\ r}\ ,$$

$$F_2 = -\frac{g_1^- g_2^-}{2\pi\ \varepsilon\ r} ch\frac{V_1 - V_2}{c}\ ,$$

$$F_3 = +\frac{g_1^- g_2^+}{2\pi\ \varepsilon\ r} ch\frac{V_1}{c}\ , \tag{3.12}$$

$$F_4 = +\frac{g_1^+ g_2^-}{2\pi\ \varepsilon\ r} ch\frac{V_2}{c}\ .$$

By adding up the four forces and remembering that the product of unlike charges and the product of like charges correspond to the attraction and repulsion forces, respectively, we obtain the total specific force per unit length of the conductor

$$F_\Sigma = \frac{g_1\ g_2}{2\pi\ \varepsilon\ r}\left(ch\frac{V_1}{c} + ch\frac{V_2}{c} - ch\frac{V_1 - V_2}{c} - 1 \right)\ . \tag{3.13}$$

where g_1 and g_2 are the absolute values of charges. The signs of the forces appear in the bracketed expression. Assuming $V \ll c$, we use only the two first terms in the expression of $ch\frac{V}{c}$, i.e. $ch\frac{V}{c} \cong 1 + \frac{1}{2}\frac{V^2}{c^2}$. Eq. (3.13) gives

$$F_{\Sigma 1} = \frac{g_1 V_1\ g_2 V_2}{2\pi\ \varepsilon\ c^2 r} = \frac{I_1\ I_2}{2\pi\ \varepsilon\ c^2 r}, \tag{3.14}$$

where g_1 and g_2 are the absolute values of specific charges, and V_1 , V_2 are taken with their signs. It is seen that Eqs. (3.6), (3.9) and (3.13) coincide though they were obtained by different methods.

According to Feynman (see the introduction), the e.m.f. of the circuit can be interpreted using two absolutely different laws. The paradox has however been clarified. The force of the enteraction between the current-carrying systems can be obtained even by three absolutely different methods. But in the third method, the motion “magnetic field” is no longer necessary and the lattice can directly participate in the formation of the interaction forces. This was impossible with the previous two techniques.

In practice the third method however runs into a serious obstacle. Assuming $g_2^+ = 0$ and $V_2 = 0$, i.e. the interaction, for example, between the lower current-carrying system and the immobile charge g_2^- the interaction force is

$$F_{\Sigma 2} = -\frac{1}{2}\times\frac{g_1\, g_2 V_1^2}{2\pi\, \varepsilon\, c^2 r} \quad (3.15)$$

This means that the current in the conductor is not electrically neutral, and the electric field

$$E_{\perp} = \frac{g_1\, V_1^2}{4\pi\, \varepsilon\, c^2 r}, \quad (3.16)$$

is excited around the conductor, which is equivalent to an extra specific static charge on the conductor

$$g = -g_1 \frac{V_1^2}{c^2}. \quad (3.17)$$

Before [13], there was no evidence for generation of electric fields by d.c. currents.

When Faraday and Maxwell formulated the basic laws of electrodynamics, it was impossible to confirm Eq. (3.17) experimentally because the current densities in ordinary conductors are too small to detect the effect. The assumption that the charge is independent of its velocity and the subsequent introduction of a magnetic field were merely voluntaristic acts.

In superconductors the current densities permit us to find the correction for the charge $\sim g\frac{V_1^2}{c^2}$ experimentally. Initially, [13] was taken as evidence for the dependence of the value of the charge on its velocity. The author of this study has also investigated this problem [6, 12, 14], but, unlike [13], in his experiments current was introduced into a superconducting coil by an inductive non-contact method. Even in this case a charge appeared on the coil [6, 12, 14]. The experimental objects were superconducting composite Nb – Ti wires coated with copper, and it is not cleat what mechanism is responsible for the charge on the coil. It may be brought by mechanical deformation which causes a displacement of the Fermi level in the copper. Experiments on non-coated superconducting wires may be more informative. Anyhow, the subject has not been exhausted and further experimental findings are of paramount importance to fundamental physics. Using this model, we should remember that there is no reliable experimental data on static electric fields around the conductor. According to Eq. (3.16), such fields are excited because the value of the charge is dependent on its velocity. Is there any physical mechanism which could maintain the interacting current-carrying systems electrically neutral within this model? Such mechanism does exist. To explain it, let us consider the current-carrying circuit in Fig. 3.3. This is a superconducting thin film whose thickness is smaller than the field penetration depth in the superconductor. The current is therefore distributed uniformly over the film thickness. Assume that the bridge connecting the wide parts of the film is much narrower than the rest of the current-carrying film. If persistent current is excited in such a circuit, the current density and hence the current carrier velocity V_1 in the bridge will much exceed the velocity V_0 in the wide parts of the film.

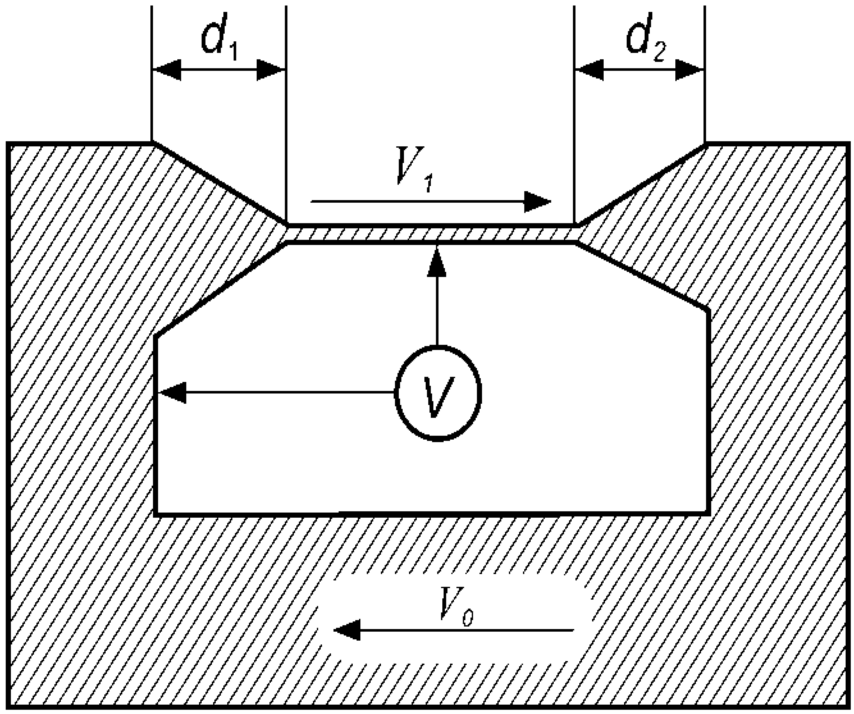

Fig.3.3: Schematic view of a current-carrying circuit based on a superconducting film

Such situation is possible if the current carriers are accelerated in the part d_1 and slowed down in the part d_2. But acceleration and slowing-down of charges is possible only in electric fields. If $V_1 > V_0$, the potential difference between the parts d_1 and d_2 which causes acceleration or slowing-down is determined as

$$U = \frac{m V_1^2}{2\ e} \quad . \tag{3.18}$$

This potential difference can appear only due to the charge density gradient in the parts d_1 and d_2, i.e. the density of charge carriers decreases with acceleration and increases with slowing down. The relation $n_0 > n_1$ should be fulfilled, where n_0 and n_1 are the current-carrier densities in the wide and narrow bridge parts of the film, respectively. It is clear that some energy is needed to accelerate charges which have masses. Let us find out where this energy comes from.

On acceleration the electrostatic energy available in the electrostatic field of the current carriers converts into kinetic energy. The difference in electrostatic energy between two identical volumes having different electron densities can be written as

$$\Delta W = \Delta n \frac{e^2}{8\pi\ \varepsilon\ r} \quad , \tag{3.19}$$

where $\Delta n = n_0 - n_1$, e is the electron charge, r is the electron radius.

Since

$$\frac{e^2}{8\pi\ \varepsilon\ r} = m\, c^2\ , \tag{3.20}$$

where m is the electron mass, Eq. (3.19) can be rewritten as

$$\Delta W = \Delta n\ m\, c^2\ . \tag{3.21}$$

This energy is used to accelerate the current carriers.
Hence,

$$\Delta W = \frac{n_0\ m\, V_1^2}{2}\ , \tag{3.22}$$

and

$$\Delta n = n_0 \frac{1}{2} \times \frac{V_1^2}{c^2}\ . \tag{3.23}$$

The electron density in a moving flow is

$$n_1 = n_0 \left(1 - \frac{1}{2} \times \frac{V_1^2}{c^2}\right). \tag{3.24}$$

We see that the change in the current-carrier density is quite small, but this change is just responsible for the existence of the longitudinal electric field accelerating or slowing down the charges in the parts d_1 and d_2. Let us call such fields "configuration fields" as they are connected with a certain configuration of the conductor. These fields are available in normal conductors too, but they are much smaller than the fields related to the Ohmic resistance.

We can expect that a voltameter connected to the circuit, like is shown in Fig. 3.3, would be capable of registering the configuration potential difference in accordance with Eq. (3.18). If we used an ordinary liquid and a manometer instead of a voltameter, according to the Bernoulli equation, the manometer could register the pressure difference. For lead films, the configuration potential difference is ~10^{-7} B, though it is not observablt experimentally. We can explain this before hand. As the velocities of the current carriers increase and their densities decrease, the electric fields njrmal to their motion enhance. These two precesses counterbalance each other. As a result, the normal component of the electric field has a zero balue in all parts of the film. In terms of the considered, this looks like

$$F_1 = -\frac{g_1^+ g_2^+}{2\pi\ \varepsilon\ r}\ ,$$

$$F_2 = -\frac{g_1^- g_2^-}{2\pi\ \varepsilon\ r}\left(1 - \frac{1}{2}\times\frac{V_1^2}{c^2}\right)\times\left(1 - \frac{1}{2}\times\frac{V_2^2}{c^2}\right) ch \frac{V_1 - V_2}{c}\ ,$$

$$F_3 = \frac{g_1^- g_2^+}{2\pi\ \varepsilon\ r}\left(1 - \frac{1}{2}\times\frac{V_1^2}{c^2}\right) ch\, \frac{V_1}{c}, \tag{3.25}$$

$$F_4 = \frac{g_1^+ g_2^-}{2\pi\ \varepsilon\ r}\left(1 - \frac{1}{2}\times\frac{V_2^2}{c^2}\right) ch \frac{V_1}{c}\ .$$

The bracketed expressions in Eqs. (3.25) allow for the motion-related change in the density of the charges g_1^- and g_2^-.

After expanding ch, multiplying out and allowing only for the $\sim V^2/c^2$ terms, Eqs. (3.25) give

$$F_1 \cong -\frac{g_1^+ g_2^+}{2\pi\ \varepsilon\ r},$$

$$F_2 \cong -\frac{g_1^- g_2^-}{2\pi\ \varepsilon\ r}\left(1-\frac{V_1V_2}{c^2}\right),$$

$$F_3 \cong \frac{g_1^- g_2^+}{2\pi\ \varepsilon\ r}, \tag{3.26}$$

$$F_4 \cong \frac{g_1^+ g_2^-}{2\pi\ \varepsilon\ r}.$$

By adding up F_1, F_2, F_3 and F_4, we obtain the total force of the interaction

$$F_\Sigma = \frac{g_1^- V_1\, g_2^- V_2}{2\pi\ \varepsilon\ c^2\ r} = \frac{I_1\, I_2}{2\pi\ \varepsilon\ c^2\ r}. \tag{3.27}$$

Again, we have a relation coinciding with Eqs. (3.6) and (3.9). However, in this case the current-carrying conductors are neutral electrically. Indeed, if we analyze the force interaction. For example, between the lower conductor and the upper immobile charge g_2 (putting $g_2^+=0$ and $V_2=0$), the total interaction force will be zero, i.e. the conductor with flowing current is electrically neutral.

If we consider the interaction of two parallel – moving electron flows (taking $g_1^+=g_2^+=0$ and $V_1=V_2$), according to Eq. (3.12), the total force is

$$F_\Sigma = -\frac{g_1^- g_2^-}{2\pi\ \varepsilon\ r}. \tag{3.28}$$

It is seen that two electron flows moving at the same velocity in the absence of a lattice experience only the Coulomb repulsion and no attraction included into the magnetic field concept.

Physically, in this model the force interaction of the current-carrying systems is not connected with any now field. The interaction is due to the enhancement of the electric fields normal to the direction of the charge motion.

The phenomenological concept of the magnetic field of correct only when the charges of the current carriers are compensated with the charges of the immobile lattice, the current carriers excite a magnetic field. The magnetic field concept is not correct for freely moving charges when there are no compensating charges of the lattice. In this case a moving charged particle or a flow of charged particles does not excite a magnetic field. Thus, the concept of the phenomenological magnetic field is true but for the above case.

It is easy to show that using the scalar-vector potential, we can obtain all the presently existing laws of magnetism. Besides, the approach proposed permits a solution of the problem of the interaction between two parallel-moving charges which could not be solved in terms of the magnetic field concept.

V. Problem of Electromagnetic Radiation

Whatever occurs in electrodynamic, it is connected with the interaction of moving and immobile charges. The introduction of the scalar-vector potential answers this question. The potential is based on the laws of electromagnetic and magnetoelectric induction. The Maxwell equations describing the wave processes in material media also follow from these laws. The Maxwell equations suggest that the velocity of field propagation is finite and equal to the velocity of light.

The problem of electromagnetic radiation can be solved of the elementary level using the scalar-vector potential and the finiteness of propagation of electric processes.

For this purpose, the retarded scalar-vector potential

$$\varphi(r',t) = \frac{g_1 \, ch\frac{V'_\perp}{c}}{4\pi\,\varepsilon\, r'}, \tag{3.29}$$

is introduced, where $V'_\perp$ is the velocity of the charge g_1 at the moment $t' = t - \frac{r'}{c}$, normal to the vector $\vec{r}\,'$, r' is the distance between the charge g_1 and point 2, where the field is sought for at the moment t. The field at point 2 can be found from the relation $\vec{E} = -grad\,\varphi$. Assume that at the moment $t - \frac{r'}{c}$ the charge g_1 is at the origin of the coordinates and its velocity is $V'_\perp(t)$ (Fig. 4.1). The field E_y at point 2 is

$$E_y = -\frac{\partial\,\varphi(2\ ,t)}{\partial\, y} = -\frac{e_0}{4\pi\,\varepsilon\, r'} \times \frac{\partial}{\partial\, y} ch\frac{V'_\perp(\mathrm{t})}{\mathrm{c}}\ . \tag{3.30}$$

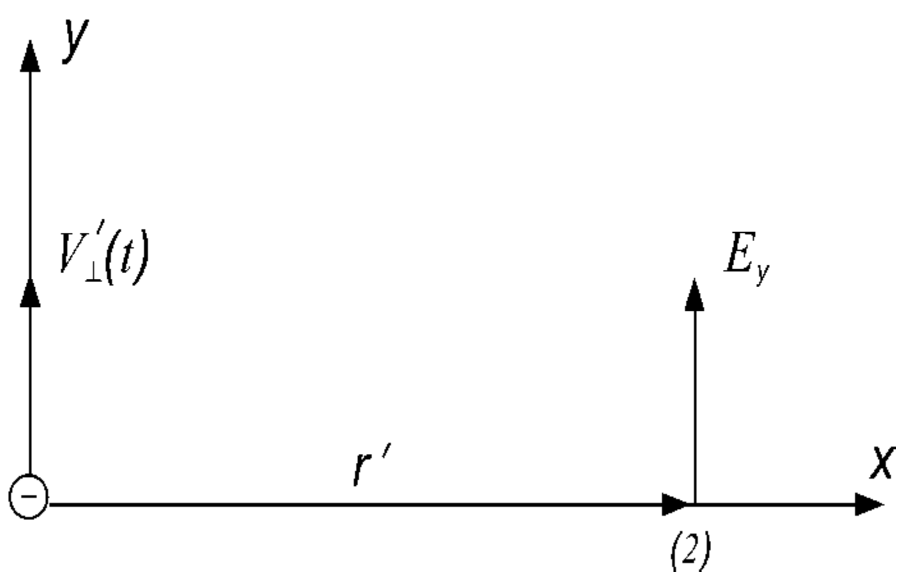

Fig. 4.1: Formation of the retarded scalar-vector potential

Differentiation is performed assuming r' to be a constant magnitude. From

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Eq. (3.30) we obtain

$$E_y = -\frac{e_0}{4\pi\,\varepsilon\,c\,r'} \times \frac{\partial\, V'_\perp(t)}{\partial\, y} s\,h \frac{V'_\perp(t)}{c} = -\frac{e_0}{4\pi\,\varepsilon\,c\,r'} \times \frac{1}{V'_\perp(t)} \times \frac{\partial\, V'_\perp(t)}{\partial\, t} s\,h \frac{V'_\perp(t)}{c}. \quad (3.31)$$

Using only the first term of the expansion of $s\,h\frac{V'_\perp(t)}{c}$ we can obtain from Eq. (3.31)

$$E_y = -\frac{e_0}{4\pi\,\varepsilon\,c\,r'} \times \frac{\partial\, V'_\perp(t)}{\partial\, t}. \quad (3.32)$$

This law of radiation from a moving charge is well known though its derivation is more complex [2].

All the problems of radiation can be solved at the elementary level using Eq. (3.32) . this equation is also the induction law assuming that the retardation time is very short.

VI. Conclusions

It is surprising that Eq. (3.29) actually accounts for the whole of electrodynamics beause all current electrodynamics problems can be solved using this equation. What is then a magnetic field? This is merely a convenient mathematical procedure which is not necessarily gives a correct result (e.g., in the case of parallel-moving charges). Now we can state that electrocurrent, rather than electromagnetic, waves travel in space. Their electric field and displacement current vectors are in the same plane and displaced by $\pi/2$.

In terms of Eq. (3.29), electrodynamics and optics can be reconstructed completely to become simpler, more intelligible and obvious.

The main ideas of this approach were described in the author's publications [5], [6], [12], [14], [15]. However, the results reported have never been used, most likely because they remain unknown. The objective of this study is therefore to attract more attention to them.

Any theory is dead unless important practical results are obtained of its basis. The use of the previously unknown transverse plasma resonance is one of the most important practical results following from this study.

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Z-Theory the Ultimate Paradigm Shift

By Allan Zade

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GJSFR-A Classification: *FOR Code: 029999p*

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Strictly as per the compliance and regulations of:

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Experience without theory is blind, but theory without experience is mere intellectual play.

- Immanuel Kant

The truth is terrible

- Friedrich Nietzsche

I. The Matter of "Time"

There are two separate ways to describe nature. Those are qualitative and quantitative descriptions. Qualitative decryption shows comprehension of a thinker regarding a subject or something else put under question. In a standard way of comprehension, a thinker gives a qualitative description before quantitative one. That happens because

A qualitative description explains the point of view of a given thinker and application of the measurement device(s) that seems correct for the person. (S1)

That necessity comes from the scientific method developed a few centuries ago and required physical support of any human idea that describes nature. Therefore, every thought that comes from the human mind can be verified against physical experiments to separate correct ideas describing nature from human illusions.

That application of the measurement devices in the form of their readings before, during and after the experiment leads to the physical support of the human idea or destruction of a given concept.

There is one more aspect in the application of any measurement device.

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The way of action of a given measurement device should be clearly understood by the person before the experiment. Otherwise, readings of the device become useless for the person because that person does not comprehend physical interaction between a measurement device and physical attributes of a measuring process coming to measured values during the experiment. (S2)

Statement (S2) seems apparent until the person comes to the categories that cannot be defined.

Definition of a category coming from a thinker is an essential one to the comprehension of his/her point of view on a given category by another thinker. (S3)

As a result, in case of an undefined category, any discussion with a thinker becomes useless because the person ever tries to replace physical attributes of a given physical entity *by an illusion coming from a wrong category that roots deep in his/her mind*.

The worst situation appears when a thinker tries to comprehend interrelation (or mutual interaction) between more than one undefined categories. Such a case looks impossible, but it does exist in some areas of science which touch "dark lands of thoughts." The rest of this section explains the situation in details.

The problem comes from the definition of speed (as motion of something regarding something else) that includes references on two categories which were not correctly defined throughout the history of the humankind. Those are *Space and Time*.

'Motion, in physics, means change with time of the position or orientation of a body…

'All motions are relative to some frame of reference. Saying that a body is at rest, which means that it is not in motion, merely means that it is being described with respect to a frame of reference that is moving together with the body. For example, a body on the surface of the Earth may appear to be at rest, but that is only because the observer is also on the surface of the Earth.' (Motion. (2008). Encyclopedia Britannica)

'Reference frame, also called frame *of reference* in dynamics, means system of graduated lines *symbolically* attached to a body that serve to describe the position of points relative to the body.' (Reference frame. (2008). Encyclopedia Britannica).

Motion was understood for a long time as something that happens in some part of space.

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'Space means a boundless, three-dimensional extent in which objects and events occur and have relative position and direction.' (Space. (2008). Encyclopedia Britannica)

Therefore, all definitions mentioned above have a direct or indirect reference to (or relationship with) something called Space and Time throughout the entire history of humankind.

'Many metaphysicians have argued that neither time nor space can be *ultimately real*. Temporal and spatial predicates apply only to appearances; reality, or what is real, does not endure through time, nor is it subject to the conditions of space. The roots of this view are to be found in Plato and beyond him in the thought of the Eleatic philosophers Parmenides and Zeno, the propounder of several paradoxes about motion…

'Reference has already been made to the way in which Kant argued for an intimate connection between time and space and human sensibility: that human beings experience things as being temporally and spatially situated is to be connected with the nature of their minds, and particularly with their sensory equipment. Kant was entirely correct to describe space and time as "intuitions," by which he meant that they are peculiar sorts of particulars; he was right again to insist on the centrality in sensing of the notions of here and now, which can be indicated but not reduced to conceptual terms.' (Metaphysics. (2008). Encyclopedia Britannica)

More than that, 'Time means a measured or measurable period, a continuum that lacks spatial dimensions…

'Time appears to be more puzzling than space because it seems to flow or pass or else people seem to advance through it. But the passage or advance seems to be unintelligible. The question of how many seconds per second time flows (or one advances through it) is obviously an absurd one, for it suggests that the flow or advance comprises a rate of change with respect to something else—to a sort of hypertime. But if this hypertime itself flows, then a hyper-hypertime is required, and so on, ad infinitum.' (Time. (2008). Encyclopedia Britannica)

There is one more strange observation in "definition" of Time. 'Time means a measured or measurable period…' In other words, they try to define a category (Time) by quantitative-only description. Reference to "a continuum that lacks spatial dimensions" as well as all other physical attributes also seems suspicious. In other words,

Any physical entity that lacks any measurable physical attribute suitable for a definition of that entity supposed to be unreal because a category based on that thing comes only from the human mind instead of nature. *(S4)*

Statement (S4) leads to the point of view that treats so-called "Time" as a human illusion and nothing more.

What is Time?

Logical Definition: Time is a logical link in the human mind to any physical process that has observable duration.

Physical Definition: Time does not exist (and never existed) as a physical property of the Universe.

Mathematical Definition: Time means a rate of duration between any two different physical processes.

Philosophical Definition: Time is an ancient innate idea of humankind.

Common Definition: Time is a link between an indication of a clock and the duration of its own internal recurrent physical process.

What is "Now"? "Now" is a point in the Universe from where an observer (object, body, etc.) makes interaction with the surrounding Universe. (Zade Allan, 2012)

That illusion becomes heavier during technical progress of the last centuries. The problem comes from "invention" of escapement clock.

'The origin of the all-mechanical escapement clock is unknown; the first such devices may have been invented and used in monasteries to toll a bell that called the monks to prayers…

'Clock is mechanical or electrical device other than a watch for displaying time. A clock is a machine in which a device that performs regular movements in equal intervals of time is linked to a counting mechanism that records the number of movements. All clocks, of whatever form, are made on this principle.' (Clock. (2008). Encyclopedia Britannica)

There is a peculiar aspect in the definition given above. 'A clock is a device for *displaying time*.' In other words, it makes not any measurement of so-called "Time." It only displays something that has some relationship with the category of "Time" that does exist in the human mind.

The problem also comes from the scientific method that requires physical measurements of any category by a physical device instead of human perception. In other words, physical presence (existence) of any physical entity should be confirmed by a given (dedicated) measurement.

There is one more problem here. A scientist should explain step-by-step the principle of operation of any physical device used in the experiment. That is a qualitative requirement for the experiment. That requirement guarantees this. The person who conducts the experiment has a clear understanding of the physical operation of the measurement device. Any experimental result becomes useless without a proper understanding of the physical process of interaction between a physical measuring process and the measurement device. That interaction leads to the indication of the measurement device.

Unfortunately, 20th-century physics does not answer a straightforward question about physical interaction between a clock and so-called "flow of Time." However, they do understand the operation of a given clock by definition given above - "A clock is a machine in which a device that performs regular movements in equal intervals of time is linked to a counting mechanism that records the number of movements."

That definition looks weird for some extent. If that machine has two interacting devices, then *there is nothing related to so-called Time in that process.*

Moreover, "regular movements" mean a particular case of physical implementation of a "clock." In general case, those "regular movements" turns to oscillations of a specific device dedicated to producing those oscillations. That is *an oscillating device or an oscillator.*

Any oscillating device utilizes some physical process that gives pulses with equal duration. That requirement comes from *the human mind* that needs to make any given duration compatible with *a unit* duration of a given oscillating device. Stability of that physical process (of oscillations) gives stability of operation of the oscillating device. Inside or outside environmental influence on that process of oscillations appears as some error or deviation of a stable duration of the process of oscillations (in comparison with other processes). Different physical processes have different sensitivity to such influence. As a result, different physical oscillators show different precision of oscillations (in comparison with other physical processes). That precision comes from the ability of the oscillating device to generate each oscillation with the constant duration regardless of any physical influence.

Therefore, the definition given above can be rephrased the following way by the mentioned explanation of oscillation device operability.

A clock is a machine in which a counting device records the number of oscillations coming from the corresponding (local) oscillating device. (S5)

Therefore, there is not any room for so-called "Time" in the definition given by the statement (S5). As a result, "time measurement" becomes *oscillation counting by a machine* (a clock). Moreover, a process of the counting means an application of the human mind on a given measurement because, at the physical level, a physical process of oscillations has not any relationship with a counting procedure that can be understood only by a human being.

All aspects, mentioned above, push the human mind to become self-trapped by the idea of *"human perception of Time that can be physically supported by a specific measurement device called clock."*

The side-effect of that point of view leads the human mind to the idea of "strong mathematical appearance of so-called Time" because "Time" appears only as "counts and numbers" without any other physical attributes. *That is a great failure of the human mind*.

In other words, so-called "Time" reduces to a physical process with a given duration that a human being uses to make a comparison with the duration of another physical process (and nothing more).

II. The Matter Of Speed

The first section explains the core problem of comprehension of so-called "Time." This section explains some problems in notions of 'space,' 'path,' 'trajectory' and other categories related to comprehension and calculation of "speed."

As mentioned above, 'Motion, in physics, means change with time of the position or orientation of a body… ' In mathematical application, 'the magnitude of the velocity (i.e., the speed) is the time rate at which the point is moving along its path.' (Velocity. (2008). Encyclopedia Britannica)

That definition can be rephrased by the statement (S5) the following way.

The speed is a value of spatial relocation that a point makes by moving along its path in a given number of oscillations coming from a given oscillating device. (S6)

In common sense, '*a given number of oscillations coming from a given oscillating device*' gives a duration of a given physical process.

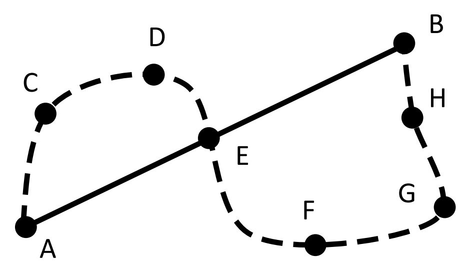

Figure 1: Shows the statement (S6) graphically

Suppose an observer observes two physical bodies moving from the point 'A' to the point 'B'. The first body uses the straight path AB. The second body uses the curved path ACDEFGHB.

There are two possible observable situations in that case.

- Each process shows an individual value of a duration

- Both processes show the same value of the duration

The first situation means this — two physical bodies which start their motion from the point 'A' simultaneously do not meet each other at the point 'B'. As a result, a given oscillating device makes some extra counts "waiting" for the body that comes to the point 'B' later than another one. In that situation, the observer comprehends two values of duration of two processes of relocation by their speeds as $V_1 = S_1/D_1$ and $V_2=S_2/D_2$, where V means value of a speed of a given body; S means spatial relocation of the given body during the experiment; D means the duration of motion of a given body by a given trajectory (path, way, etc.) between points A and B.

The second situation means a particular case when two bodies which left the point 'A' simultaneously meet each other at the point 'B'. In other words, those bodies coexist at both points simultaneously at the beginning and the end of the experiment (measurement).

In a mathematical way of describing it gives the following result.

$$D_1 = D_2 = S_1/V_1 = S_2/V_2 \tag{1}$$

or

$$S_1/S_2 = V_1/V_2 \tag{2}$$

In verbal (qualitative) definition, equation (2) means this.

Anything that has N times greater speed covers N times greater distance than another thing that has N times lesser speed in a given reference frame by a given number of oscillations of a given oscillating device (S7)

Statement (S7) leads the observer to the following idea. If two bodies (things, objects) in the described experiment coexist (to be observed simultaneously at the beginning and the end of the experiment) at the points A and B and the speed of the second body N times greater than the sped of the first body then path ACDEFGHB is N times greater than the path AB.

That idea has a direct link to some optical phenomena.

III. The Matter of Signal Propagation

'In optics, a statement that all points of a wave front of light in a vacuum or transparent medium may be regarded as new sources of wavelets that expand in every direction at a rate depending on their velocities. Proposed by the Dutch mathematician, physicist, and astronomer, Christiaan Huygens, in 1690, it is a powerful method for studying various optical phenomena.

'A surface tangent to the wavelets constitutes the new wave front and is called the envelope of the wavelets. If a medium is homogeneous and has the same properties throughout (i.e., is isotropic), permitting light to travel with the same speed regardless of its direction of propagation, the three-dimensional envelope of a point source will be spherical; otherwise, as is the case with many crystals, the envelope will be ellipsoidal in shape… An extended light source will consist of an infinite number of point sources and may be thought of as generating a plane wave front.' (Huygens' Principle. (2008). Encyclopedia Britannica)

It is apparent that the Huygens' Principle is applicable for *any signal-medium combination without any restriction*. Suppose now this; an observer has a signal transmitter. In case of signal transmission, that signal forms a perfect sphere in an isotropic physical medium by signal propagation (by the principle mentioned above).

Suppose also this. The observer has an oscillating device. Each oscillation of that device has some duration. *The signal, transmitted from the transmitter spends the same duration to cover the same distance.* Therefore, that signal forms concentric spheres at each oscillation coming from the oscillating device. The distance between them becomes equal to the distance covered by the signal in its propagation during each oscillation of the oscillating device.

In that case, the distance between the observer and any other body (object, thing, material point, etc.) can be described in a number of oscillations of the oscillating device. In other words, it forms a perfect *reference frame* that defines a location of a material point (or a physical body) regarding the distance between the point and the observer shown in the number of oscillations that a given signal spends to reach that point coming from the transmitter (the point of origin).

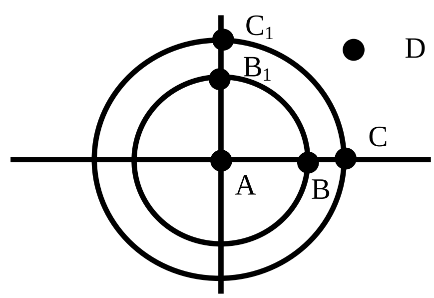

Figure 2: Shows that process schematically. The transmitter and the observer are located at the point 'A'.

The transmitter transmits a signal. The wave front of that signal keeps the form of an exact sphere all the time by Huygens' Principle mentioned above.

It reaches points B and B_1 simultaneously in M oscillations of the oscillating device. As a result of further propagation, the wavefront reaches points of C and C_1 simultaneously in N oscillations of the oscillating device counting from the beginning of the experiment (measurement).

Suppose now this. An observer likes to make a measurement of signal propagation and determine the speed of its propagation. In that case, the observer takes something suitable for such measurement (a rod, for example) puts it in any direction he likes and observes signal propagation regarding that rod. The observer notices this.

Each oscillation of the oscillating device coincides with a new location of the wavefront separated from the previous location with a constant distance. It is also possible for the observer to make a scale on the rod so as each mark of the scale coincides location of the wavefront at each oscillation of the oscillating device.

That way of action coincides with observer's point of view on something that he calls speed. In observer's understanding, any motion has direction and magnitude (speed). In case of a rod, mentioned above, that way of measurement coincides with that point of view. However, the wavefront itself makes propagation in every direction (*unlike a given physical body*).

Therefore, the observer becomes puzzled if he detects the same signal at the point B1. He may think that two bodies located at the points B and B1 have zero distance between them because the signal reaches them simultaneously. Such way of thoughts leads to absurd. The presence of the signal at another point located away from the rod requires another understanding of motion and speed that includes wavefront propagation in every direction instead of linear propagation along the rod. There is one more aspect here.

Propagation of wavefront in any medium depends on relevant physical properties of that medium which affects the speed of that propagation.
Therefore (unlike motion of physical bodies),

Observer-to-medium relative motion makes not any impact on the speed of signal-to-medium relative motion (S8)

In case of body-to-body physical interaction, both bodies do exist before and after the interaction. As a result, after the interaction, both bodies become affected by the speed that they have before interaction. For the same reason, a moving gun gives a higher speed for a shell in the same reference frame if it fires the shell toward the direction of gun's motion.

Unlike such interaction, waves have not any impact from motion of the transmitter. In other words,

There is not any signal source that changes the speed of a created signal in any medium (S9)

IV. The Wave Reference Frame (WRF)

Suppose now this. An observer likes to determine the observer-to-medium speed of relative motion by sending and reserving signals through a given medium. The observer uses an oscillating device with the corresponding counting device, a transceiver, a signal reflector, and a Distance Measurement Device (DMD or a rod in a particular case). The observer put the transceiver and the signal reflector at the opposite ends of the rod. Counting and oscillating devices hold a place at the same end of the rod with the transceiver (point 'A' in Figure 3).

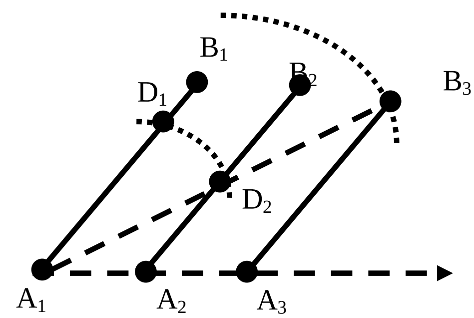

Figure 3

The experiment begins (Figure 3). The transmitter sends a signal in all directions. The counting device starts counting of oscillations coming from the oscillating device simultaneously with signal transmission. That artificial action establishes mutual relationship between duration of signal propagation and number of oscillations (N) coming from the oscillating device by a unit duration of one oscillation.

At the first moment of the experiment, the transmitter and the signal hold the same place that coincides with the point A1 in the reference frame bound to the medium that supports propagation of the signal or in Wave Reference Frame (WRF).

After M oscillations of the oscillation device, the signal reaches the point D2. The rod or the Observer-Bound Reference Frame (ORF) reaches location A_2-B_2. There is a critical aspect here.

A signal and a rod move independently in the Wave Reference Frame. A signal forms sphere as explained above. That sphere makes interaction with the rod in the one point D (at any given moment of the experiment). The observer comprehends that point as the point "of signal location" because he cannot make interaction with the same signal at another point *by definition of the experiment*.

As a result, the observer detects only some *"projection" of signal propagation on the rod*. In other words, the observer determines signal-to-rod relative motion (signal propagation in ORF) instead of signal-to-medium relative motion (signal propagation in WRF). For example, in case of static rod-to-medium location (A_1B_1), the same signal reaches point D_1 with the same number of oscillations of the oscillating device.

Therefore, a moving observer determines a lesser speed of the signal because the same signal covers distance A_2D_2 in ORF and distance RM = A_1D_1 = A_1D_2 in WRF. RM is the radius of the sphere formed by the signal in M oscillations of the oscillating device. That exactly matches the Huygens principle mentioned above. As a result, image distance of signal propagation in ORF (A_2D_2) becomes lesser than RM.

Moreover, the signal propagation and motion of the rod described above, happen in the same duration of M oscillations of the oscillating device. Therefore, both processes have the same duration (M oscillations).

Suppose, the speed of the signal in WFR is N times greater than the speed of the observer with his rod in the same reference frame (WRF). In that case, the signal covers N times greater distance in WRF during each oscillation of the oscillating device in comparison with relocation of the observer (and his rod, DMD) in the same reference frame (WRF). That coincides statement (S7) (see above). Therefore, $A_1D_2 = N(A_1A_2)$. In general case, that equation transforms to the following form.

$$R = NS \tag{3}$$

where R is the radius of the sphere formed by the signal wavefront in WRF in a given number of oscillations of a given oscillating device, N is the ratio of signal-to-medium and observer-to-medium speed of motion in WRF, S is spatial relocation of the observer by the same duration. In other words,

A given signal that has N times greater speed of propagation in a given medium forms a sphere with a radius that N times greater than spatial relocation of the body (observer, point, etc.) in the same medium in a given duration. *(S10)*

Statement (S10) remains correct to any duration of the experiment. Therefore, point D "slides" through the rod during the experiment. That is the point of interaction of the signal and the measurement device from the observer's point of view. However, it is only some "projection" of real signal propagation in the medium *accessible to measurement that way*.

Location of that point coincides with the point A at the beginning of the experiment. Later, the wavefront covers N times greater distance in WRF with each oscillation of the oscillating device than the distance covered by the observer in the same reference frame (WRF). From the observer's point of view, the process of wave propagation coincides with relocation (motion) of the point D along the rod. That means *physical interaction* of the wave front and his measurement device (DMD) in his reference frame (ORF).

At any moment of the experiment, the radius of the sphere formed by the wavefront is N times greater than the distance covered by the observer and his measurement device (see statement (S10)).

In other words, the observer cannot cover higher or lesser distance in a given number of oscillations of the oscillating device because he keeps a constant speed in WRF and the signal keeps a constant speed in the same reference frame (WRF) by the definition of the experiment (the observer keeps straight uniform motion).

The experiment ends at the moment when the wavefront reaches the other end of the rod. In that very moment, the rod has location A_3B_3 in WRF. That location has not any unique aspect regarding observer motion and propagation of the signal in WRF. That condition only informs the observer that *one-way signal propagation* comes to an end.

In that case, duration of one-way signal propagation becomes equal to the duration of the one-way experiment. The distance covered by the wavefront of the signal (A_1B_3) becomes N times greater than the distance (A_1A_3) covered by the observer in the same reference frame (WRF).

However, from the observer's point of view, the experiment includes the propagation of the signal along the rod (motion of the point D) that coincides his comprehension of the experiment in his reference frame (ORF).

V. Backward Propagation Of A Signal In Wave Reference Frame

After reflection at the other end of the rod, the signal starts its backward propagation. That process has not any difference in any physical law applicable to the first one-way experiment. Figure 4 shows that process graphically.

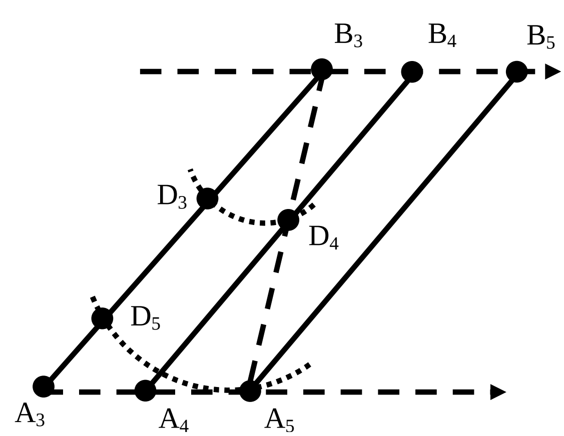

Figure 4

The signal starts propagation in a given medium from the point B_3. After some oscillations of the oscillating device, the wavefront reaches point D_4, and the rod reaches location B_4A_4. Point D again "slides" along the rod making the observer's illusion that he sees the propagation of the signal along the *rod*. However, it is only some "projection" of the physical signal propagation on the rod accessible to the observer's comprehension of the experiment.

At that very moment, the wavefront forms sphere with radius RN = B_3D_3 = B_3D_4. In observer-bound reference frame, it coincides distance B_4D_4 that is greater than the radius RN. Therefore, the observer "determines" a higher speed of signal propagation along the rod in the second one-way experiment because the signal "covers higher distance" by the same number of oscillations of the oscillating device in comparison with the first one-way experiment.

That point of view is wrong regarding the Wave Reference Frame because the signal keeps the same constant speed in that reference frame (or signal-to-medium relative motion) as well as in the first one-way experiment.

That difference comes only from observer-to-medium relative motion and changing the location of the observer regarding the point of origin of the signal (B3, the initial location of the signal transmitter or a signal reflector).

The signal comes back to the other end of the rod where the observer and the transmitter do exist. That is point A_5 (Figure 4). The wavefront forms sphere with the radius B_3A_5 (B_3D_5) at that moment. The experiment finishes because the observer detects the signal reflected from the other end of the rod (by definition of the experiment).

The second one-way experiment follows the same physical law of signal propagation and motion of the rod as mentioned above. Therefore, duration of the second one-way experiment coincides signal propagation from the point B_3 to A_5 and relocation of the rod from location A_3B_3 to A_5B_5. Duration of both processes is the same because the experiment cannot have a different duration. That happens because the observer determines the end of the experiment at the only one moment when he coexists (or detects the signal) with the reflected signal coming from the other end of the rod.

Application of statement (S10) on the second one-way experiment gives the following result.

$$B_3A_5 = N(A_3A_5) \tag{4}$$

In other words, the distance covered by the signal during the second one-way experiment (backward propagation of the signal) is N times greater that relocation of the observer with his rod (DMD) during *the same experiment*. That coincides the law of the first experiment (measurement).

In general case, the oscillating device makes M oscillations during the second one-way experiment and N ≠ M because each one-way experiment has *individual duration.*

VI. A Two-Way (or a Round-Trip) Experiment

A round-trip experiment combines two one-way experiments described above in any case when those one-way experiments conducted one after another. That is a common situation when an observer uses only one oscillating device located at the end of the rod and counts the duration of the entire experiment by that device. Figure 5 shows that case graphically. Letters and subscripts of the figure coincide with their meaning for figures three and four.

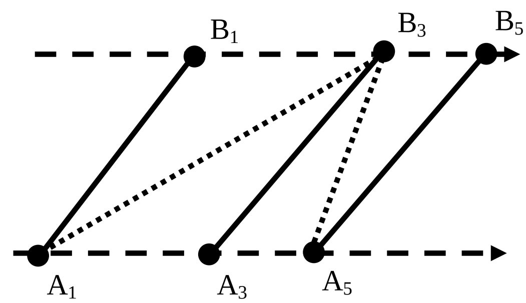

Figure 5

As a result of both experiments conducted one after another, full duration of the experiment becomes equal to the sum of the duration of each one-way experiment. Therefore,

$$D = D_F + D_B \tag{5}$$

where D is the duration of the round-trip experiment, DF is the duration of the first one-way experiment (forward propagation), D_B is the duration of the second one-way experiments (backward propagation). Moreover,

$$A_1B_3 = N(A_1A_3) \tag{6}$$

Sum of both elements of the round trip experiment A_1A_3 (equation (6)) and A_3A_5 (equation (4)) gives the full distance of the rod relocation during the experiment.

Therefore,

$$S = A_1B_3 + B_3A_5 = N(A_1A_3) + N(A_3A_5) = \\ = N(A_1A_3 + A_3A_5) = NL \tag{7}$$

where S is full distance covered by the signal in WRF determined by radiuses of its propagation in both one-way experiments, N is the ratio of signal-to-medium relative motion and observer-to-medium relative motion, L is linear relocation of the observer with all his devices (the rod, the oscillating device, etc.) during the round-trip experiment in the same reference frame (WRF).

Equation (7) shows statement (S10) again in the mathematical form applicable to a round-trip experiment. Figure 6 shows both of them graphically in general case.

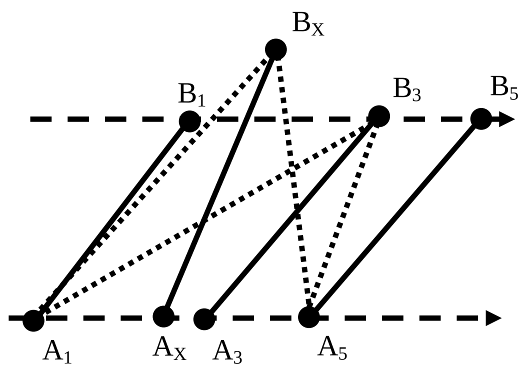

Figure 6

A casual orientation of the rod is shown in the figure by the line A_XB_X. In that casual orientation forward propagation of the signal takes radius A_1B_X. The rod covers distance A_1A_X during the experiment. Moreover, $A_1B_X = N(A_1A_X)$ as explained above.

Backward propagation of the signal takes radius B_XA_5. The rod covers distance A_XA_5 during the experiment. Moreover, $B_XA_5 = N(A_XA_5)$ as explained above. Therefore,

$$\begin{aligned} S &= A_1B_X + B_XA_5 = N(A_1A_X) + N(A_XA_5) + = \\ &= N(A_1A_X + A_XA_5) = NL \end{aligned} \tag{8}$$

Equation (8) shows this.

In a general case of forward and backward propagation of a signal, that signal keeps specific duration in each one-way experiment. However, full duration of a round-trip experiment that includes both one-way experiments remains constant regardless orientation of the measurement device. (S11)

Figure 6 shows two casual orientations of the measurement device (the rod) according to statement (S11) graphically. Those are AXBX and A3B3. In both cases, each one-way experiment keeps its specific duration because of A1BX ≠ BXA5 ≠ A1B3 ≠ B3A5. However, the full duration of each round-trip experiment remains constant.

That happens because specific duration of each one-way experiment appears as a result of interaction of three aspects. Those are:

1. The speed of signal-to-medium relative motion
2. The speed of observer-to-medium relative motion
3. Orientation of the measurement device

All aspects affect both one-way experiments equally by definition of the experiment. The first and the second aspects are constants during the experiment by definition of the experiments.

The third aspect also affects both one-way experiments but compensates its impact if the observer takes both experiments together. The following figure shows that graphically in the observer-bound reference frame (ORF).

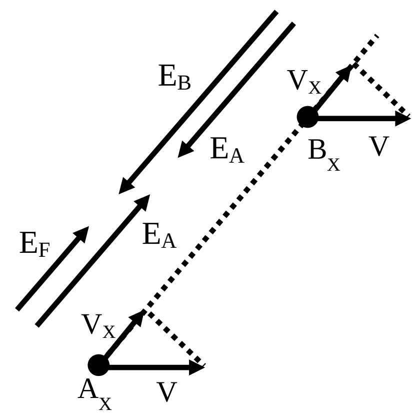

Figure 7

Figure seven shows the observer's measurement device AXBX. The device moves through the medium (observer-to-medium relative motion) by a constants velocity V.

A signal that the observer uses to make measurements has the constant speed E (signal-to-medium relative motion) by definition of the experiment.

In case of static location of the observer in a given medium, V becomes equal to zero. As a result, the signal uses the same speed E in propagation in both directions (both one-way experiments). In that case, the duration of each one-way experiment becomes equal to the duration of any other one-way experiment despite the orientation of the measurement device.

Suppose now this. The observer has some speed V relative to a given medium (or possesses straight uniform observer-to-medium relative motion). In that case, that speed affects the speed of signal propagation in the observer-bound reference frame, and the speed of the signal appears as its "projection" on the measurement device as explained above (motion of the point D in the figures three and four).

That impact has two results. The first result appears as a greater duration of each one-way experiment and a round-trip experiment. Figure 8 shows that result graphically.

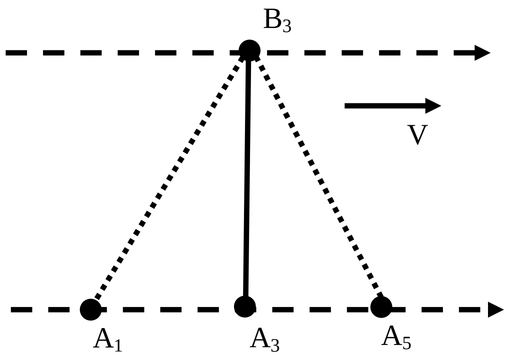

Figure 8

A signal makes interaction with both ends of the measurement device at the points A_1 and B_3 in case of observer-to-medium relative motion with speed V. In case of static location of the observer in a given medium the signal makes interaction at the points A_3 and B_3. As a result, the observer determines a lesser speed of the signal (in case of observer-to-medium relative motion).

In that case of perpendicular motion of the measurement device in a given medium (it is a particular case), duration of both one-way experiments become equal to each other. Therefore, the average speed (EA) determined by the observer that way coincides physical speed that appears as motion of the projection of the signal on the measurement device (point D, figures three and four). That happens because velocity V makes the equal impact on each one-way experiment (and extends the duration of each one-way experiment equally). As a result,

$$D_F = D_B \tag{9}$$

where DF is the duration of a one-way experiment in forward propagation of the signal, DB is the duration of a one-way experiment in backward propagation of the signal.

Suppose now this. The observer changes the orientation of the measurement device (Figure 7).

In that case, the interaction between the measurement device and the direction of its motion in a given medium appears as the projection of the velocity V on the measurement device (on the line that connects two points of measurements AX and BX). That is velocity VX shown in the figure.

Therefore, that projection of velocity affects the average speed EA of the signal the same way in both experiments.

In case of the first one-way experiment, the signal moves (forward) from the point AX to the point BX in the observer-bound reference frame (ORF). As a result, a detectable speed of the signal in the ORF becomes lesser than average (and the one-way experiment has a higher duration)

$$E_F = E_A - V_X \tag{10}$$

In case of the second one-way experiment, the signal moves (backward) from the point BX to the point AX in the observer-bound reference frame (ORF). As a result, a detectable speed of the signal in the ORF becomes higher than average (and the one-way experiment has a lesser duration)

$$E_B = E_A + V_X \tag{11}$$

In case of duration, equations 10 and 11 transform to the following form

$$D_F = D_A + D_X \tag{12}$$

$$D_B = D_A - D_X \tag{13}$$

where D_A is the average duration of the signal propagation determined in case shown in Figure 8, D_F is the duration of forward propagation of a given signal in a given medium at a given orientation of the measurement device, D_B is the duration of backward propagation of a given signal in a given medium at a given orientation of the measurement device, D_X is the duration caused by motion of the measurement device in a given medium at a given orientation of the measurement device.

Therefore, the duration of a round-trip experiment that includes the duration of each one-way experiment becomes

$$D = D_F + D_B = (D_A + D_X) + (D_A - D_X) =$$

$$D_A + D_X + D_A - D_X = 2D_A = \text{constant} \tag{14}$$

VII. A Signal Reflection Ellipsoid

The explanation given above leads to the following result shown in figure nine (see below).

Meaning of points and subscripts in figure nine coincides with their meaning for other figures mentioned above.

Figure nine shows a general case of signal propagation in a round-trip experiment *divided into two one-way experiments.*

Suppose now this. The observer likes to determine elements of signal propagation in a casual orientation of his measurement device. The easiest way to complete that task is this.

In case of orthogonal orientation of the measurement device regarding the direction of its motion in a given medium, the signal covers distance SE in forward and backward propagation ($A_1B_3 = B_3A_5 = S_E$).

In that case, spatial relocation of the observer with his devices regarding a given medium appears as relocation SV = A1A3 during forward propagation of the signal and the equal relocation A3A5 = SV during backward propagation of the signal. As mentioned

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above, a signal covers N times greater distance than the observer in any case ($S_E = NS_V$).

Suppose now this. The observer changed the orientation of the measurement device so as the new orientation coincides with the direction of motion of the observer in a given medium (direction A_1F_9).

In that case, the signal covers some distance during the round trip experiment. It starts propagation from the point A_1 (as usual) covers distance SV twice to reach the point A_5 in the WRF, goes further to the point B5 where it makes reflection from the other end of the measurement device and comes back to the point A_5 where it meets the observer again.

The signal makes interaction with the other end of the measurement device (point B_5 in the WRF) at some moment when the observer keeps some location A_X between points A_3 and A_5. Therefore, the observer covers some distance in WRF (A_XA_5) during the backward propagation of the signal in the given medium (B_5A_5).

In that case, the full path of the signal becomes

$$SR = SF + SB = (SV + SV + SX) + (SX) \qquad (15)$$

where S_X is some distance in WRF between points A_5 and B_5.

From the other hand, S_R (or distance covered by the signal in a round-trip experiment) equals to $2S_E$ (as explained above). Therefore,

$$SR = SF + SB = (SV + SV + SX) + (SX) = 2SE \qquad (16)$$

$$2SE = (SV + SV + SX) + (SX) = SV + SV + SX + SX = 2SV + 2SX \qquad (17)$$

$$2SX = 2SE - 2SV \qquad (18)$$

$$SX = SE - SV \qquad (19)$$

In other words, distance S_X appears as some deviation from the average distance (S_E) covered by the signal in case of parallel orientation of the measurement device to the observer-to-medium velocity. In that case, deviation (S_X) reaches its maximal value.

That value (S_X) adds some distance to forward propagation of the signal and retracts the equal distance from the average distance (S_E) to backward propagation of the signal.

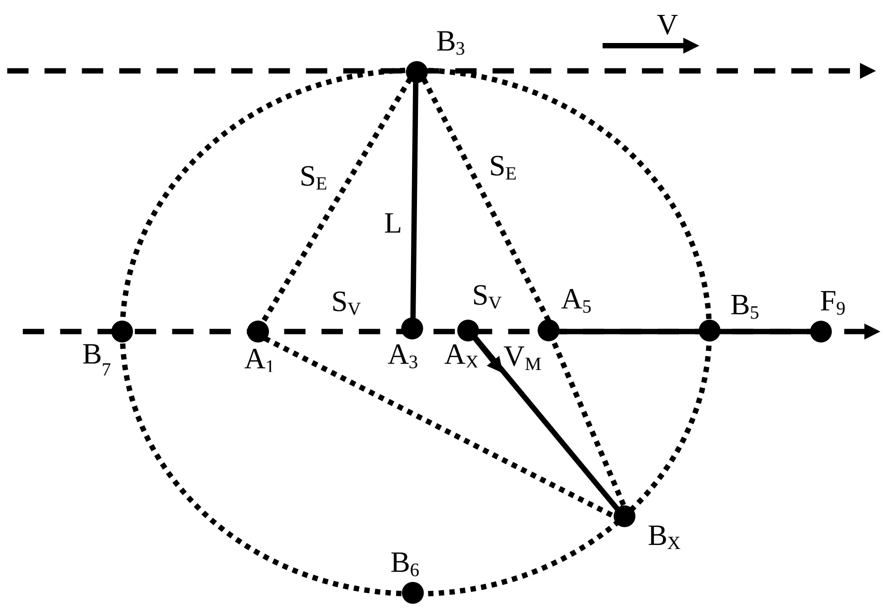

Figure 1

Figure 9

[CH_S] Therefore, as soon as the observer covers constant distance (A_1A_5) in case of straight uniform motion in WRF during a round-trip experiment, rotation of the measurement device any possible way gives an exact ellipsoid (in WRF by the location of the point of reflection of the signal, point B_X) with two focuses which coincide location of the observer at the start and the end of the experiment (points A_1 and A_5). Figure nine shows cross-section of that ellipsoid that transforms into an ellipse that way.

The ellipsoid, made by the point of signal reflection, becomes more elongated if the measurement device increases its speed in WRF and comes back to a sphere as soon as the device-to-medium speed of relative motion drops to zero. In that case, the duration of any one-way experiment in any direction becomes constant. *(S12)*

That is a Signal Reflection Ellipsoid (SRE) that transforms back to a sphere in a particular case when the speed of observer-to-medium relative motion drops to zero.

It is possible for the observer to rotate the measurement device to see the described deviation of distance between the observer's location at the start (or at the end of the measurement) and the point of signal reflection (Bx). In case of V<<E (the speed of observer-to-medium relative motion is many times lesser than the signal-to-medium speed of relative motion) that deviation becomes slightly different from sinusoid if expressed graphically. Figure ten shows a general case of one-way signal propagation in case of rotation.

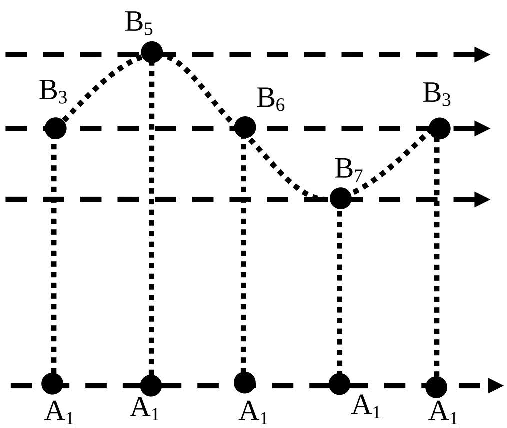

Figure 10

In that case, the observer starts rotation of the measurement device from a casual orientation regarding observer-to-medium relative motion. As soon as the device reaches orthogonal orientation (regarding the direction of device-to-medium relative motion) the wave path (appeared by the signal propagation in a given medium) reaches the distance A_1B_3 in the Wave Reference Frame.

Further rotation of the measurement device causes interaction of the signal and the other side of the measurement device at the point B5. As a result, the signal covers the greatest distance in the experiment.

Further rotation of the measurement device causes interaction of the signal and the other side of the measurement device at the point B_6. That is orthogonal orientation again. As a result, the distance A_1B_3 becomes equal to the distance A_1B_6.

Further rotation of the measurement device causes interaction of the signal and the other side of the measurement device at the point B_7. That is the shortest distance (A_1B_7) covered by the signal during the experiment.

Further rotation of the measurement device causes interaction of the signal and the other side of the measurement device at the point B_3 as soon as the device reaches the orthogonal orientation again. After that, the process starts all over again.

In case of duration measurement of the signal propagation in a one-way experiment, the observer sees the same deviation from the mean value of duration because the signal covers a variable distance in a given medium caused by rotation of the device. *(M)* (S13)

In case of a two-way experiment (or a round trip experiment), Figure 10 transforms to Figure 11.

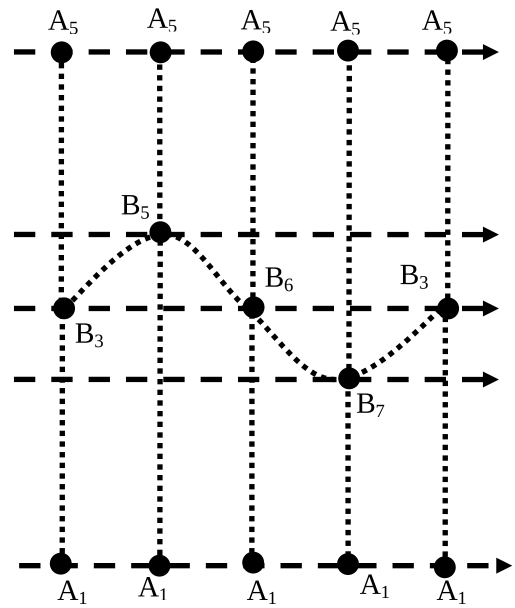

Figure 11

In case of a round-trip experiment, the reflected (or retransmitted) signal comes to the point A_5 where it meets the observer again.

As soon as the signal meets the other side of the measurement device at the point B_3, the signal covers the equal distance in its backward propagation (B_3A_5).

Further rotation of the measurement device causes interaction of the signal and the other end of the measurement device at the point B_5. That coincides with the greatest wave path in forward propagation (A_1B_5) and the shortest wave path in backward propagation (B_5A_5) of the signal in a given medium (or in a Wave Reference Frame).

Full wave path of a round-trip experiment that includes both one-way experiments remains constant as explained above. Therefore distance $A_1B_xA_5$ remains constant (see Figure 11).

VIII. The Doppler Effect

A wave has some extra parameters in comparison with an object (body). Those are frequency, wavelength, and phase. All of them are interconnected by wave propagation through a given medium and the duration of wave creation. The following figure shows

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those interconnected parameters in key experiments of relative and absolute motion.

Figure twelve represents wave propagation and observer-to-wave interaction in four experiments (A, B, C, and E). Wave propagation happens along the X-axis. Axis D represents oscillations of the oscillating devices used by the observers. It is a relative axis. Therefore, it does not have points but represents pulses of oscillating devices by rectangles.

All experiments involve one observer with an oscillating and a signal transmitting device (the observer A, the active observer) and two observers with oscillating devices and signal receivers (observers B and C, passive observers).

The observers keep motionless locations regarding the medium during the experiment. The experiment 'A' begins. The observer 'A' starts disturbing of the medium at the point WA4 by a disturbing device. The device makes physical interaction with a given medium and transmits disturbance to the medium at the point of the device location. The disturbed medium transmits disturbance to the next point that locates farther from the device location. That process takes some duration. As a result, disturbance generated by the disturbing device moves away from the point of disturbance origin in any direction with some constant speed that depends on the physical properties of a given medium. Axis 'A' (fig. 12) shows that process graphically in one casually taken direction.

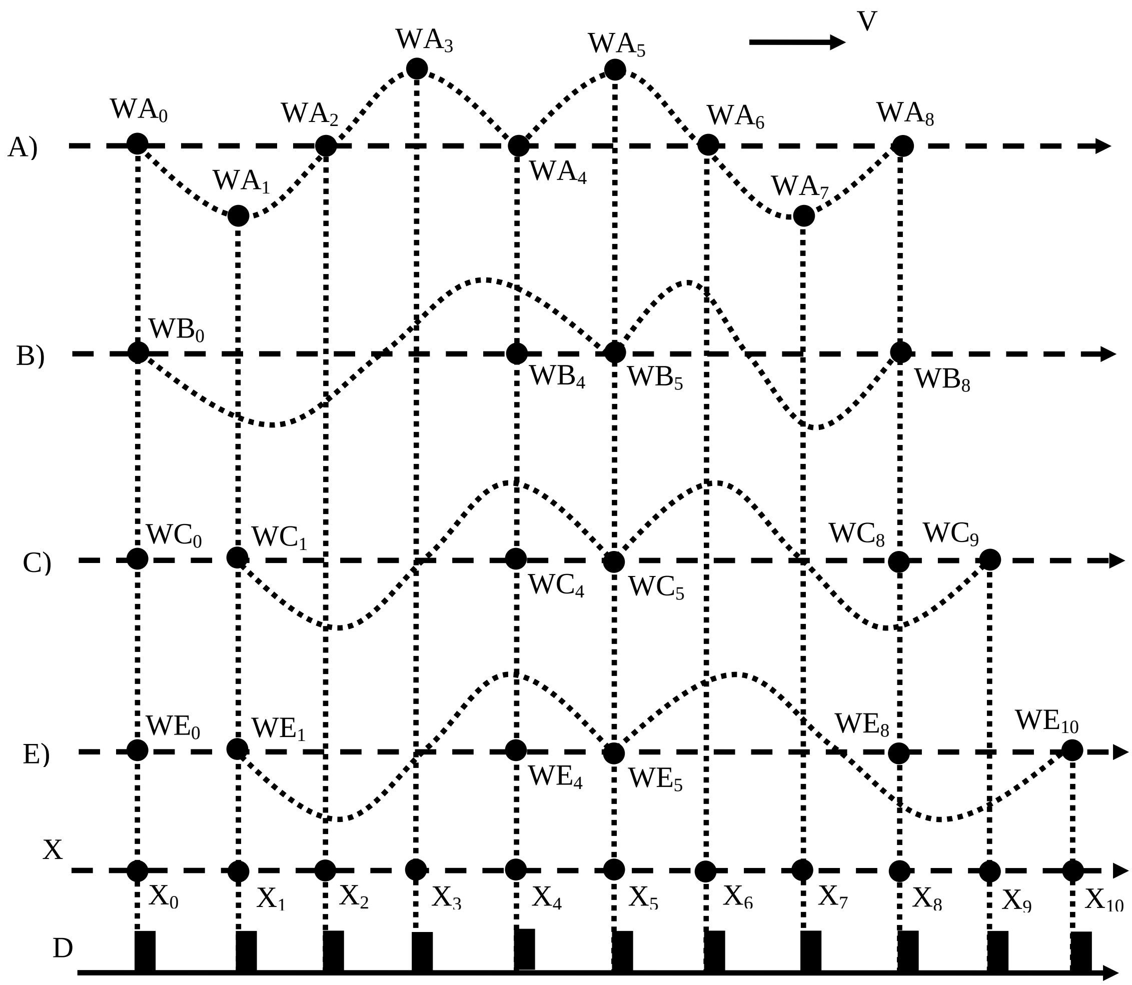

Figure 2

Figure 12

The oscillating device of the observer 'A' makes oscillations during the experiment. The disturbance made by the disturbing device reaches the point WA5 in one direction and the point WA3 in the opposite direction after one oscillation of the oscillating device. That coincides with equal distances ΔX covered by the disturbance in two opposite directions (X5 – X4) and (X4 – X3). In other words, the speed of the signal in a given medium becomes ΔX per an oscillation of the oscillating device.

The disturbing device of the observer 'A' makes a sinusoidal disturbance. As a result of physical

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interaction between the device and a given medium, the medium follows the same way of disturbance. Therefore, sinusoidal disturbance made by the disturbing device reaches points WA_6 and WA2 in two oscillations of the oscillating device.

In its further propagation, the disturbance reaches points WA0 and WA_8 in four oscillations of the oscillating device. After that, the process of disturbance propagation uses the same way for the next circle of disturbance and so on until the disturbing device keeps the medium disturbed.

According to the figure, the duration of the full circle of disturbance becomes equal to the duration of four oscillations of the oscillating device.

Observer 'B' keeps location at the point WA_8 during the experiment. The observer detects a disturbance and makes some measurements. He detects this.

The disturbance reaches the observer and passes him making physical interaction with the detecting device. The observer confirms that by detection of changing magnitude of disturbance by the same law that was used at the point of disturbance creation.

The observer 'A' makes a comparison of duration of the full circle of the disturbance made by the disturbing device, and the number of oscillations came from the oscillating device (N, four in a given case of Figure 12).

The observer 'B' makes a comparison of duration of the full circle of disturbance detected by the detecting device, and the number of oscillations came from the oscillating device of the observer 'B' (the local oscillating device). The full circle of the disturbance coincides with four oscillations of his oscillating device.

Numerical coincidence coming from both measurements leads the observers to the following conclusion.

The speed of the disturbance in a given medium remains constant during the experiment, and the speed of observer-to-medium relative motion remains constant as well. As a result, the observer-to-disturbance speed of relative motion remains constant. (S14)

That happens because any deviation of a given duration shows some deviation in the observer-to-disturbance speed of relative motion. In other words, equal duration of the process of disturbance for both observers coincides their motionless location regarding the medium that supports propagation of the disturbance.

The observer 'C' also agrees observers 'A' and 'B' because he has the same result of the measurement. After the first experiment, the observers conduct the second experiments (B). The observer 'A' starts motion toward the observer 'B' (to the right, see fig. 12) so as he covers the distance ΔX during one oscillation of the local oscillating device.

The disturbing device keeps its operation the same way as in the first experiment, but observers 'B' and 'C' detect something unequal the first experiment.

The disturbing device starts the circle of the disturbance at the point WB_4 and finish that circle at the point WB_5. Therefore, the medium spends some duration to transmit that disturbance from the point of creation to the point of detection as well as in the first experiment. The disturbance propagation from the point WB4 to the observer 'B' located at the point WB_8 takes four oscillations of the oscillating device of each observer.

The disturbance propagation from the point WB_5 to the observer 'B' located at the point WB_8 takes three oscillations of the oscillating device of each observer.

As a result, the beginning of the circle of disturbance reaches the observer 'B' in four oscillations of the local counting device, and the end of the same circle of disturbance reaches the observer 'B' in three oscillations. Therefore, the observer detects some reduction of the full duration of the circle of disturbance equal to the one oscillation (in a given case). As a result, the observer 'B' detects the circle of disturbance equal to three oscillations of the local oscillating device. That is an observable fact for the observer caused by his way of measurement.

However, another way of measurement gives a null result. For example, if the observer measures the speed of disturbance propagation regarding his location, he detects not any deviation from the measurement in the same way for the first experiment. That happens because the speed of disturbance in a given medium remains constant as long as the physical properties of the medium remain constant.

The observer 'C' determines a similar situation in the opposite propagation of the disturbance. In that case, the disturbance propagation from the point WB_4 to the observer 'C' located at the point WB_0 takes four oscillations of the oscillating device of each observer.

The disturbance propagation from the point WB5 to the observer 'C' located at the point WB0 takes five oscillations of the oscillating device of each observer.

As a result, the beginning of the circle of disturbance reaches the observer 'C' in four oscillations of the local counting device, and the end of the same circle of disturbance reaches the observer 'C' in five oscillations. Therefore, the observer detects some increment of the full duration of the circle of disturbance equal to the one oscillation (in a given case). As a result, the observer 'C' detects the circle of disturbance equal to five oscillations of the local oscillating device. That is an observable fact for the observer caused by his way of measurement. In other words, *The duration of signal detection becomes affected by the duration of signal propagation from different points with different distances from the location of the passive observer.* (S15)

Therefore, the detectable duration of the circle of disturbance for both observers (B and C) changes to the same extent but in the opposite way. If those observers put together each duration detected separately, they have precisely the same value (summarized value) of duration that they have in the first experiment.

That happens because the disturbance-to-medium speed of relative motion remains constant in both experiments.

After the second experiment, the observers conduct the third experiments (C). In that case, all observers keep straight uniform motion in the same direction regarding the medium so as each of them covers the distance ΔX in one oscillation of the oscillating devices.

In that experiment, the disturbing device starts the circle of the medium disturbance at the point WC4 and ends it at the point WC5 in the WRF.

The observer 'B' starts detection of the disturbance circle at the point WC_8 and ends it at the point WC_9.

Therefore, the beginning of the circle of disturbance spends four oscillations to reach the observer (in a given case), and the end of the circle of disturbance spends the equal number of oscillations (four) to reach the observer at the point WC_9.

The observer 'C' has a similar situation. The beginning of the circle of disturbance spends four oscillations to reach the observer at the point WC0 (in a given case), and the end of the circle of disturbance spends the equal number of oscillations (four) to reach the observer at the point WC1.

As a result, the duration of the disturbance propagation in a given medium becomes equal by magnitude but opposite by sign impact on the process of detection of the circle of disturbance by its duration. Therefore, the duration of Disturbance Circle Creation (DCC) made by the disturbing device (of the observer 'A') becomes equal to the duration of the Disturbance Circle Detection (DCD) (observers 'B' and 'C').

That *numerical coincidence* leads the observers to the heavy illusion that the experiment C becomes equal to the experiment 'A' because they do not detect any difference of those experiments by their *method of measurement.*

However, at the physical level, those experiments have a significant difference. A full circle of the medium disturbance made by the disturbing device (the experiment 'A') covers some distance L_A (in WRF) equal to $WA_8 – WA_4$. It is also equal to $WA_4 – WA_0$ in the opposite direction of the disturbance propagation. That distance is a physical attribute of disturbance propagation in a medium. In physics, disturbance makes propagation through a medium by waves. Therefore, a full circle of the medium disturbance made by a disturbing device becomes Physical Wave Duration (PWD) and the distance covered by that wave in WRF becomes Physical Wave Length (PWL).

In the second experiment (B), waves coming from the disturbing device have the same Physical Wave Duration (PWD) (by operation of the disturbing device) but a different Physical Wave Length (PWL). That happens because the disturbing device moves regarding the medium during the process of wave creation (points $WB_4 – WB_5$). Therefore, each element of a wave becomes created (by the disturbing device) at a different point of the medium (in the WRF) that coincides with the *physical location* of the disturbing device at a given moment. As a result, Physical Wave Length becomes variable in that experiment and dependent on the direction of motion of the disturbing device.

The disturbing device keeps the same speed in the WRF in the third experiment (C). Therefore, Physical Wave Length and Physical Wave Duration remain equal to the experiment 'B.' However, the observers do not detect that because all devices keep straight uniform motion regarding the medium.

The observer 'B' makes physical interaction with the Physical Wave Length of WB8 – WB5 shorted for ΔX because of disturbance device to medium relative motion in comparison with Physical Wave Length of the first experiment.

As a result of observer 'B' to medium relative motion, the duration of interaction of its detecting device and the Physical Wave Length leads to increasing of the duration of the measurement in comparison with the second experiment (B), and the detected duration of a disturbance circle (that the observer detects) comes back to the value observed during the first experiment (A).

In other words, that coincidence of measured duration caused by the transformation of the Physical Wave Length in a given medium (caused by motion of the disturbing device regarding that medium) and Duration Transformation at the detecting device (caused by the method of measurement).

That numerical coincidence leads to a heavy illusion of the observers that the experiment 'C' has not any difference from the experiment 'A' and the Physical Wave Length is the same in both experiments and any direction *regardless their condition of motion*.

The observers conduct one more experiment 'E' after experiment 'C.' In that experiment, the observer 'B' increases its speed and covers doubled distance in one oscillation of the oscillating devices (2ΔX, WE10 – WE_8).

The beginning of the disturbance circle spends four oscillations (in a given case) to reach the observer 'B' (WE_8 - WE_4) and the end the disturbance circle

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spends five oscillations to reach the observer 'B' (WE_{10} – WE_5). Therefore, the observer counts one more oscillation by its local oscillating device during physical interaction of the local detecting device and the physical wave created in the medium by the disturbing device of the observer 'A.' As a result, the observer detects the increased *duration of the observing process*.

That observation leads the observer to a heavy illusion that Physical Wave Length also increased by its relative motion regarding the observer 'A' because the observer 'C' that keeps motionless location regarding the observer 'A' detects no deviation in the duration of the observing process.

An ordinary observer usually uses a notion of frequency instead of duration in experiments with waves because a standard unit of duration is many times greater than the duration of the wave. Frequency is the inversed value of duration. Therefore, all observations and physical processes explained above become applicable to frequency *but still more accessible to explain in a notion of duration*.

The first scientist who explained measurable frequency deviations in wave propagation and moving observers was Christian Doppler.

'Doppler effect is the apparent difference between the frequency at which *sound or light waves* leave a source and that at which they reach an observer, caused by relative motion of the observer and the wave source. This phenomenon is used in astronomical measurements, in Mössbauer effect studies, and in radar and modern navigation. It was first described (1842) by Austrian physicist Christian Doppler.' (Doppler Effect. (2008). Encyclopedia Britannica)

The critical aspect of a definition given above is 'the effect caused by relative motion of the observer and the wave source.' Strictly speaking, that definition applies only to the experiment 'E' (see above) and observers A and B because they have relative motion 'of the observer and the wave source' regardless observer-to-medium, disturbance-to-medium (wave-to-medium) and source-to-medium relative motion.

In general case, the Doppler Effect transforms into a set of effects. Those are:

1. Active Doppler Effect (ADE) that makes the linear deviation of the Physical Wave Length in a given medium by source-to-medium relative motion (see experiment 'B').
2. Passive Doppler Effect (PDE) that makes frequency deviation for the observer (that changes his observer-to-medium speed of relative motion) by increasing or decreasing the duration of the observer to physical wave interaction
3. Double Doppler Effect (DDE) is a combination of Active and Passive Doppler Effects that hides physical wavelength deviation in case of zero speed of observer-to-source relative motion. Otherwise, it appears as the common Doppler Effect (see experiment 'C').

The Double Doppler Effect is responsible for the heavy illusion mentioned above that the experiment 'C' has not any difference from the experiment 'A.' That illusion led to the heavier illusion that in case of straight uniform motion of all observers involved in the experiment the idea of physical medium that supports propagation of the physical waves becomes redundant and can be frown away. In that case propagation of waves becomes explainable as their motion "by themselves" without any physical interaction with a medium.

That idea possessed huge dissemination especially in the area of Electromagnetic Radiation and light propagation through space.

That point of view shows one more big illusion explained in the following section.

IX. Z-Continuum

In physics, the presence of something can be confirmed by its physical, measurable interaction with something else. In case of measurement, something that detects the presence of something else becomes a measurement device. Something that makes physical interaction with a detecting unit of a measurement device becomes a detectable thing. Measurable Physical Interaction of detectable thing and the detecting unit becomes a measuring value.

The easiest way of measurement comprises the utilization of the same attribute in a detecting unit and in a detectable thing.

For example, the temperature of given liquid put in a glass can be measured by a thermometer that makes physical interaction with that liquid (detectable thing) by temperature (the same physical attribute). The result of that physical interaction leads to a value indicated by the thermometer. In other words,

> *Any measurement device measures a given attribute of a detectable thing by its value (S16)*

A thermometer mentioned above, has some mass, but that attribute cannot be used in measurements because it is not an attribute of measurements for a thermometer.

From the age of Newton presence of fields and their physical existence supports by force method that uses force measurement to detect and measure force attribute of a given field.

'Electric field is a region around an electric charge in which an electric force is exerted on another charge. Instead of considering the electric force as a direct interaction of two electric charges at a distance from each other, one charge is considered the source of an electric field that extends outward into the surrounding space, and the force exerted on a second

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charge in this space is considered as a direct interaction between the electric field and the second charge.' (Electric field. (2008). Encyclopedia Britannica)

That definition has reference to an electric charge. 'Electric charge is basic property of matter carried by some elementary particles. Electric charge, which can be positive or negative, occurs in discrete natural units and is neither created nor destroyed.

'Electric charges are of two general types: positive and negative. Two objects that have an excess of one type of charge exert a force of repulsion on each other when relatively close together. Two objects that have excess opposite charges, one positively charged and the other negatively charged, attract each other when relatively near.' (Electric charge. (2008). Encyclopedia Britannica)

The following Figure 13 explains electric attribute of field graphically.

The figure shows schematically two physical particles A and B separated by some distance (seen at the X-axis). Both particles have electric charge shown in the vertical axis. Zero levels (magnitude) of charge coincides with X- axis (points QA0 and QB0). A positive value of charges shown above X-axis and the negative value is shown below X-axis. Under usual circumstances, each particle has some value of charges of both signs. That case is shown in the figure by points $QA^{+}1$, $QA^{-}1$ for the particle A and $QB^{+}1$, $QB^{-}1$ for the particle B.

In Z-Theory something that makes physical interaction with something else by a given way of disturbance and supports propagation of that disturbance calls Z-Field or Z-Continuum. Those categories are interchangeable in Z-Theory.

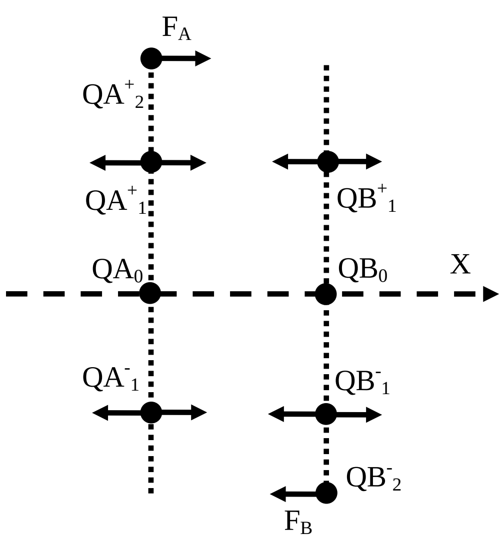

Figure 13

In case of the figure, Z-Continuum accepts disturbance caused *by the presence of the charge* and propagates that disturbance in all directions that appears for the observer as Z-Field detectable by force method of measurement (observation).

As soon as that disturbance reaches another particle, physical interaction between disturbed Z-Continuum and the particle appears as some force applied to the particle.

In case mentioned above, both particles have an equal electric charge. Therefore disturbance of both charges makes equal interaction with Z-Field. Z-Field supports propagation of that disturbance to another particle and makes physical interaction with it.

In a given case, both particles have equal value of positive and negative charges. As a result, the interaction of those charges with Z-Field (at the points of location of the particles) and Z-Field with another particle makes the same value of interaction at both locations, but they have opposite directions.

The result of that interaction appears as compensated forces (net force) applied to each particle at the point of its location.

The observer that uses force method of field detection detects nothing that way because he does not detect anything by using way of measurement. As a result, the observer concludes that both particles have not any interaction. That is incorrect because the particles show not any interaction only by a given method of measurement.

The illusion disappears as soon as both particles possess some level of uncompensated charges. Those are $QA^{+}2$ level and $QB^{-}2$ level (shown in Figure 13).

Those uncompensated charges make a disturbance in Z-Field the same way as other charges. However, they are not compensated by other charges of the particles. As a result, the interaction of Z-Field with those uncompensated charges at the points of particle locations shows some forces applied to both particles (FA and FB) and the observer becomes able to detect that situation by Force Method of Measurement (FMM) (a given method of measurement).

There is one more critical aspect of interaction explained above. That is the distance between particles. Z-Field transmits any disturbance by a given speed because of that process caused by physical interaction between points of the field. Therefore, propagation of any disturbance cannot be faster of slower than changes made by that disturbance in the Z-Field. As a result,

Propagation of any disturbance in Z-Continuum (Z-Field) takes some duration measured in Wave Reference Frame associated with that continuum (the field) (S17)

It is feasible for the observer to change some charges in some object and keep a number of charges variable continuously. In that case, the disturbance caused in Z-Field by the presence of charges also becomes variable continuously. Z-Field transmits that disturbance (as well as any other disturbance) in all directions as mentioned above. That disturbance is well known as Electromagnetic Wave. The following Figure 14 shows that process graphically.

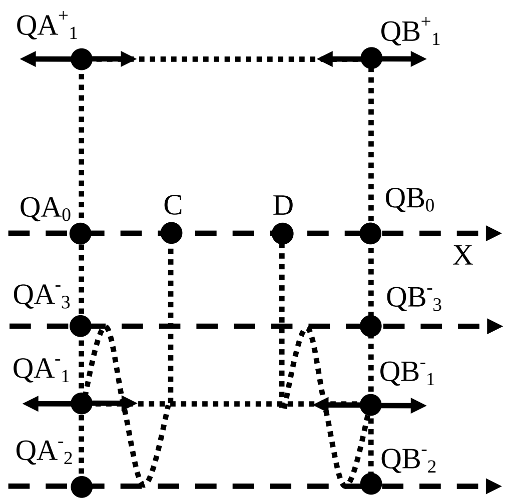

Figure 14

Letters and subscripts of Figures 13 and 14 have the same meaning.

A mentioned above, the observer makes continuous disturbance by continuous variation of a number of negative charges at point A. Therefore, a negative charge of the disturbing device becomes variable from $QA^{-}3$ to $QA^{-}2$.

Z-Field makes propagation of that disturbance as explained above. The observer B located at point B detects that disturbance by Force Method of Measurement. In other words,

> *Electromagnetic Wave appears as disturbance propagation by Z-Field caused by manipulation of negative charges at the point of disturbance origin. That is Negative EM-Wave (NEMW) (S18)*

The observer A cannot manipulate positive charges. Therefore, the creation of EM-Wave by the positive component is not feasible for the observer. That limitation comes from the method of EM wave creation. The observer uses the easiest way to make a disturbance in Z-Field by adding or retracting electrons (negatively charged particles) to the disturbing device at the point of disturbance. Positively charged particles (protons) cannot be used that way because they are trapped in the crystal structure of a disturbing device.

As a result, a constant number of positively charged particles at the point of disturbance origin (A) causes a constant value of interaction of Z-Field and the detecting device at point B. Therefore the observer B does not comprehend that interaction by *his method of measurement*.

Suppose now this. The observer ‘A’ makes pulses of continuous disturbance separated by some duration of no disturbance.

Figure 14 shows that case as a wave between points A and C and another wave between points D and B.

The observer B detect the first pulse by detection of NEMW at point B. The observer detects nothing after that (until the next pulse) and falls under the illusion that there is not any interaction between points A and B that way. However, that interaction does exist but becomes undetectable for the observer *by his method of measurement*.

That illusion made a massive impact on 20th-century physics by the idea that EM Waves *need not any medium for propagation*.

There is one more question here shown in the following Figure 15. Letters and subscripts of Figures 14 and 15 have the same meaning. Figure 15 shows the propagation of NEMW by interaction with Z-Field (Z-Continuum) as explained above.

However, both observers associate propagation of that wave in something that they call Space because they do not comprehend the presence of Z-Field. That space mention in the figure as Space type (A).

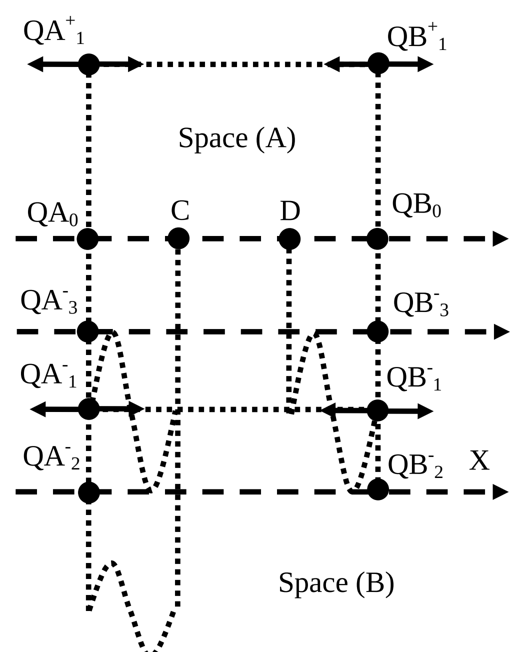

Figure 15

From their point of view, EM-wave makes propagation by itself in pure space. That situation is shown in the figure below the X-axis (Space (B)).

Here appears a question about space. Does it possible to comprehend space as something that lacks all physically measurable and detectable attributes?

That is impossible because there is not any disturbance that can propagate through such space as explained above.

Suppose now this. The observer A uses his disturbance device in the Space B, but the observer B detects nothing because there is not any disturbance (including static disturbance caused by the presence of the observer A and his device) that reaches the observer B. Therefore, the observer B becomes unable to detect anything in such situation. In other words,

"Pure Space" that has not any physical attribute that can be measured does exist only in the human mind as a pure category without any reference to a physical entity that supports propagation of disturbance (Z-Continuum) *(S19)*

Therefore, the notion of "pure Space" becomes redundant for the description of physical processes. Z-Field (or Z-Continuum) replaces that category in Z-Theory.

Category of Space is still applicable for Z-Theory in the form of Clear-Event Space (CE-Space) that coincides Space type (A) (Figure 15).

As far as humankind concern, the entire Universe appears for observers as CE-Space because earthbound observers can detect remotely located objects in the Universe by interaction explained above. For example, 'quasar is any of a class of rare cosmic objects of high luminosity as well as strong radio emission observed at extremely great distances… The tremendous brilliance of quasars allows them to be observed at distances of more than 10,000,000,000 light-years.' (Quasar. (2008). Encyclopedia Britannica)

X. A Wave Oscillator

Suppose now this. An observer likes to make an oscillator based on wave propagation in a given medium. The following figure shows the principle of operation of that device graphically.

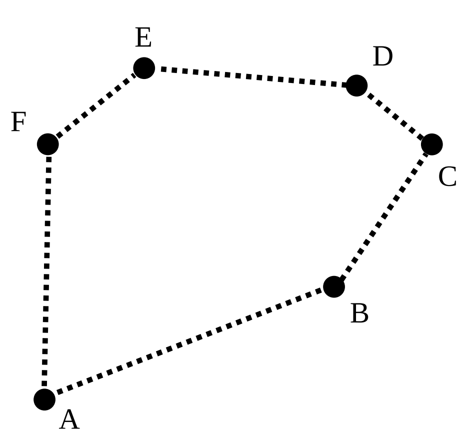

Figure 16

The observer sends a signal through a given medium from point A in a round trip by some number of other points. Each of those points makes reflection of retransmission of the signal as soon as the signal reaches a given point to the next point. As a result, the signal makes propagation in the medium by points ABCDEFA.

That propagation takes some duration, and the signal comes back to the first point (A) later than emitted.

The observer uses that duration of signal propagation to make pulses separated by that duration. The device emits a signal, makes a pulse, waits for the signal (to come back), emits the signal again and makes pulse again. As a result, the device makes pulses based on the duration (separated by the duration) of a round-trip propagation of a given signal (wave) in a given medium and becomes a Wave-Oscillator (WO).

In case of static location of WO in a given medium, the device makes pulses separated by some duration. The device works for a while, and the observer changes its orientation in a given medium. That action makes not any impact on the duration of pulses coming from the device because the distance covered by the signal in the physical medium remains constant.

At the next experiment, the observer puts the device in accelerated motion reading the medium. In that case, the duration of each pulse becomes longer than the duration of the previous pulse because the signal covers a higher distance in each measurement.

At the next experiment the observer drops the acceleration of the device to zero. As a result, the device comes to the straight uniform motion regarding the medium.

In that case, the duration of each oscillation coming from the device remains constant because each signal sent to the medium keeps a constant distance of propagation in that medium.

From the observer's point of view, the signal covers some distance in the observer-bound reference frame (ORF) that is also constant from his point of view. However, the physical wave path of the signal in the medium does not match the length of the signal path in the observer bound reference frame. As explained above, the observer sees only some "projection" of a physical signal that "slides" along each element of the device.

At the next experiment, the observer puts the moving device in a rotation. In that case, the duration of each pulse coming from the device remains constant as explained above.

In the most straightforward case, the observer uses only AB element of the device and comes to the Linear Wave Oscillator (LWO) (a particular case of Wave Oscillator) explained in detail in the section VII 'A Signal Reflection Ellipsoid.'

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Those experiments lead the observer to the following conclusion:

Duration of signal propagation in a Wave Oscillator depends on the speed of signal-to-medium relative motion, the size of the oscillator (size of its elements), and the speed of device-to-medium relative motion. That duration is independent of the orientation of the device. (S20)

XI. Physical Experiments

Michelson-Morley experiment is the most famous experiment for 19th-century physics. The impact of the experiment was so huge that all 20th-century physics depends on it. However, Michelson himself made some critical mistakes in his famous article published in 1887. There are two figures and some citations from that work below.

'The transmitted ray goes along ac, is returned along ca1 and is reflected at a1, making ca1e equal 90-α, and therefore still coinciding with the first ray. It may be remarked that the rays ba1 and ca1, do not now meet exactly in the same point a1, though the difference is of the second order; this does not affect the validity of the reasoning. Let it now be required to find the difference in the two paths aba1 and aca1.'

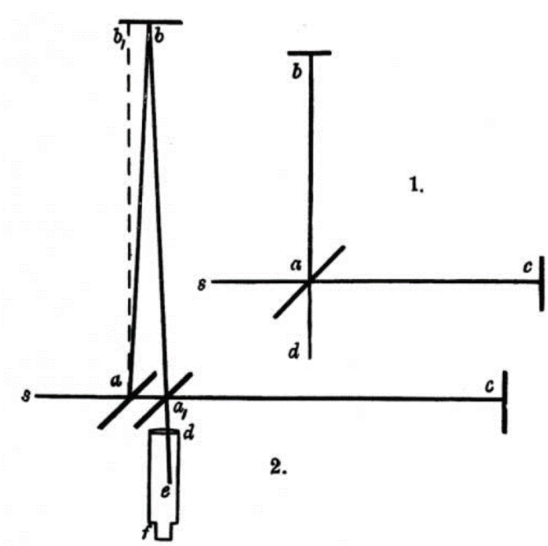

Figure 17: (Figures 1 and 2 from the Michelson article)

'The difference is therefore D(v2/V2)' (p. 336)
Therefore, from Michelson's point of view,

'The reflected rays of the interferometer in their backward propagation do not now meet exactly in the same point (MA)

That is Michelson's postulate made a priori (or before experiment). He used a very simplified way of thoughts and calculations. For example, he made all qualitative and quantitative descriptions of the experiment using one particular case instead of a general case.

Observer-to-medium relative motion is unknown for the observer before the experiment, and the measurement device has a casual orientation at the beginning of any such experiment.

As a result, Michelson's speculations contradict general case of signal propagation explained above. The central contradiction comes from the violation of the statement (S7).

As a result, Michelson's calculations lead to a different ratio (N) of observer-to-medium relative motion (V) and signal-to-medium relative motion (E) *in a different orientation of the measurement device*. That contradicts a priori statement of Michelson that the observer keeps straight uniform motion during the experiment and the signal keeps anisotropic propagation in a given medium (i.e., space, by Huygens Principle).

According to the scientific method, any a-priory statement should be confirmed *by a relevant experiment*. In a given case, the experiment destroyed a-priori point of view claimed by Michelson (with all his speculations).

Despite that fact, Michelson insists that his point of view is correct and the experiment is wrong. According to the scientific method, he should conduct a similar experiment in another signal-medium combination to check his point of view. *He never conducted any such experiment*. That experiment was conducted many decades later by a German researcher Norbert Feist.

Norbert Feist has done something that should be done by Michelson himself. Norbert conducted Michelson-Morley experiment in the acoustic environment using the acoustic signal in air. He had the following result.

'An ultrasonic range finder was mounted on a horizontally rotatable rail at fixed distance, s, to a reflector on the top of a car. The change of the distance reading, s, determined the two-way velocity of sound as a function of the car's velocity and direction. As a result of this experiment, the out and back velocity C_2 was determined to be isotropic – as in the optical case of the Michelson-Morley experiment. Within the experimental error, the velocity was found to vary as $C_2 = (C^2\text{-}V^2)/C$

'The results confirm the hypothesis that the two-way velocity of sound is isotropic in a moving system – as in the case of the optical MME (p.2)'.

According to the experiment he has the following figures for various orientation of the measurement device.

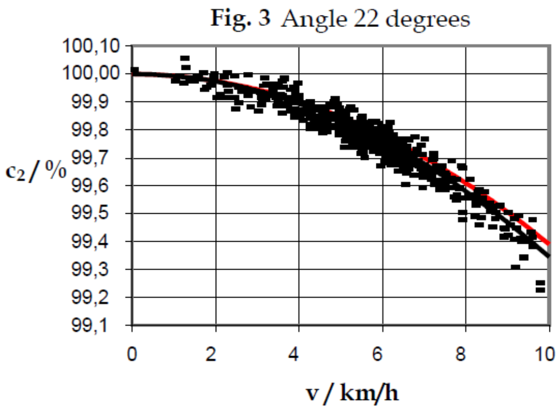

Figure 18: (Figure 3 of the original article)

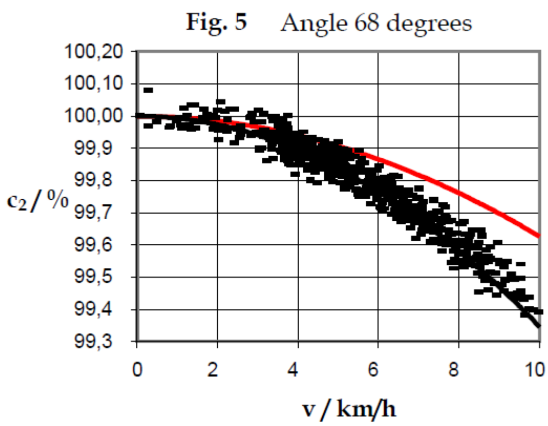

Figure 19: (Figure 5 of the original article)

Those diagrams confirm the result explained above in details that the full duration of a signal round-trip experiment in case of uniform straight motion of the observer in any medium remains constant regardless orientation of the measurement device and signal-medium combination.

Therefore, from the one hand, optical and acoustic tests destroy all speculations of Michelson. From the over hand, they confirm explanations given above by Z-Theory for any signal-medium combination.

Moreover, the explanation given above leads to the conclusion that observer-to-medium relative motion can be determined by analysis of the duration of one-way experiments with signals (see statement (S11)).

Such experiments were not possible in the 19th century and at the beginning of the 20th century for light-space combination until atomic "clocks" were invented. Such devices have enough oscillation frequency of the oscillating device and stability of those oscillations that can be used in the measurement of the duration of one-way experiments in any signal-medium combination including light-space combination.

The first published evidence of such experiments comes from Roland De Witte Experiments.

According to the source, 'In 1991 Roland De Witte carried out an experiment in Brussels in which variations in the one-way speed of RF (Radio Frequency) waves through a coaxial cable were recorded over 178 days. The data from this experiment shows that De Witte had detected absolute motion of the earth through space …'

Figure 20 shows that result graphically.

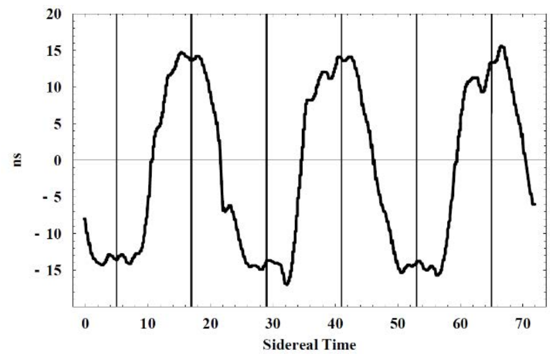

Figure 20: (Figure 6 of the original article): Variations in twice the one-way travel time, in ns, for an RF signal to travel 1.5 km through a coaxial cable between Rue du Marais and Rue de la Paille, Brussels. An offset has been used such that the average is zero. The cable has a North-South orientation, and the data is the difference of the travel times for NS and SN propagation. The sidereal time for maximum effect of _5hr and _17hr (indicated by vertical lines) agrees with the direction found by Miller. Plot shows data over 3 sidereal days and is plotted against sidereal time. De Witte recorded such data from 178 days, and confirmed that the effect tracked sidereal time, and not solar time. Miller also confirmed this sidereal time tracking. The fluctuations are evidence of turbulence in the flow

That experiment shows this. Despite any method of "atomic clock synchronization" one-way experiment of light propagation between those clocks shows constant instability of their indication. That instability shows sinusoidal deviation with a constant duration that coincides with the sidereal rotation of the planet. That is Aurora Effect explained in details by the source 6.

Strictly speaking, that deviation caused by different distance A1BX (figure 9) covered by a signal (light) in a given medium (space) by one-way measurements in a various orientation of the measurement device.

Therefore, it is not a "clock problem." It is a problem of human comprehension of the experiment. Clocks synchronized by any method keep their operation regardless of any illusion of an observer. They only count oscillations coming from the corresponding oscillating device and do nothing more (as explained above).

Deviation found by De Witte comes from various distance of signal propagation in the one-way experiment. Greater distance caused a greater duration of signal propagation that appears for the observer as a

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higher number of oscillations counted by the counting device of the "clock." That coincides with the law of any other motion. There is not here any room for "mystery."

There is one more experiment in that area that supports all explanations given above. That is Torr-Kolen Experiment.

That experiment was conducted in 1981. They used two "clocks" with rubidium oscillating devices.

Figure 21 (seven) from their paper published in 1984 shows their findings. The figure (see below) shows the same sinusoidal deviation as in case of De Witte Experiment. Rubidium oscillator has lesser precision than cesium one. Therefore, data from De Witte Experiment shows a better picture.

In both cases, one–way experiments show the same way of light propagation. Duration of that propagation depends on the one-way direction of measurement.

The full process of deviation repeats in one sidereal revolution of the planet. That happens because all earth-bound observers and their measurement devices move and rotate with the planet regarding the Z-Continuum (medium, i.e., space) that makes propagation of the signal (NEMW, i.e., light) possible (as explained above).

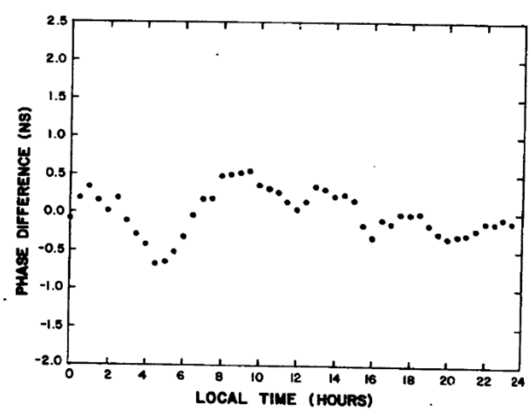

Figure 21: (Figure 7 of the original article)

The coherent sum of 23 days' data for the separated clocks for the period February to June, 1981. Summing was carried out using half hour bins.

Both experiments give physical support for the Figure 10 that shows a general case of the duration of a one-way experiment in any medium by motion and rotation of the measurement device regarding the medium (that supports propagation of the signal).

XII. Zero Synchronization Remote Operation Method (ZSROM)

Suppose now this. There are two Earth-bound observers A and B who like to detect Aurora Effect in a physical experiment.

Each observer uses a local oscillating device and corresponding counting device. As soon as they turned them on the indication of each counting device becomes casual. Despite that observers start the experiment.

The observer A sends an Electromagnetic Signal (EM-Signal) to the observer B and records the number shown by the local counting device at that moment.

The observer B detects the signal and sends it back immediately. The observer also records the number shown by the local counting device at that moment and sends it to the observer A by a communication channel.

The observer A detects the signal came back from the observer B and records the number shown by the local counting device at that moment.

The following Figure 22 shows that process graphically.

The difference of indications of both counting devices in case of forward propagation of the signal becomes to B1 – A1 = M1. The difference of indications of both counting devices in case of backward propagation of the signal becomes to A2 – B1 = N1. It looks like there is nothing unusual in that experiment.

The observers wait for a while and conduct one more experiment sending and receiving the signal.

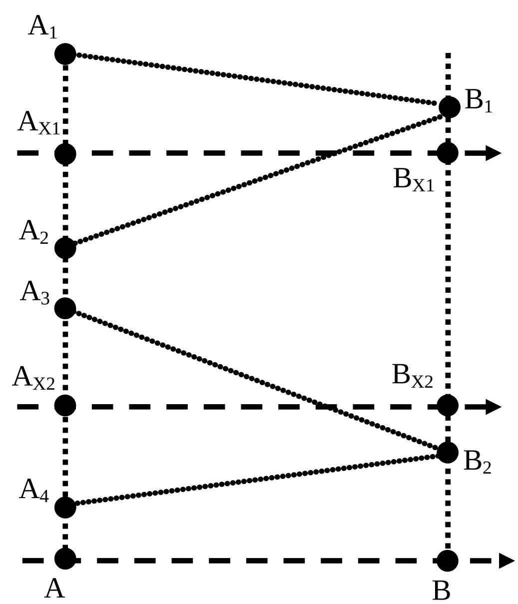

Figure 22

Rotation of the Earth between experiments causes some change in orientation of the measurement device. As a result, the signal covers a different distance (in a given medium) in the second experiment in comparison with the first one (see Figure 9).

Therefore, the second experiment shows indications of B2 – A3 = M2 and A4 – B2 = N2. Moreover, M2 becomes unequal to M1, and N2 becomes unequal to N1. Their difference (M2-M1) and (N2-N1) gives a physical value of duration shown by the

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Aurora Effect. That coincides all one-way experiments with EM-Radiation including De Witte and Torr-Kolen Experiments (explained above). In other words,

Any method of counting device synchronization changes only values indicated by local counting devices and change nothing in their comparison. Therefore, Aurora Effect becomes detectable regardless of any way of synchronization including Zero Synchronization (no-synchronization) Method. (S21)

Statement (S21) eliminates all speculations based on the idea of "a wrong way of clock synchronization" as a primary cause of Aurora Effect.

XIII. Reference to Relativity

There is another theory born at the same place explained above. Michelson's illusion about his correct point of view and "incorrect experiment" that gives not any physical support for his ideas and calculations led to something proposed by Albert Einstein. Later, that theory became famous as the theory of Relativity. That is a postulate-based theory.

Every such theory has an embedded problem at the basic level of postulates. Postulates as statements of a person taken without proper logical step-by-step (qualitative) explanation, repeatedly lead to illusions of a higher level. In other words, illusions coming from the human mind as postulates make more illusions as a result of "thoughts" based on hose postulates.

The scientific method denies such way of thoughts in any branch of science and requires experimental support for any idea in science to separate correct ideas from human illusions.

In case of Michelson's illusions and Relativity, that requirement was replaced by a postulate-based surrogate that uses mathematics as the primary source of "correct ideas." In other words, it was an attempt to replace natural human thoughts based on the scientific method by "calculations" which show some numerical coincidence with experimental results. That way leads to the suppression of qualitative explanation and its replacement by quantitative-only explanation.

As a result, the same way led to the enormous distortion in the human mind because of distortion of some basic categories, making them "applicable" to calculations. Michelson was so brave with his experiment that denied any idea that the experiment disproves his a priori point of view. In other words, the scientific method immediately disproved his point of view by an experiment. Michelson disagrees that because his point of view based on "mathematics and calculations" cannot "be ever wrong." Michelson forgot this.

Mathematics, as a product of the human mind, cannot be used to check the human mind and its thoughts because a product cannot be used to analysis of the product source in the area of philosophy (S22)

Einstein shared a similar point of view and got further. His famous "thought method" known as Gedankenexperiment (thought experiment) established the idea of the human mind as the thing of the first order and experiments as things of the second order. That point of view contradicts the scientific method from the beginning.

Einstein started his speculations from "a natural" postulate 'We have not defined a common "time" for A and B, for the latter cannot be defined at all unless we establish by definition that the "time" required by light to travel from A to B equals the "time" it requires to travel from B to A.' (Einstein A., 1905).

This article destroys all and every element of that illusion by the explanation given above including the category of so-called "Time." Moreover, Einstein's statement applies only to the experiment 'A' (see Figure 12). In that case, the duration of the signal propagation in the forward direction between points WA4 and WA8 becomes equal to the duration of backward propagation (in the opposite direction) from the point WA4 to the point WA0 (and from WA8 to WA4). In other words, the fundamental postulate proposed by Einstein describes a motionless location of the observer in a given medium and becomes wrong in case of a moving observer (when the speed of observer-to-medium relative motion exceeds zero in WRF).

However, Einstein insists that the postulate is correct and his mind became immediately trapped behind all limitations of that postulate. That is a common result of all postulate-based speculations (including his famous Gedankenexperiment).

Furthermore, 'Examples of this sort, together with the unsuccessful attempts to discover any motion of the earth relatively to the "light medium," suggest that the phenomena of electrodynamics as well as of mechanics possess no properties corresponding to the idea of absolute rest.' (Einstein A., 1905). Explanations given above destroy that point of view as well. Z-Continuum plays a crucial role in any interaction between any bodies in the Universe. Presence of Z-Continuum explains the full set of phenomena that Relativity refuses to explain.

Moreover, 'They suggest rather that, as has already been shown to the first order of small quantities, the same laws of electrodynamics and optics will be valid for all frames of reference for which the equations of mechanics hold good. We will raise this conjecture (the purport of which will hereafter be called the "Principle of Relativity") to the status of a postulate, and also introduce another postulate, which is only apparently irreconcilable with the former, namely, that light is always propagated in empty space with a definite velocity C which is independent of the state of motion of the emitting body. These two postulates suffice for the attainment of a simple and consistent theory of the electrodynamics of moving bodies based on Maxwell's theory for stationary bodies.' (Einstein A., 1905). Ironically, the speed of any disturbance in Z-Continuum remains constant in Wave Reference Frame (as explained above) and becomes E in Z-Theory (the speed of Electromagnetic disturbance propagation in WRF). An interaction of observer-to-medium relative motion in any round-trip experiment with back and forth propagation of that disturbance in WRF appears as some constant value that Einstein claims C in case of straight uniform motion of the observer regarding Z-Continuum with his measurement device.

Einstein's postulate of relativity became a grave problem for the entire theory because that postulate mistakenly takes the experiment C (Figure 12) as the experiment A (the same figure) and tries to use all physical processes equally for all observers regardless they condition of motion in WRF.

Moreover, 'We have to take into account that all our judgments in which time plays a part are always judgments of simultaneous events. If, for instance, I say, "That train arrives here at 7 o'clock," I mean something like this: "The pointing of the small hand of my watch to 7 and the arrival of the train are simultaneous events."' (Einstein A., 1905)

The technological level of 1905 offers not any device that can be used in the measurement of one-way light propagation. Such measurement devices appear later in the form of atomic "clocks." The idea of their "synchronization" immediately destroyed Einstein's illusion mentioned above (about simultaneity, see De Witte Experiment). Einstein's statement about simultaneity transforms to the following one (in case of "atomic clocks").

'The train reaches a given point at the station at some moment. The light coming from the Sun makes interaction with that train at that moment. The reflected light makes propagation by the Hugeness Principle and forms a perfect sphere in WRF. A linear propagation of that light between the train and the observer (that the observer comprehends as a light beam) comes to the observer located at some point of the station. Light uses some duration to cover a given distance between the train and the observer.

'Another ray of sunlight makes interaction with the "clock" located at some other point of the station (above the Einstein's head, at the Station tower or somewhere else). The sunlight makes interaction with the "clock." The result of the interaction is a reflection. The reflected light comes from that "clock". It makes propagation by the Hugeness Principle and forms a perfect sphere in WRF. A liner propagation of that light between the "clock" and the observer (that the observer comprehends as a light beam) comes to the observer located at some point of the station. Light uses some duration to cover a given distance between the "clock" and the observer. The observer detects another ray of light.

'The observer makes a comparison of moments of detection of both rays by his local combination of oscillating and counting devices. The local oscillating device makes some oscillations between those two events. If those number equal to zero, the observer detects "simultaneous" events. Otherwise, he detects two events without simultaneity.'

That is a critical mistake of the observer because he comprehends moments of events happened remotely by comparison with indications of the local counting device. That procedure involves some duration of signal propagation between points where physical events have a place and the point of observer location.

In other words, that is the same problem that appears as an attempt to find a moment of a remotely happened event by a locally located counting device. In that case, the duration of one-way signal propagation between points of events and the observer affects indication of the local counting device, and the device counts more oscillations of the oscillating device for a signal coming from a higher distance that separates a point of the event and the point of observer location.

As mentioned above, "Now" is a point in the Universe from where an observer (object, body) makes interaction with the surrounding Universe. (Zade A., 2012)

As a result, the notion of simultaneity falls into two separated notions of Physical simultaneity and Observable simultaneity.

Physical simultaneity appears as a physical coincidence of two or more events separated by a given distance.

Observable simultaneity of two or more events appears as a coincidence of signals of those events which reach the observer so as the counting device that the observer uses to determine a duration of events counts zero oscillations between those events of observations. (S23)

Therefore, Einstein's speculations mentioned above refers only to Observable Simultaneity. That illusion leaves no room to a category of Physical Simultaneity. That is one more grave illusion of relativity. Figure 9 shows that illusion graphically.

There are some simultaneous events shown in the figure. The first event is the emission of the signal from the point A1. That means Physical Simultaneity of signal emissions from that point and physical location of the observer at the same point of the Wave Reference Frame.

The signal spends some duration to reach the other point of measurements (the point B, as explained above). Location of that point coincides a given ellipse or ellipsoid (in space, Bx). Location of point A at that moment means physical simultaneity of two events. Those are the location of the observer at some point Ax and interaction of the signal with the other end of the measurement device Bx (a rod, in the easiest case). That happens because the rod keeps one and the only one physical location (and orientation) in the WRF at that very moment and that moment does exist physically (as a given location of the device, Ax-Bx in WRF).

Einstein's observer does not comprehend that moment because he is impossible to determine it.

The signal comes back to the observer and makes physical interaction with him at the point A5. Those are two events with Physical Simultaneity because the signal and the observer do exist (coexist) at the same point of WRF at the same moment.

However, Einstein's observer comprehends that situation as *Observable simultaneity* because he detects a signal reflected from the other part of the measurement device. In other words, such observer *does not count* the duration of backward propagation of the signal.

Michelson saw some problem in such an interpretation of the experiment. 'If it were possible to measure with sufficient accuracy the velocity of light without returning the ray to its starting point, the problem of measurement the first power of the relative velocity of the earth with respect to the ether would be solved' (Michelson, 1887). That is a correct point of view, but it refers to one-way experiments which were impossible in 1887.

However, those experiments become feasible as soon as the atomic oscillating device was invented (at the second half of the 20th century). That device has enough stability of oscillations and short duration of oscillations to make measurements of one-way experiments with EM-signals. As a result, all one-way measurements made that way give similar results and detect Aurora Effect as the most noticeable one that disproves relativity (see Figures 10, 18, 20, 21).

Further development of relativity made huge distortion in attributes of basic categories making them "compatible" with basic postulates of relativity (like length contraction and time dilation). As explained above, a physical entity that they call "Time" does not exist. Therefore, it cannot be dilated, expanded, twisted, or distorted any other way. In other words,

Something that does not exist as a physical entity cannot be physically "transformed" (S24)

The best example of that perverted method is this. 'if an observer is moving with velocity **v** relatively to an infinitely distant source of light of frequency v in such a way that the connecting line "source-observer" makes the angle ϕ with the velocity of the observer referred to a system of co-ordinates which is at rest relatively to the source of light, the frequency v' of the light perceived by the observer is given by the equation

$$\nu' = \nu \frac{1 - \cos\phi \cdot v/c}{\sqrt{1 - v^2/c^2}} \tag{20}$$

'This is Doppler's principle for any velocities whatever. When ϕ = 0 the equation assumes the perspicuous form

$$\nu' = \nu \sqrt{\frac{1 - v/c}{1 + v/c}} \tag{21}$$

(Einstein A, 1905)

That is Einstein's explanation of "Relativistic Doppler Effect." However, that explanation has some problem regarding Einstein's postulates claimed for Relativity and basic physical principles.

The first controversy comes from the definition 'with the velocity of the observer referred to a system of co-ordinates which is at rest relatively to the source of light.' In case or Relativity, all reference frames are equal to each other and physical processes should follow the same way (the same law) in any of them. However, Einstein uses a reference frame 'which is at rest relatively to the source of light'. Therefore, that reference frame is not at rest relatively to the observer because it is another reference frame!

In other words, Einstein himself becomes unable to explain the Doppler Effect in the observer-bound reference frame without a reference to another reference frame. That way contradicts postulates of Relativity and makes the theory self-contradictory. That is the worse situation for any theory because "development" of a theory destroys basic assumptions (including postulates) from where the theory starts to rise.

Moreover, as soon as all observers should use the same reference frame "which is at rest relatively to the source of light" that reference frame becomes the Preferred Reference Frame (PRF) and *destroys basic principles of Relativity again.*

That Reference Frame transforms to Wave Reference Frame (WRF) in Z-Theory because it appears as a result of PHYSICAL interaction between the physical wave source and the physical medium that supports physical propagation of disturbance made by the wave source (as explained above).

It is time to look back to Figure 14. Suppose now this. There are two observers A and B separated by some distance AB. The observer B keeps straight uniform motion regarding the observer A. The observer A emits EM-wave that covers distance AC in a given duration in the reference frame bound to the observer A.

According to Einstein's speculations, that EM-wave makes propagation between points C and D by some "magic" without and wave-medium interaction. It "magically" disappears from the first reference frame at some point C and "magically" reappears at the point D in the reference frame bound to the observer B. That wave covers some distance DB in that reference frame and reaches the observer B.

According to Einstein's speculations, that EM-Wave has an equal wave-to-observer speed of relative motion. Because "the speed of light in any reference frame is constant for all observers regardless of their condition of motion."

Therefore, the duration of physical interaction between each wave and the detecting device of the observer B coincides with the duration of each wave created by the disturbing device of observer A.

Equality of that duration for both observers leads to the absence of any physically detectable phenomena based on their relative motion. In other words frequency of created wave and frequency of detected wave should be equal to each other. That happens because duration is the inversed value of frequency and constant duration of a given physical process leads to constant frequency of the same process.

That exactly matches the principle of relativity that claims equality of all physical processes in any reference frames bound to any observer regardless of their condition of motion. However, that principle contradicts observable phenomena as explained above. Despite that contradiction (observable electromagnetic Doppler Effect destroys Einstein's speculations) Einstein incorporates that effect in his theory and claims that effect supports the proposed theory by sophisticated calculations. In other words,

Relativity treats numerical coincidence (quantitative explanation) between calculations and observable facts as unavoidable prove of the theory without proper physical (qualitative) explanation (S25)

Therefore, equations 20 and 21 contradict basic principles of Relativity (as explained above). In other words,

Relativity is not a theory. It is a predatory way of mathematical "transformations" that make some observable facts consistent with the initial set of postulates by numerical coincidence (S26)

XIV. Comparison of Z-Theory and other Theories

The following figure shows a comparison of Z-Theory and other theories graphically.

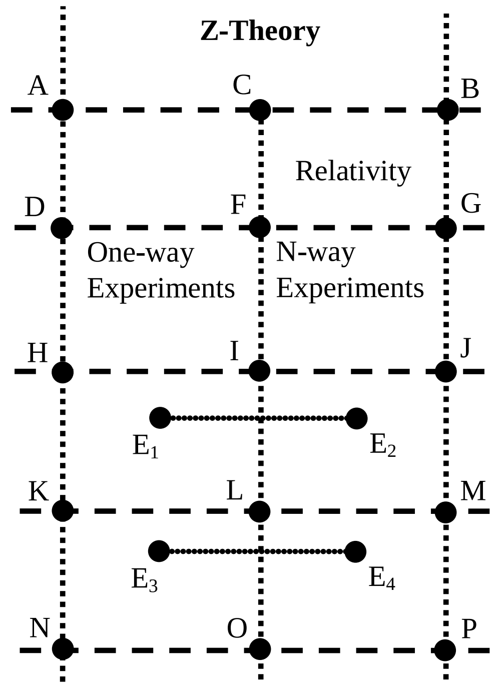

Figure 23

Figure 23 shows that Z-Theory occupied a full set of feasible experiments in any signal-medium combination between lines 'AN' and 'BP.'

That set of experiments can be divided into two groups of experiments. Those are one-way experiments and N-way experiments. A two-way experiment or a round-trip experiment becomes a particular case of N-way experiment. Z-Theory explains each N-way experiments as a proper combination of one-way experiments.

Relativity occupies the area between lines CO and BP. Moreover, it extracts only light-space experiments from their full set and tries to explain all other experiments by that combination. That is IJML area. The famous Michelson-Morley experiment falls in that area (point E2). That area shows limitations of Relativity from other areas.

Line IL shows the limitation of Relativity in one-way experiments. Relativity denies the physical existence of the HILK-area because of its postulate of equality of one-way and round-trip experiments. Therefore, all physical experiments from that area falsify (destroy) Relativity. De Witte experiment is the best example of such experiments (point E1 in the figure).

LM-line shows another limitation of Relativity. It separates experiments with light in space and other experiments with signals in any other signal-medium combination. As a result, Norbert Feist experiment shows a constant duration of a round-trip experiment in sound-air combination at a constant observer-to-medium relative motion *that Relativity cannot explain.* Moreover, Relativity insists on a different result of all such experiments. Therefore, the result of physical measurements in another signal-medium combination contradicts all "predictions" (speculations) of Relativity. That is point E4 in the figure.

There is one more hidden aspect of any theory that appears as a proposed way of creation of new categories of a given theory. That aspect is known as Ockham's razor 'also spelled Occam's razor, also called law of economy, or law of parsimony, principle stated by William of Ockham (1285–1347/49), a scholastic, that *Pluralitas* non *est ponenda* sine necessitate; "Plurality should not be posited without necessity." The principle gives precedence to simplicity; of two competing theories, the simplest explanation of an entity is to be preferred. The principle is also expressed "Entities are not to be multiplied beyond necessity."' (Ockham's razor. (2008). Encyclopedia Britannica.)

The same principle is applicable for all physical entities and all categories in the human mind which explain those entities. In other words,

Any theory tries to establish a relationship between physical entities and corresponding categories of the thinker's mind. (S27)

As a result, categories of pure Space and Time knew throughout human history become redundant in Z-Theory. In other words, Z-Theory shows the best application of Occam's razor to those categories. That way destroys many illusions of the humankind which persist in the human mind for ages.

Unfortunately, the 20th century made many illusions regardless of Ockham's razor. As a result, "new categories" proposed for explanation of physical entities became weirder than ever. For example, 'By the mid-1990s, these and other obstacles were again eroding the ranks of string theorists. But in 1995 another breakthrough reinvigorated the field. *Edward Witten* of the Institute for Advanced Study, building on contributions of many other physicists, proposed a new set of techniques that refined the approximate equations on which all work in *string theory* had so far been based. These techniques helped reveal a number of new features of *string theory*. Most dramatically, these more exact equations showed that string theory has *not six but seven extra spatial dimensions*; the more exact equations also revealed ingredients in string theory besides strings—membrane like objects of various dimensions, collectively called branes. Finally, the new techniques established that various versions of string theory developed over the preceding decades were essentially all the same. Theorists call this unification of formerly distinct string theories by a new name, M-theory, with the meaning of M being deferred until the theory is more fully understood.' (String theory. (2008). Encyclopedia Britannica)

In other words, "further development of String Theory" led to "invention" of seven extra spatial dimensions that raise the number of "dimensions" up to eleven dimensions (four dimensions proposed by Einstein and seven more).

However, proponents of M-Theory never proposed a single physical device that can be used to separate any of those "dimensions" from each other. As a result, M-Theory shows only some numerical coincidences between calculations and experimental results without proper qualitative explanation (as well as Relativity).

Unlike those theories, Z-Theory proposes a universal measurement device that makes physical measurements, supports exaltations of Z-Theory by results of those measurements and subsequently falsifies (destroys) all other theories made by the human mind earlier. That is a Signal Medium Motion Measurement Apparatus (SMA).

XV. A Signal Medium Motion Measurement Apparatus

All aspects of that apparatus at the engineering level were disclosed in the patent application (World Intellectual Property Organization (WIPO) WO 2015/040505; European Patent Office (EPO) 14729725.3; Australia 2014322789). This section explains some physical aspects that the apparatus uses.

Unlike other devices, SMA uses two apparatuses to make measurements. Each apparatus comprises an oscillating device that makes oscillations; a local counting device configured to count oscillations coming from the oscillation device, a transmitting device, and a detecting device. Detecting devices of the apparatuses configured to detect signals coming from transmitting devices of other apparatus(s). Two apparatuses are needed at least to make measurements. In other words, two apparatuses are the minimal number of them that can split a round-trip experiment into two one-way experiments. The following figure shows the operation graphically.

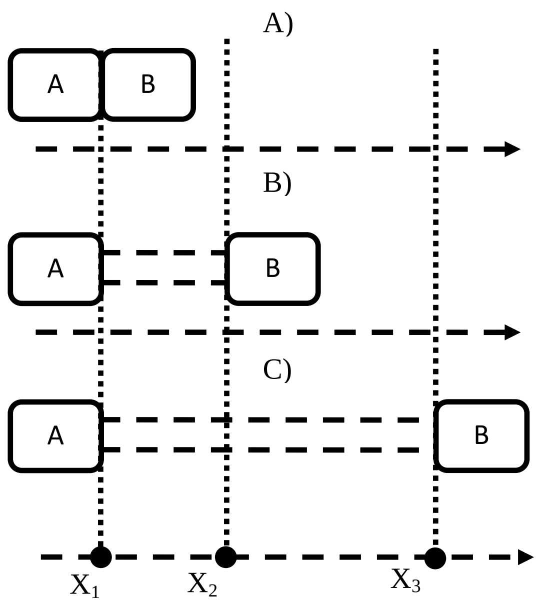

Figure 24

The primary method of SMA operation is Local Synchronization Remote Operation Method (LSROM). The notion of Synchronization applied to the apparatuses means the procedure to set up their local counting devices to a specific number. A given value of that initial number has not any importance for the proposed method of measurement.

To make that synchronization, the apparatus A sends some number to the apparatus B by the communication channel. The apparatus B sets that number on its counting device and waits for the next step of synchronization.

The apparatus A sends a signal to the apparatus B as soon as the counting device of the apparatus A reaches a value that was sent to the apparatus B at the previous step of synchronization.

The apparatus B connects the local oscillating device to the local counting device as soon as it detects the signal sent from the apparatus A. The synchronization sequence is completed now, and the apparatuses are ready to operation (measurements).

The following explanation shows the easiest situation when both oscillating devices have an equal duration of each oscillation and corresponding counting devices change counted number of oscillations on the minimal value suitable for measurements (one).

In that condition, each pulse coming from each local oscillating device to the corresponding (local) counting device increases the number stored in that counting device to a given number (one). That means this. The counting device counts pulses of the corresponding oscillating device. Each pulse means a given duration shown by the oscillating device utilizing its internal recurrent physical process of oscillation. That physical process is self-sufficient and has not any relationship (or dependence) with any category of the human mind (like "flow of Time"). The same physical process has not any relationship with any other physical processes in the Universe. As a result, termination (or creation) of any other physical process in the Universe makes not any impact on a given process of oscillations in a given oscillating device.

That independent operation of both apparatuses means independent counting of pulses by the local device of each apparatus coming from the local oscillating device.

Each pulse coming from the local oscillating device changes the number stored in the local counting device.

Because of synchronization made earlier, each counting device shows a predictable value after each counted oscillation. In other words, the counted values of both counting device remain equal to each other at any given moment. That means Physical Simultaneity (explained above) in an indication of counting devices of the apparatuses.

The apparatuses can prove that condition. To do that, the apparatus A sends a signal to the apparatus B again and waits for the answer from it. The apparatus B detects the signal and sends the number stored at the local counting device at the moment of signal detection to the apparatus A by a communication channel.

The apparatus A makes a comparison of two values. One value comes from the indication of the local counting device of the apparatus A *at the moment of signal emission*. The other value comes from apparatus B by the communication channel. That value shows the indication of the counting device of the apparatus B at the moment of signal detection. The apparatus A determines zero difference in those values because of previous synchronization and location of the apparatus B next to the apparatus A. That means this. The signal spends zero duration to cover zero distance. Another interpretation is also possible that there is not any Space (CE-Space, see above) between apparatuses in that experiment. The apparatus B is also able to emit signal toward the apparatus A at any moment and send an indication of its local counting device at the moment of signal emission to the apparatus A by the communication channel. The apparatus A makes the same comparison of both values and finds zero difference between them again. That is another experiment that uses backward propagation of a given signal. In other words, the signal shows zero duration in forward and backward propagation. That is the first case (A) shown in Figure 24. In that case, both apparatuses share location X1.

After the first experiment, the apparatus B moves slowly away from the apparatus A. Apparatuses continue measurements. Suddenly, apparatuses determine some value of signal propagation. That

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means this. The distance between them reaches enough value to be detected by signal propagation under given circumstances (speed of the signal, duration of oscillations of oscillating devices). Further motion of the apparatus B increases the duration of both measurements or forward and backward propagation of a given signal in a given medium. However, both experiments show equal values. That means zero sped of apparatus-to-medium (observer-to-medium) relative motion or insufficient precision of measurements. In case of SMA, precision becomes higher with a shorter duration of oscillating devices and a higher distance between apparatuses. Therefore, the apparatus B improves the precision of measurement the easiest way by further motion away from the apparatus A.

Suddenly, the apparatuses determine some difference in the duration of forward and backward propagation of a given signal. The minimal detectable difference equals to one oscillation of their oscillating devices. It is also apparent that difference of forward and backward duration of signal propagation rises continuously during motion of the apparatus B and becomes detectable as soon as it rises higher than the duration of one oscillation. That result means detectable motion of both apparatuses regarding the medium that supports propagation of a given signal.

The apparatus B continues its motion away from the apparatus A to improve the precision of measurements and stops at some point X2. The apparatuses keep a constant distance between them for a while making some extra measurements. All of them give X oscillations for forward propagation of the signal and Y oscillations for backward propagation. That means detectable motion of both apparatuses regarding the medium that supports propagation of a given signal. The full duration of all round-trip experiments (D) also keeps a constant value.

$$D = X + Y; (X \neq Y) \qquad (22)$$

The apparatus B continues its motion away from the apparatus A to prove measurements. It stops at some point X3 that has N times greater distance from the point X1 than the point X2 (in the observer-bound reference frame, ORF). Apparatuses make measurements again. All measurements increase their values N times and show

$$ND = NX + NY; (X \neq Y) \qquad (23)$$

That proves all experiments because a given signal spends N times greater duration to cover N times greater distance in a given medium (WRF). It also proves that the speed of signal-to-medium relative motion and the speed of apparatus-to-medium relative motion keep constant for all experiments.

Suppose now this. The apparatus B comes back to the point X2 and moves around the apparatus 'A' keeping a constant distance between apparatuses. Figure 9 shows that case. As explained above, both apparatuses determine a changing duration of each one-way experiment (X and Y values), but *the full duration (D) of round-trip experiments remains constant*. In that case, apparatuses determine a projection of their speed (a component speed) in a given medium on the line connecting them. Therefore, they detect a maximal speed of apparatus-to-medium relative motion in B5-B7 direction and zero component speed in any orthogonal directions. That is a particular case when both one-way experiments become equal to each other in measured duration (X=Y).

Moreover, each revolution of the apparatus 'B' around apparatus 'A' shows an equal deviation of the duration of each one-way measurement. In other words, the same orientation of the apparatuses (point Bx for example) in each revolution leads to the same ratio of a duration of experiments (X/Y). Therefore, each revolution shows the same curve of duration deviation (see Figure 10) in case of a constant speed of apparatus-to-medium relative motion.

As mentioned above, all explanations given in this article are applicable to any signal-medium combination without any exception.

Suppose now this. An observer uses SMA in light-space combination. The apparatuses give exact values of duration for each one-way experiment and determine the component speed of observer-to-medium relative motion and the speed of signal-to-medium relative motion by the duration of experiments and the distance that separates apparatuses. Information about distance comes from a Distance Measurement Device (DMD) that determines a given distance between apparatuses in the observer-bound reference frame. However, the full duration of both one-way experiments (a round-trip experiment) remains constant. That is an application of SMA to all Michelson-Morley set of experiments.

At the same time, each one-way experiment means the application of SMA to all De Witte set of experiments (including Torr-Kolen experiment).

All of them show deviation in the duration of signal propagation only in one-way experiments and constant duration of round-trip experiments.

In case of sound-medium application, SMA shows the same way of signal propagation. That means the application of SMA to all Norbert Feist set of experiments. They can be conducted in any mechanical signal-medium combination (in gases of liquids). SMA confirms the result shown by Norbert Feist. Moreover, SMA determines a component speed of observer-to-medium relative motion in each measurement (that Norbert's device never does). The apparatuses determine two critical values of apparatus-to-medium relative motion and signal-to-medium relative motion in any signal-medium combination the easiest way:

$$VF = L/DF \quad (24)$$

$$VB = L/DB \quad (25)$$

$$E = (VF + VB)/2 \quad (26)$$

$$V = (VF - VB)/2 \quad (27)$$

Where L is the distance between apparatuses in observer-bound reference frame (ORF); DF is the duration of forward propagation of the signal between apparatuses; DB is the duration of backward propagation of the signal between apparatuses; VF is the speed of forward propagation of the signal in the ORF; VB is the speed of backward propagation of the signal in the ORF; E is the speed of the signal-to-medium relative motion; V is the speed of the apparatus-to-medium relative motion. (Zade Allan, 2016) The explained way of measurement needs not any calibration of the apparatuses before experiments or any information about the physical properties of the medium or a signal.

Strictly speaking, SMA exceeds limitations of all measurement devices invented ever before and becomes a universal measurement device with the highest capability of measurements.

XVI. Discussion and Conclusion

One can ask an easy question now. What is Z-Theory? Strictly speaking, Z-Theory works with and transforms fundamental categories of the human mind applying the scientific method to all possible observations and experiments without any exception or postulate.

Therefore, it is so vast that it is better to understand the theory by application of the theory in a given area.

Other theories have significant limitations at the basic level. Unfortunately, those fundamental limitations lead to the inability of theory to work with new pieces of evidence and experimental results obtained another way that was impossible (or look impossible) at the time of creation of a theory.

Many thinkers comprehend their mental inability to think another way as physical impossibility of physical existence of a physical entity or process. In other words, they deny the fundamental law of the scientific method that requires priority of experiments before thoughts.

Einstein denied that request and used his famous Gedankenexperiment or "thought experiment" as the source of "unavoidable prove" of his speculations. That is the wrong way for science.

The problem of that way is his. A thought experiment includes only known categories of the human mind and their attributes and never gives any category that contradicts basic categories of the thinker's mind.

The most straightforward example of that aspect is this. Einstein used some extra attributes for the category of so-called "Time" without a proper definition of that category. Other thinkers do the same mistake many times trying to comprehend a given category without any definition.

Z-Theory defines that category and destroys it because a pure category without any attribute has not any corresponding physical entity and its physical attributes (as explained above).

Einstein's theory has one more embedded problem. That is a postulate-based theory. As a result, anything that stays beyond postulates of a given theory destroys the theory wholly and immediately.

For example, Michelson-Morley experiment falsified (destroyed) all their a priori speculations. First observable EM-Doppler Effect came from early radars (mid 40's of the 20th century) falsifies Relativity (as explained above).

Torr-Kolen and De Witte experiments falsified Relativity in the second half of the 20th century. Norbert Feist conducted acoustic Michelson-Morley Experiment and falsified relativity in the early years of 21st century. Z-Theory explained illusions of Relativity and proposed a unique measurement device (SMA) with a capability of measurements of one-way and round-trip (two-ways) experiments in the 21st century.

In other words, Relativity cannot be used as a credible scientific theory any longer.

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Theory of Photon Quanta

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Abstract- The purpose of this project is to create a new line of thinking among we scientists and change the way which we understand things, therefore developing new theories in physics and science in a whole which will be able to answer to disturbing questions which the universe poses.

The research problem that motivates this project is actually the complexity of our universe and the numerous phenomena which unfortunately we scientists can't still explain given the improvement in technology like the black hole, gravitational lensing of light and questions like why is the speed of light what it is (300,000km/s)? Which factors aid in making it constant?

Keywords: charge carriers; electromagnetic radiation; electromagnetic spectrum; electrostatic force; gravitational force; matter; space-time curvature; quantum.

GJSFR-A Classification: FOR Code: 020504

THEORYOFPHOTONQUANTA

Strictly as per the compliance and regulations of:

Theory of Photon Quanta

Ernest Chukwuma Jnr.

Abstract- The purpose of this project is to create a new line of thinking among we scientists and change the way which we understand things, therefore developing new theories in physics and science in a whole which will be able to answer to disturbing questions which the universe poses.

The research problem that motivates this project is actually the complexity of our universe and the numerous phenomena which unfortunately we scientists can't still explain given the improvement in technology like the black hole, gravitational lensing of light and questions like why is the speed of light what it is (300,000km/s)? Which factors aid in making it constant?

In this project, we employ the use of practical evidence, real life situations and phenomena, theoretical formulations, theories and principles which form the bedrock of physics. Documents such as; 'The evolution of Physics: From Early concepts to Relativity and Quanta' , 'The world as I see it' both by Albert Einstein, 'Advanced level Physics' by Nelkon & Parker, 'New school Physics' by Anyakoha W.

I therefore came up with the theory of photon quanta and my principle of light. I concluded that light isn't just what we think it is but there's more to light. There are charge carriers in light which are responsible for the numerous phenomena we fail to comprehend.

I believe this new theory help we scientists in providing answers/explanations to phenomena around us and will take us a step further in understanding fully our universe and the mysterious black hole; at least we're succeeding gathering the last pieces of the puzzle to fully understand light, matter and the whole universe.

Keywords: charge carriers; electromagnetic radiation; electromagnetic spectrum; electrostatic force; gravitational force; matter; space-time curvature; quantum.

I. Introduction

Light is of course one of or maybe the most important phenomenon in our universe till date and still keeps us puzzling. It is said to be an electromagnetic wave consisting of a stream of photons and these photons are prescribed by science as just bundles of energy. Although, this definition/perspective by which we see light can't just seem to provide adequate explanations to situations and phenomena in space and our universe in a whole like dark energy, black hole and even gravitational lensing. Gravitational lensing is the distribution of matter around a body with ggravitational force but I'm sure that we scientists didn't expect it for light to because we think light is not matter or like a few scientists say, there is no matter in light. If it's true, why does light distort space-time? Why is light said to be electromagneric meanwhile it is neither electric nor magnetic? If we say a beam of light is simply a beam of photons which we say are packets of energy, then why do we go on to say that light consists of electromagnetic field? Where does the electromagnetic field come from? If light is truly affected by gravity as Prof. Einstein predicts, then why don't photons fall down? In fact, there are a lot of questions about light and it is obvious that our present view of light can't answer and that's what I've come up to address. We need to look around us and all the puzzling events which occur and wonder critically at the complexity of our universe. We need to look back at the foundations of science, see if they can stand up to the events which we puzzle about and our problems and if not modify them, crate new bedrocks on which modern science would rely on for answers; that's the exact reason we are scientists.

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II. Materials and Methods

First Experiment (Light Bulb Experiment): Materials used:

2 large yam tubers, 2 Volt light bulbs, copper wires, tapes, knife, 2 pieces cut from galvanized zinc.

Method used: (1.) First 2 cuts were made on each yam tuber (2.) Then a copper wire and a piece of zinc were inserted in the two openings of each tuber (3.) The tape was used to connect the first copper wire to the light bulb (4.) And then another wire was connected to the zinc in the other yam tuber from the other end of the light bulb (5.) Then, a copper wire was used to connect the other zinc piece with the last copper wire. (Note, a thick copper wire is saved for the last connection (number 5). Watch what happens…

Second Experiment (Match Experiment): Materials used: A match box containing match sticks.

Method: A match stick is removed from the matchbox and is used to strike the rough part of the matchbox multiple times but softly. Watch what happens…

Then, that same matchstick is used to strike the matchbox multiple times but this time, harder. Watch what happens…

Third Experiment (Torchlight Experiment): Materials used:

Torch light, a ladder of about 1.5m, a building with ceiling 2m from ground level.

Method: I climb the ladder of 1.5m with the torchlight to get closer to the ceiling and then switch the torch light on and point it at the ceiling. What happens…?

I come down from the ladder and point the same torchlight at the same ceiling. What happens…?

Then I go outside of the building in the evening time all alone in empty space and point the same torchlight but this time in the sky. What happens…?

There are many experiments, basically real life everyday experiments but I'd just like to use these three only out of the numerous lists to portray my point.

III. Results

Now in the first experiment, the result was light. The light bulb lighted.

And in the first case of the second experiment, nothing happened but in the second case, there was fire.

In the third experiment, when I was on the ladder, the intensity of the torchlight was high and I could see it very well. When I came down, the intensity became low and it wasn't really clear but the most fantastic thing happened when I went outside and pointed it at the sky trying to get it to the bodies in space like stars, it completely disappeared.

IV. Discussion

Now, we all know the famous light bulb experiment first experimented by our dear famous Thomas Edison, that's the same principle applied in the first principle, just that the yam tubers acted as the source of electrons that is the battery. But the honest question is why was there light in the light bulb? And the most honest answer is due to the presence of electrons. This implies that light is simply an expression/manifestation of the presence of charges, in this case electrons. What happens if I increase the size of the yam tubers? Higher intensity of light in the bulb Why? More charges.

Now, in the second experiment, one of the simplest in the world actually but it doesn't mean we can still answer to all the phenomena it has to offer. As I stroked the match softly, no light. But when I increase force and strike it harder, there come fire. Let me remind that: Fire=visible light + infrared (heat). Now, how does this fire come about? When I started striking it harder, I started generating more friction than ever-charges are produced. There is a spontaneous transfer of electrons from the rough matchbox to the matchstick, and then light comes in the form of fire. Let me remind of the principle of conservation of charges that charges can neither be created nor destroyed and the net charge in the universe is zero but we never ask what keeps the net charge in the universe at zero? What is that that is responsible for balancing the charges in our universe? Light. In this match scenario, electrons were produced. Allow me to remind that in science a universe could be said to be a chemical system under investigation. In this match universe, what balances the negative charge of the electrons? It has to be light.

$Q=Q_0+Q_{\text{transferred in}} - Q_{\text{transferred away}}$ where Q is the net charge in a body at time t_1 , Q_0 is the initial quantity of charges in that body.

Then in the third experiment, when I was closer to the ceiling more intensity- higher photon flux- high concentration of charges. Then, I step down from ladder, lesser photon flux, lesser concentration of charges, and lesser intensity. Then I point in sky and I don't see my beam of light anymore. Why? Because if light is just composed of packets of energy (photons), it's not meant to be affected, I'm still meant to see my light up there. The point I'm trying to make is that the continuity of charges in matter is evident in light. Imagine a group of five hefty man with energy trying to push a cargo and they are succeeding pushing it little by little but then you add a truck on top of the cargo, what happens? They can push it farther no more. This explains this torchlight experiment.

We are scientists. We are supposed to make new ways of explaining our universe and not destroy it or shun it simply because there's no existing principle to explain it. If I shine a powerful beam of light at a sheet of paper and it tears through, then there must be something in light that exert this force on the paper; packets of energy can't just exert force, No. By the way, packets of energy can't just distort space-time, they can't. We physicists say that the outward force of the light escaping the core of a star, working with thermal pressure acts to balance the inward gravitational forces on the outer layers. But if light consists of only photons which we assume to be just packets of energy, then where does the electric and magnetic fields which light propagates come from? What does the work in light that releases electromagnetic radiation? Charges builds up in the cloud and objects on the ground and then lightning hits a tree and it falls? What happens? Simply negative charges come to the bottom of the cloud and positive charges on the ground and then light with high charge concentration comes to balance the charges in the universe. Unfortunately for the tree which is on the ground, the light hits it and the charges in the light exert force on the tree and it falls. At least the lightning has done its job of balancing the charges in the cloud and in the ground. It's not its fault that the negative charge concentration(electric current) was so high when it was coming. Wow! Such a beautiful world.

Gravitatonal Lensing Explained:

As Prof. Einstein's prediction tells us, 'a body could distort space-time only by virtue of its matter'.

Also, as is known already, charges exert electrostatic force and electrostatic force is usually stronger than gravitational force. But, when light containing charges encounters a massive object, say a massive star with massive gravitational force, the electrostatic force cannot withstand the gravitational force and therefore, it distributes its matter around the star and curves around it. Although, in a small star with little gravitational force, it bends only a little, negligibly because the electrostatic force can stand the gravitational force in this case.

V. Conclusion

I therefore came up with the theory of photon quanta: that 'Photons are entities by which theirquanta are owed to the charges which they carry'. And my principle of light: Light is basically a stream of charge carriers called photons with these charges possessing energy and propagating electric and magnetic fields with energy in an oscillating fashion.

As our dear Prof. Einstein puts it that Physics isn't meant to be just a vocation, its more than that, it is an adventure. As scientists, we are supposed to uphold science like its an adventure while taking down all the questions in our universe in a whole. Someone once said that 'scientists are on a world mission impossible to understand the full nature of matter and the universe' and that person is me!

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1. M. Nelkon. & P. Parker. *Advanced Level Physics*. London: Heinemann Educational Books, 1982, pp. 563-573; 407-499; 674-689; 843-873.
2. `M. W. Anyakoha. *New School Physics.* Nigeria: Africana First Publishers PLC, 2013, pp.72-78; 56-63; 67-69; 180-183; 108-110; 479-485; 488-490.
3. "One thing I have learned in a long life: That all our science, measured against reality, is primitive and childlike-and yet it is the most precious thing we have: ("Albert Einstein: Creator and Rebel," 1972)
4. "Without the sense of kinship with men of like mind, without the occupation with the objective world, the eternally unattainable in the field of art and scientific endeavors, life would have seemed empty to me" ("The world as I see it", 1930)
5. "The most beautiful experience we have is the mysterious. It is the fundamental emotion that stands at the cradle of true art and science whoever does not know it and can no longer wonder, no longer marvel, is as good as dead, and his eyes are dimmed." ("The world as I see it", 1930)

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Parametrically Excited Anharmonic Oscillator

By Ordin S. V.
Ioffe Institute RAS

Abstract- Earlier [0] analyzed the behavior of the “dynamic point” - the harmonic oscillator. But there are phenomena for which even the damped harmonic oscillator is not elementary, but primitive. ELEMENTARY is an oscillator, which was previously called simply parametric, but, as shown in this work, strictly speaking, should be called parametrically excited anharmonic oscillator. As the analysis showed, this oscillator has stationary solutions for a harmonic oscillator at a doubled resonant frequency and for only one strictly defined level of attenuation, the deviation from which leads to a catastrophic increase, or to full cancellation of the oscillations. As shown in the elementary model, the doubled resonant frequency of the excitation occurs with orthogonal (transverse) oscillation at the frequency of the longitudinal resonance. This analysis was done to describe the anomalous non-transmission band in boron nitride.

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PARAMETRICALLYEXCITEDANHARMONICOSCILLATOR

Strictly as per the compliance and regulations of:

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Ordin, S.V., Chaos – Imaginary Ostensibility – Orthogonality, GJSFR 2019 Vol.19

I. Mate-Solutions for the Natural Oscillations of a Parametric Oscillator

The general dependence of the resonant frequency of a harmonic oscillator ω_0 on changes in its parameters: mass or stiffness, is described by the Hill equation:

$$\frac{d^2 y}{dt^2} + p(t)\,y = 0 \qquad (1)$$

The Hill equation does not have a common analytical solution and even its approximate solutions are practically not used. In practice, its particular case is used with the harmonic dependence of the oscillator resonant frequency deviation, which is expressed by the Mathieu formula

$$\frac{d^2 y}{dt^2} + \left(1 + \gamma^2/\omega_0 \cos(\omega \cdot t)\right)\cdot \omega_0^2 \cdot y = 0\,, \qquad (2)$$

where γ^2/ω_0 - the relative modulation depth of the resonant frequency.

The Mathieu formula has a common analytical solution, expressed through the above and named Mathieu functions, but because of its cumbersomeness, and it is not strictly rigorously analyzed purely mathematically, which resulted in the lack of rigor of the physical models built on it.

Both equations cited correspond to an ideal, non-damping harmonic oscillator. Although some kind of confusion brought the index used in the Mathieu formula to denote the depth of modulation and, thereby, unconsciously, tied it to the attenuation. Therefore, for the “harmonic” parametric oscillations, the base models, which are beautiful but inadequate to the actual physical processes (Figure 1 from [1, 2]), are rarely used in practice and in quantitative calculations. And during the initial analysis of the stopband in boron nitride, they gave us nothing but the obvious in Figure 1 — orthogonal, transverse oscillations parametrically “feel” the longitudinal resonance.

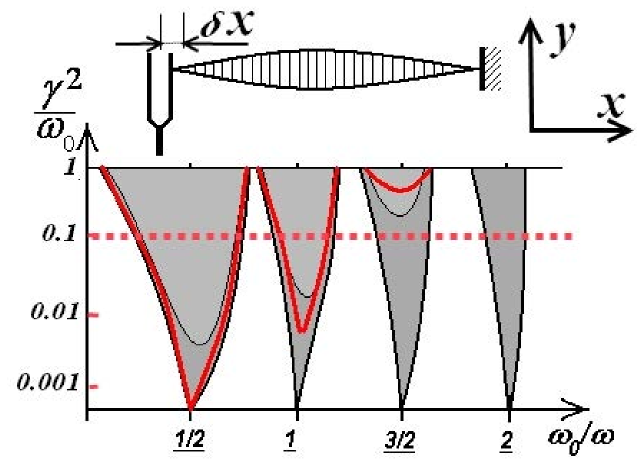

Fig. 1: The basic “picture of excitation” of parametric oscillations — the gray areas and its “refinement” —the red lines (above the 0.1 level, the Mathieu model does not work)

In depicted in Figure 1.the model as the statement of the analysis problem is precisely the practical need to detect “parasitic” vibrations. But the analysis of the oscillations of the actually modified, anharmonic oscillator (which actually gives Mathieu functions) was not carried out, but the set of modulating frequencies shown in Fig. 1 was taken for the OWN frequencies of this oscillator.

So the model shown in Figure 1 and we needed only as a seed in the direction of the search - what is the result we are looking for? And the analysis of the oscillator frequencies themselves had to start from “zero” - with Mathieu, with its functions, namely with OWN transverse (in the figure) modified vibrations, and not longitudinal (in the figure), excited by a tuning fork in Fig.1.

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To bring it into conformity with reality, we immediately introduce the damping into the Mathieu equation, which we will need later on and without which in describing the harmonic oscillator we cannot do without invoking an abstract singularity in the form of the Dirac delta function. And in order to avoid confusion, let us return the attenuation designation γ, and denote the modulation coefficient k. We also assume, without loss of generality, as in the analysis of a simple harmonic oscillator, its own resonant frequency $\omega_0 = 1$. Then equation (2) takes the following form:

$$\frac{d^2y}{dt^2} + \gamma \cdot \frac{dy}{dt} + \left(1 + k\cos(\omega \cdot t)\right) \cdot y = 0 \,, \quad (3)$$

Both in form and in fact, equation (3) corresponds to a harmonic oscillator with a single Eigenfrequency and with a driving force of an arbitrary frequency:

$$\frac{d^2y}{dt^2} + \gamma \cdot \frac{dy}{dt} + y = -k\cos(\omega \cdot t) \cdot y \,, \quad (4)$$

This elementary rewriting (4) indicates a fundamental point, without regard to which the analysis is not connected with reality and is meaningless: the Mathieu equation describes such a parameter change that is not just a parameter change for OWN (transverse in Figure 1) vibrations, but let but a real driving bias / force, parallel to the amplitude of the bias of OWN oscillations. But this compelling force is specific - it is itself proportional to the magnitude of the resulting displacement it initiates. This leads to the nonlinearity of its solutions, which gives grounds to call expression (4) the Mathieu equation of the anharmonic oscillator. We will analyze its decisions: $Y(\omega,\ t) =$ (5)

$$= e^{-\frac{t\gamma}{2}} C[1]\, MathieuC\left[-\frac{-4+\gamma^2}{\omega^2}, -\frac{2k}{\omega^2}, \frac{t\omega}{2}\right] + e^{-\frac{t\gamma}{2}} C[2]\, MathieuS\left[-\frac{-4+\gamma^2}{\omega^2}, -\frac{2k}{\omega^2}, \frac{t\omega}{2}\right]$$

where the constants C [1], C [2] are given by two initial conditions precisely for Y. It is they that give the initial impulse for Y, which determines the starting amplitude and phase, but the OWN fluctuation in Y, subject to, according to formula (3) amplitude and phase deviations.

And so, as a consequence of what has been said, the real OWN, described by the Mathieu functions, the oscillations of the anharmonic oscillator, in contrast to the purely sinusoidal oscillations of the harmonic oscillator, also have a similar sinusoidal mode of oscillations at OWN frequency $\omega_0 = 1$, BUT! their amplitude and phase are not constant (as with harmonic oscillations), but change in time, which is described by Mathieu functions. By setting the maximum parameters: an unrealistically large modulation factor of 10% and an unrealistically small zero attenuation and using the boundary conditions: y (0) = 0, y '(0) = 1, for a parametric modulation frequency equal to twice ω_0 we get its function of time and its sinusoidal approximation in the initial section (Fig.2).

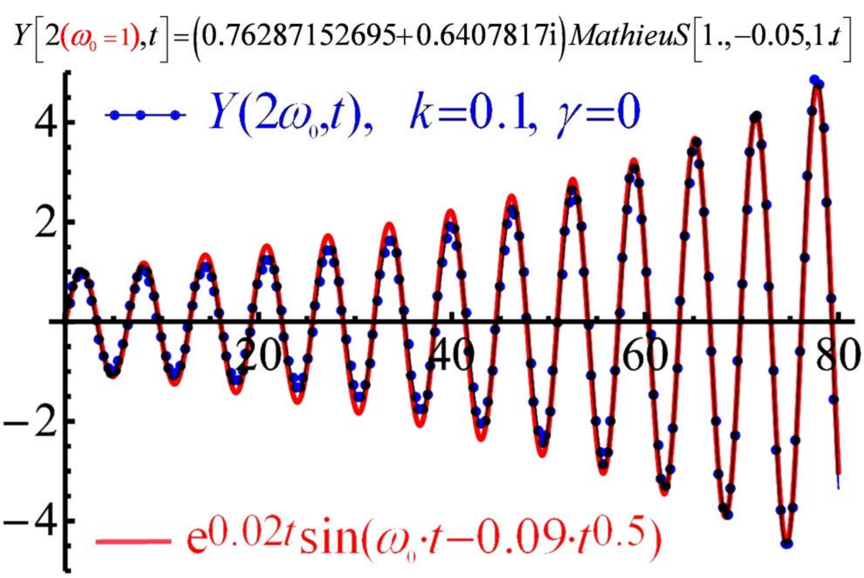

Fig. 2: Solution of the Mathieu equation for doubled modulation frequency and its approximation in the initial section by sine at single frequency

The time dependence of the amplitude and phase of OWN oscillations at a frequency ω_0 shown in Fig. 2 makes the frequency pattern shown in Fig. 1 ambiguous and incomplete. First, in Fig. 1, the modulation frequencies are indicated, and not the frequencies of OWN SPECIES. Secondly, on the asymptotics, with time tending to infinity, there is no exit to saturation and a third, time coordinate is required, the change along which is specific for each frequency of parameter change. At the same time, the picture shown is conditional, since it is not determined from which area of the three-dimensional space, at what point in time, each projection onto the drawing plane shown in the figure. So conditional that from the "received" in the classical works [1, 2] and the series of "own" parametric oscillations used in Fig. 1 ω^*

$$\omega^* = \frac{\omega}{\omega_0} = \frac{2}{n}, \quad n = 1, 2, 3 \ldots, \Rightarrow 2, \; 1, \; \frac{2}{3}, \; \frac{1}{2}, \; \frac{2}{5}, \; \frac{1}{3}, \; \frac{2}{7}, \; \frac{1}{4}, . \tag{6}$$

even with zero attenuation conditionally threshold, in the sense that capable of leading to an increase in oscillations over time, only two modulation frequencies can be considered:

$$\omega^* = 2, \; 1 .$$

Those. the doubled modulation frequency shown in Fig. 2, and a single modulation frequency with a smaller amplitude rise rate of about 300 times (Fig. 3).

$$Y\left[1(\omega_0 = 1), t\right] = (0.682593887 - 0.3097914377865i)\, MathieuS\left[4., -0.2, \frac{t}{2}\right]$$

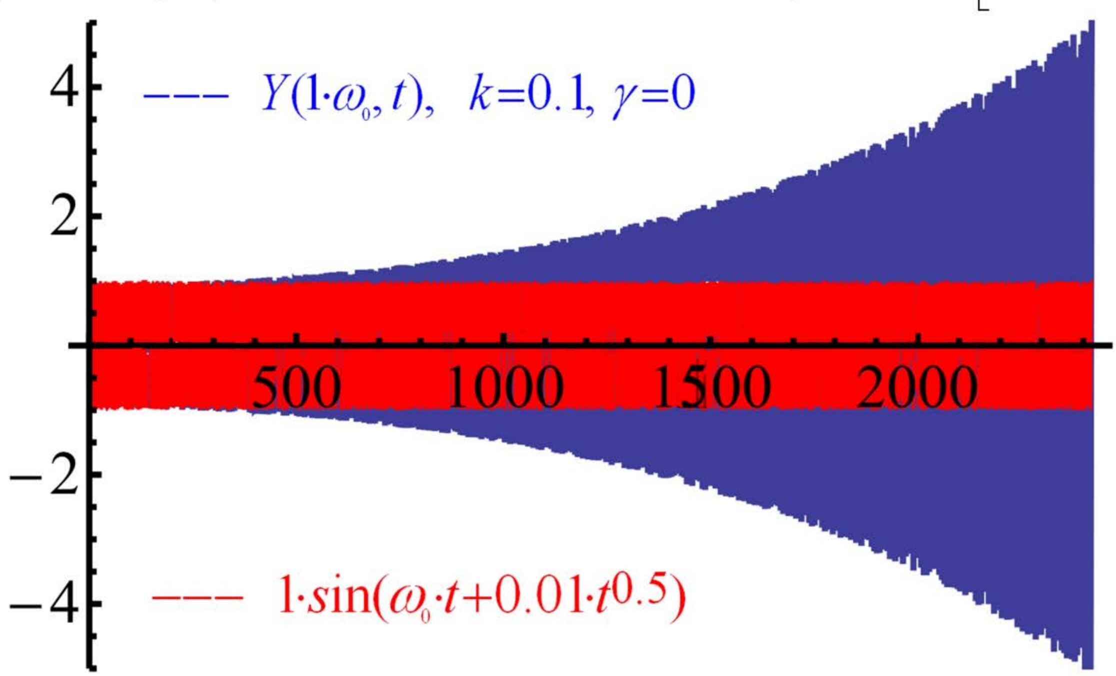

Fig. 3: Solving the Mathieu equation for a single modulation frequency and the original sine

At the next "threshold" frequency $2/3\omega_0$, even with zero attenuation, we have only weak pre-excitation (Fig. 4).

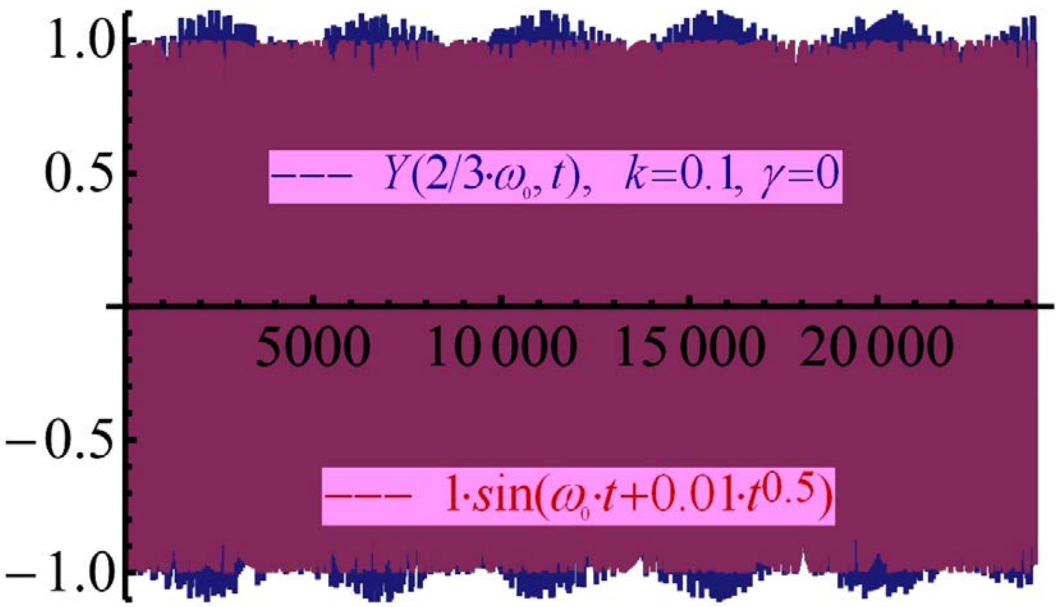

Fig. 4: Solution of the Mathieu equation for the modulation frequency of 2/3 and the original sine

And at lower modulation frequencies (at higher, shown in Fig. 1, inverse modulation frequencies), the excitation of OWNEED FUNCTIONS can only be achieved formally by increasing the modulation factor beyond the applicability limit of the Mathieu model.

And so, at any modulation frequencies, the OWN oscillator oscillations occur at the same OWN frequency (with some phase deviation), but either with a sharp increase and with almost no threshold (at zero attenuation), with a double modulation frequency, or with a weak increment at a single modulation frequency, or do not occur at all. T. h. To guess that when building a picture in Fig. 1, the author meant and I see no point in correcting it strictly, but qualitatively, conditionally, I showed her corrections with red lines. But the main feature is the unlimited increase of OWN on the marked two frequencies of parametric excitation with zero attenuation the same as that of the elementary harmonic oscillator BUT! without attenuation strictly at the resonant frequency.

A more attentive analysis of the dependence on the attenuation of OWN oscillations of a parametrically excited oscillator at the most sensitive, twice the modulation frequency will be carried out with a reasonable 1% modulation:

$$y''[t]+\gamma y'[t]+\left(1+k\cos[2t]\right)y[t]=0,\quad y'[0]=1,\quad y[0]=0\rightarrow\quad y_{k,\gamma}[t]=$$

$$/\,k=0.01,\qquad \gamma=0,\;\; 0.0001,\;\; 0.0005,\;\; 0.001,\;\; 0.002,\;\; 0.004,\;\; 0.008,\;\; 0.016$$

$$\begin{array}{l}
(0.7129898053724146+0.7007201267120846\mathrm{i})\;\; e^{-0.00000t}\,MathieuS[1.0000000000,-0.005,1.t]\\
(0.7129898090019725+0.7007204806821420\mathrm{i})\;\; e^{-0.00005t}\,MathieuS[0.99999999750,-0.005,1.t]\\
(0.7129898961113674+0.7007289760173282\mathrm{i})\;\; e^{-0.00025t}\,MathieuS[0.99999993750,-0.005,1.t]\\
(0.7129901683283144+0.7007555246028571\mathrm{i})\;\; e^{-0.0005t}\,MathieuS[0.999999750000,-0.005,1.t]\\
(0.7129912571974346+0.7008617289935156\mathrm{i})\;\; e^{-0.0010t}\,MathieuS[0.999999000000,-0.005,1.t]\\
(0.7129956126952366+0.7012867074583439\mathrm{i})\;\; e^{-0.0020t}\,MathieuS[0.999996000000,-0.005,1.t]\\
(0.7130130350275985+0.7029892037981437\mathrm{i})\;\; e^{-0.0040t}\,MathieuS[0.9999839999999999,-0.005,1.t]\\
(0.7130827298158775+0.7098410287143199\mathrm{i})\;\; e^{-0.0080t}\,MathieuS[0.9999360000000,-0.005,1.t]
\end{array}\tag{7}$$

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Under the same conditions, it is possible to calculate the dependences for attenuation close to the threshold

$$/ \; k=0.01, \qquad \gamma = 0.0047, \quad 0.005, \quad 0.0055$$

$$y_{k,\gamma}\left[t\right]=$$

$$\left(0.712997823123342+0.701502482610i\right)e^{-0.00235t}MathieuS\left[0.9999944775,-0.005,1.t\right] \quad (8)$$

$$\left(0.712998879340976+0.70160561045512i\right)e^{-0.0025t}MathieuS\left[0.99999375,-0.005,1.t\right]$$

$$\left(0.7130007848932+0.7017917042448i\right)e^{-0.00275t}MathieuS\left[0.9999924375,-0.005,1.t\right]$$

The dependence of the amplitude of these OWN oscillations on time for different attenuations corresponds to the upper limit of the corresponding (superimposed in color) absolute values (Fig. 5, 6)

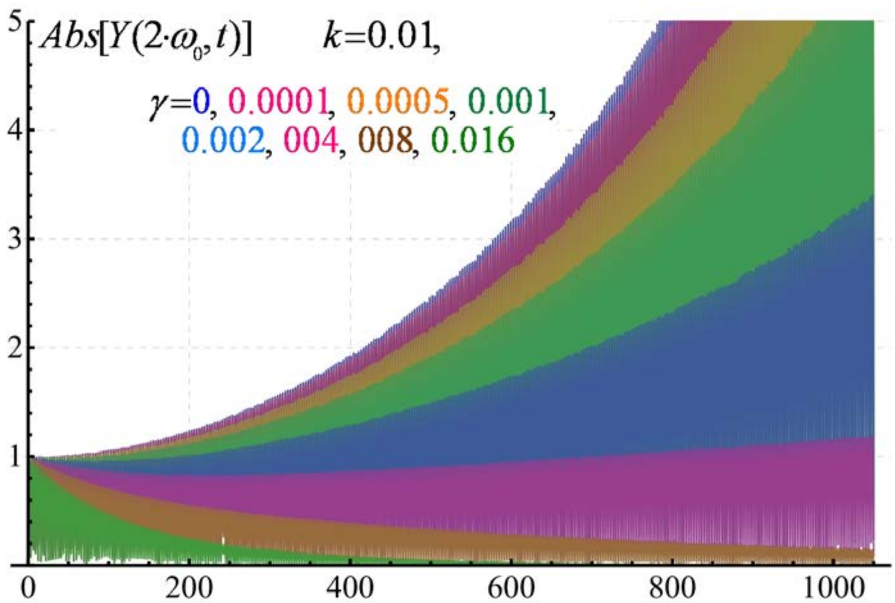
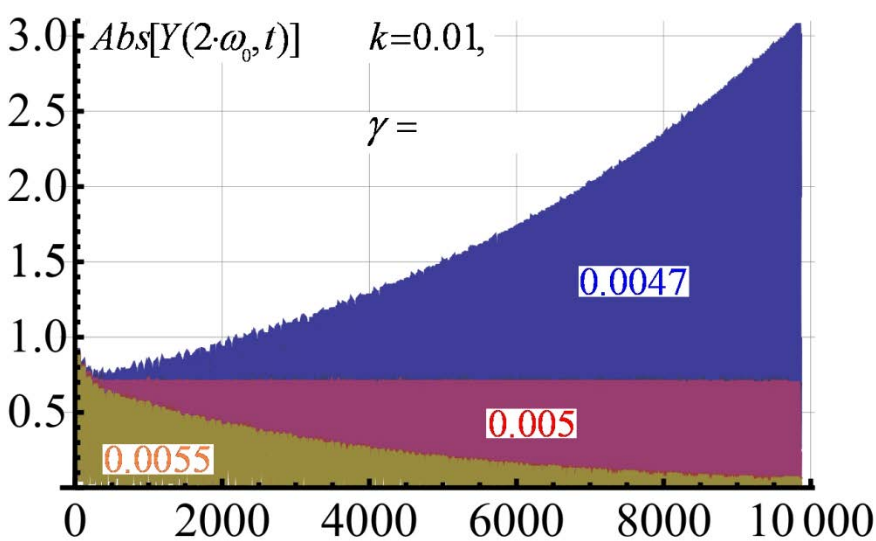


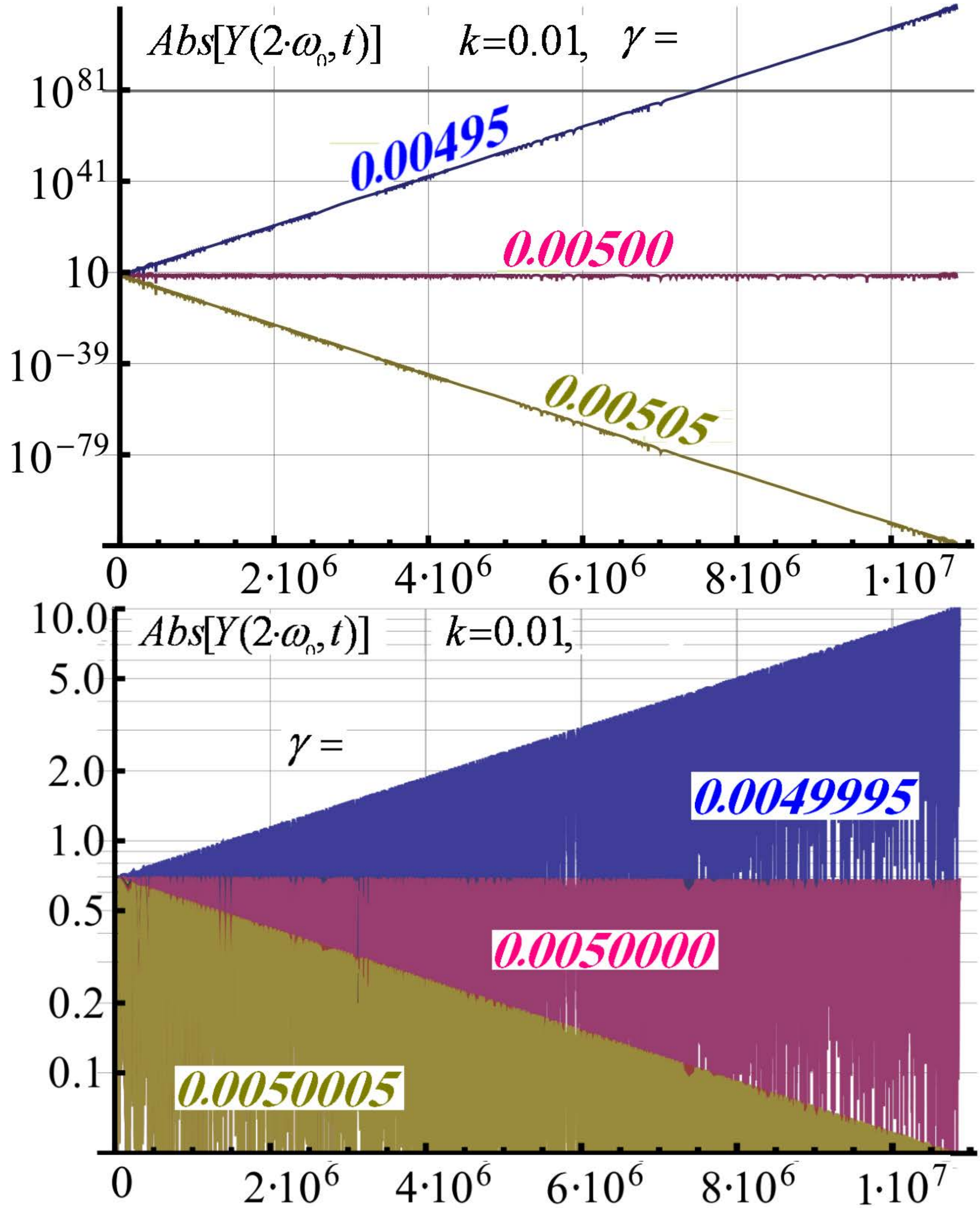
Fig. 5: The module of ω_0 oscillation is parametrically excited by a double frequency



Puc.6: The module of ω_0 oscillation is parametrically excited by a double frequency near the threshold of excitement

A characteristic feature of the obtained dependences of the Mathieu amplitude on time is a small decrease in the initial segment that is independent of attenuation due to de-phasing of the initial conditions followed by a catastrophic increase or decrease in amplitude over time dependent on damping.

At the same time, the attenuation threshold for double frequency with 1% modulation, as shown in Fig.6 and Fig.7, is 0.005 with great accuracy.



Puc.7: The module of ω_0 oscillation is parametrically excited by a double frequencynear the threshold of excitement

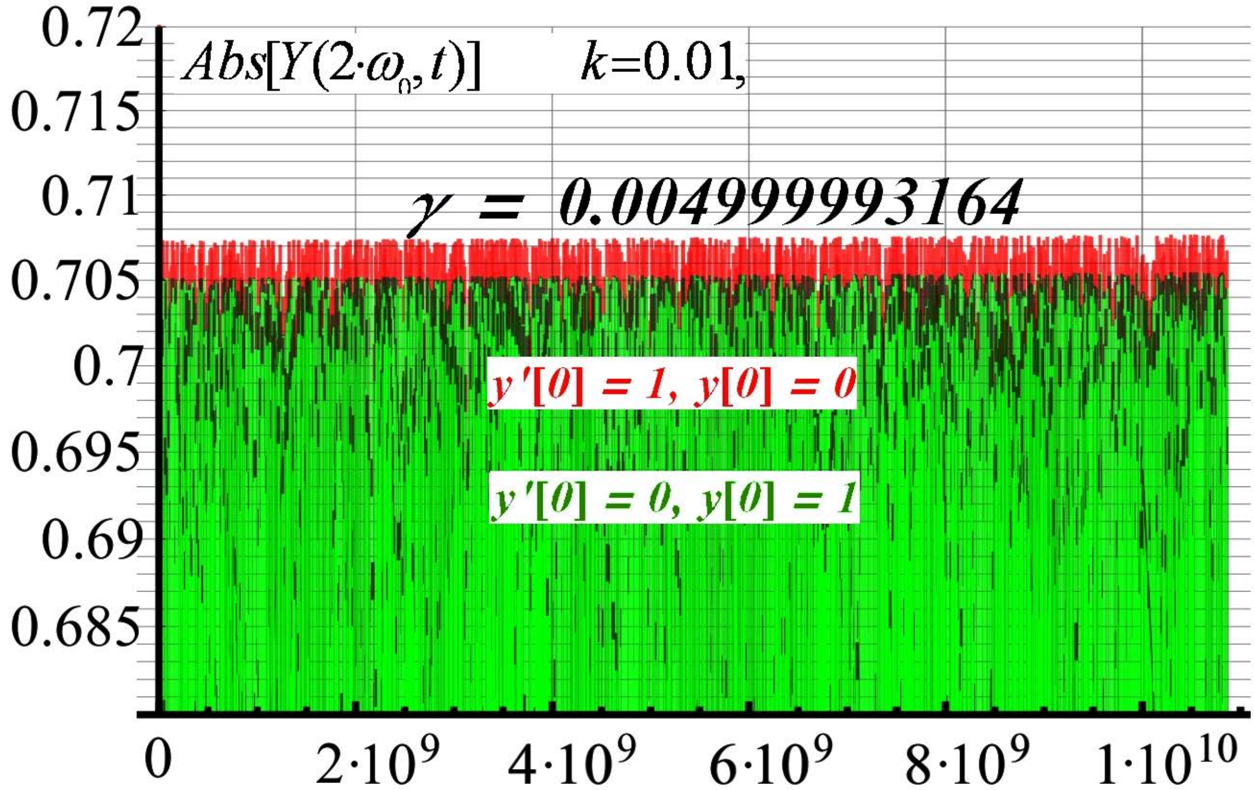


Fig. 8: A slight "instantaneous" drop in the amplitude of oscillations of the anharmonic oscillator to the saturation level with time at the threshold attenuation

The numerical value of the attenuation threshold is shown in the figure. In this damping, the oscillation amplitude weakly depends on the change in the initial conditions for the magnitude of the displacement and its derivative in a large time interval (Fig. 8).

However, the threshold amplitude increases by a factor of 200 if the unit acceleration is set to zero. But the characteristic asymptotic form of the time dependence of the amplitude is preserved. Thus, for the anharmonic oscillator, only for the threshold attenuation only, it is possible to construct, as for the harmonic oscillator, the frequency "resonance" characteristic. Whereas even an insignificant difference between attenuation and threshold leads to the time trend of the oscillation amplitude either to zero or to infinity.

And so, the numerical analysis of simple, but rigorous calculations of solutions to the Mathieu equation allows us to make qualitative conclusions and! allows them to be associated with an elementary physical model, which for a harmonic oscillator is in good agreement with many optical experiments and models.

II. Elementary Dynamicmodels

Elementary dynamic models of mechanics are used as basic in optics, in electricity, and in aero- and hydrodynamics, and static mechanical models are used as their asymptotics at zero frequency. But the development and refinement of dynamic models is often carried out at the expense of their complication and the introduction of additional, not rarely redundant dynamic parameters, which leads to their incorrectness - violation of the conditions of applicability of the original, basic static model. Therefore, we first consider the basic static model of a harmonic oscillator, the dynamic characteristics, which, describing well the normal lattice vibrations in Fedor's crystals, were previously presented in Chaos-Imagination-Orthogonality. In anisotropic crystals, it is necessary to consider not one oscillator, but at least two, corresponding to the orthogonal crystallographic directions of oscillators in a simple uniaxial crystal. Within the framework of this model, the frequencies of normal mechanical (excluding the Coulomb additive) lattice modes of an anisotropic crystal are associated (as shown in Fig. 9) only with the bond stiffness of ions in the lattice along the main crystallographic directions, for a uniaxial crystal:

$$\xi^{\perp C}, \xi^{\parallel C}$$

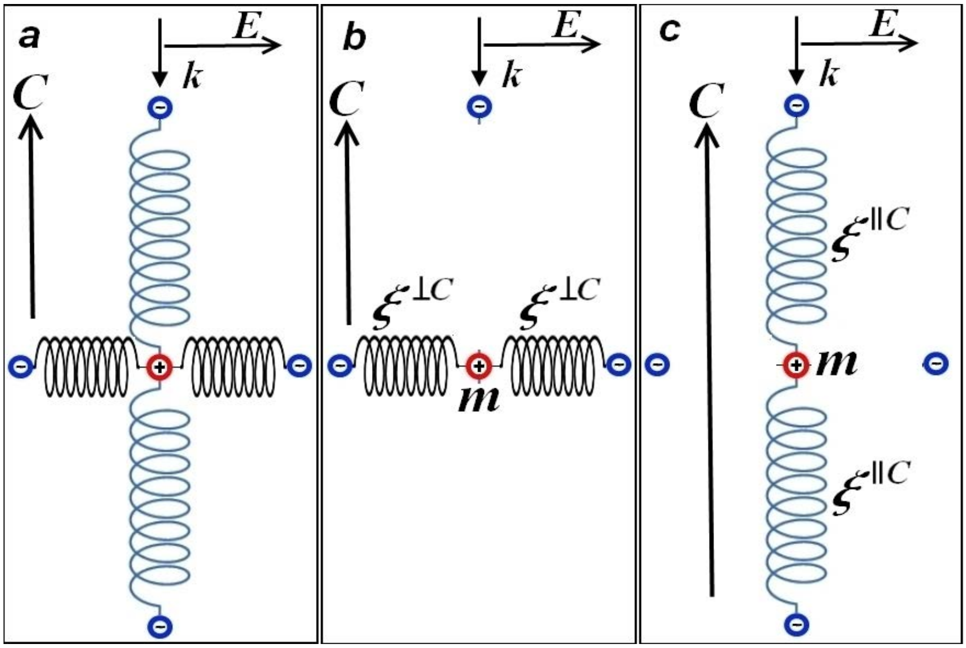


Fig. 9: Anelementary model of normal vibrations in an an isotropic medium, allowed and forbidden for light incidental on g the C axis

However, as shown for a separate chain of ions along the C axis (Fig. 9c and 10), the displacement of the central (positively conditional) along x increases the actual tension of the spring of the C axis along y, i.e. increases the resonant frequency of longitudinal oscillations propagating along C. So, the orthogonal spring stiffness $\xi^{\perp C}$, $\xi^{\| C}$ used in dynamics are some given values.

When the central ion is displaced along the C axis by an amount (Fig. 10a), an imbalance of forces F_1^y and F_2^y arises without an increase in the rigidity of the ion bonds:

$$F^y_{1/\Delta y=0} - F^y_{2/\Delta y=0} = 0 \rightarrow \Delta F^y = \left(l_0 + \Delta y\right)\cdot \xi^{\|} - \left(l_0 - \Delta y\right)\cdot \xi^{\|} = 2\cdot \Delta y \cdot \xi^{\|} \tag{9}$$

where the effective length l_0 determines the equilibrium tension of the "springs" along y.

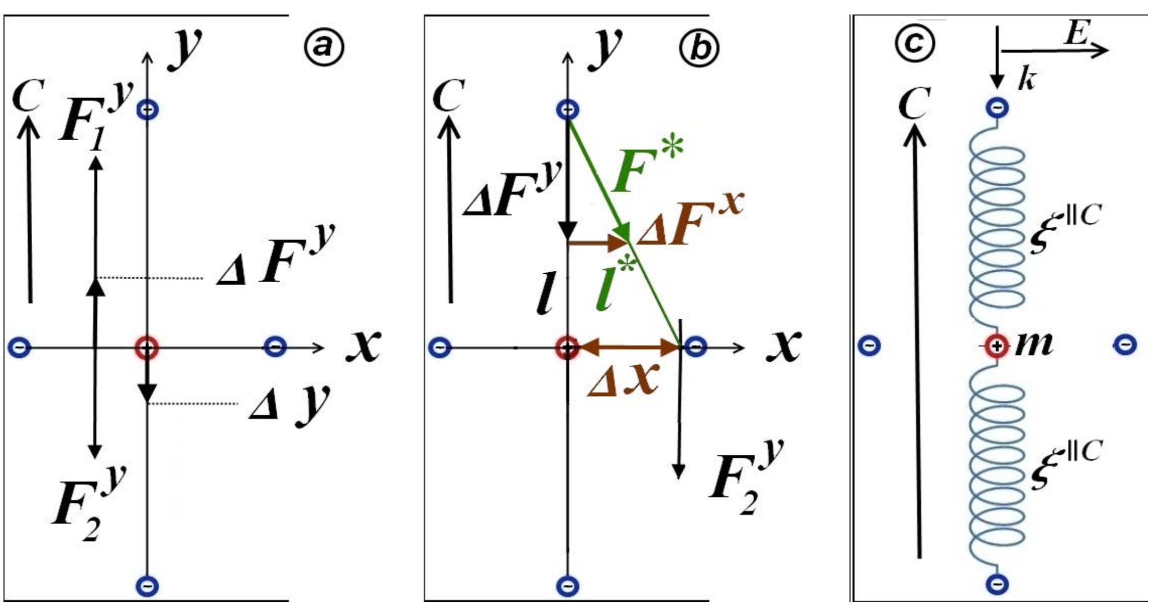


Fig. 10: Forces arising in a chain of atoms along the C axis with disregard of orthogonal C bonds of ions

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And the total doubled stiffness $\xi^{||C}$ determines the resonant frequency (fig.10c):

$$\xi_{\Sigma}^{||c} = \Delta F^{y} / \Delta y = 2 \cdot \xi^{||c} \to \omega_0^2 = 2 \cdot \xi^{||c} / m \tag{10}$$

But in the highly ordered rhombohedral phase of boron nitride, with the detection of an optical anomaly in which the analysis presented itself began, the ions form pairs along the C axis, i.e. For the formation of the resonant frequency for oscillations along the C axis in boron nitride, the single stiffness is responsible:

$$\omega_0^{||c} = \sqrt{\xi^{||c} / m} = \omega_T^{||c} \tag{11}$$

When the central (positive, conditionally) ion perpendicular to the C axis is displaced by the amount (Fig.10b), the balance of the initially balanced forces F_1^y and F_2^y is maintained, and due to the additional lengthening of the "springs" they increase in magnitude by the amount F^* (Fig.10b). At the same time, given the elementary geometric relations

$$\Delta F^{y} / \Delta F^{x} = l / \Delta x \to \quad F^{*} = \sqrt{(\Delta F^{y})^2 + (\Delta F^{x})^2} = \Delta F^{y} \cdot \sqrt{1 + (\Delta x / l)^2} \quad ,$$

$$F^{*} = \xi^{||c} \xi \cdot \Delta l = \xi^{||c} \cdot (\sqrt{l^2 + \Delta x^2} - l) = \xi^{||c} \cdot l \cdot (\sqrt{1 + (\Delta x / l)^2} - 1) \tag{12}$$

You can get the dependence on Δx - the magnitude of the displacement perpendicular to the C axis of the orthogonal forces - equivalent increments of the forces F_1^y and F_2^y

$$\Delta F^{y} = \xi^{||c} \cdot l \cdot \left(1 - \frac{1}{\sqrt{1 + (\Delta x / l)^2}}\right), \qquad \Delta F^{x} = \xi^{||c} \cdot \Delta x \cdot \left(1 - \frac{1}{\sqrt{1 + (\Delta x / l)^2}}\right) \tag{13}$$

Given the smallness of the displacement, it is possible to obtain simplified expressions for these forces.

$$\Delta F^{y} \cong \xi^{||c} \cdot \frac{Abs(\Delta x)}{2}, \qquad \Delta F^{x} \cong \xi^{||c} \cdot \frac{\Delta x}{l} \cdot \frac{Abs(\Delta x)}{2} \tag{14}$$

Thus, when the ion is displaced strictly perpendicular to the C axis, an additional, but balanced component of the force along the C axis arises, which leads to a change in stiffness (length of the initial tension l_0) of the spring along C, both at linear and harmonic displacements. For, again, boron nitride, where the ions form a pair, we have

$$\xi^{||*} \cong \xi^{||c} \cdot \left(1 + \frac{Abs(\Delta x)}{2 l_0}\right) \Rightarrow \xi^{||*} \cong \xi^{||c} \cdot \left(1 + \frac{\Delta x_0}{2 l_0} Abs(\cos(\omega t))\right) \tag{15}$$

If we set the frequency of harmonic displacements equal to the resonance ω_0, then decomposing the change of the parameter in a Fourier series, and, taking into account the first coefficients, we get

$$\xi^{||*} \cong \xi^{||c} \cdot \left(1 + \frac{\Delta x_0}{l_0} \left[\frac{1}{\pi} + \frac{1}{3\pi} \cos(2\omega_0 t) - \frac{1}{15\pi} \cos(4\omega_0 t)\right] + \ldots\right) \tag{16}$$

Neglecting in the resulting expression (16) for the dependence of the longitudinal stiffness on the transverse oscillations of a small constant additive to the resonant frequency due to the zero term, we obtain the parametric Mathieu excitation at twice the most sensitive frequency

$$\xi^{||*} \cong \xi^{||c} \cdot \left(1 + \frac{\Delta x_0}{l_0} \frac{1}{3\pi} \cos(2\omega_0 t)\right) \tag{17}$$

The excitations of the third and the following small Fourier coefficients in Φ.16 can be safely neglected, since it was shown above that the sensitivity of the excitation decreases sharply.

And so, if the ion displaced in x additionally begins to displace in y, then the returning force and the resonant frequency of oscillations along the C axis will be determined by the increased rigidity, in accordance with ф.16. But the main excitation at the doubled resonant frequency for longitudinal oscillations is a direct consequence of independence from the direction of displacement of the transverse oscillation strictly at the frequency of the longitudinal resonance.

For shear force of f. (14), since Since the transverse oscillations (at the longitudinal resonant frequency) are alternating, then there is, of course, no constant displacement. If we take into account the transverse stiffness $\xi^{\perp C}$ that was thrown out of this consideration, we obtain a small quadratic additive related to nonlinearity

$$F^{x} \cong \xi^{\perp C} \cdot \Delta x + \xi^{\| c} \cdot \frac{Abs(\Delta x)}{2l} \cdot \Delta x \tag{18}$$

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and with harmonic excitation at the longitudinal resonant frequency we have a set of its odd harmonics falling down with the number

$$\begin{aligned} F^{x} &\cong \xi^{\perp C} \cdot \Delta x_0 \cdot \cos(\omega_0 t) + \xi^{\| C} \cdot \frac{\Delta x_0^2}{2l} \cdot Abs(\cos(\omega_0 t)) \cdot \cos(\omega_0 t) = \\ &\xi^{\perp C} \cdot \Delta x_0 \cdot \cos(\omega_0 t) + \xi^{\| C} \cdot \frac{\Delta x_0^2}{2l} \cdot \left(\frac{4}{3\pi} \cdot \cos(\omega_0 t) + \frac{4}{15\pi} \cdot \cos(3\omega_0 t) - \frac{4}{105\pi} \cdot \cos(5\omega_0 t) \ldots \right) \\ &\cong \left(\xi^{\perp C} + \xi^{\| C} \cdot \frac{2\Delta x_0}{3\pi l} \right) \cdot \Delta x_0 \cdot \cos(\omega_0 t) \end{aligned} \tag{19}$$

Those the oscillation stiffness perpendicular to the C axis has a small additive that increases linearly with the oscillation amplitude due to the stiffness along the C axis.

The above calculations can also be used to examine the ion chain in a plane perpendicular to the C axis. To do this, it is enough to swap formally $\xi^{\perp C}$, $\xi^{\| C}$, not formally, to take into account the features of each chain, specifically in boron nitride, it is necessary to take into account that in its hexagonal atomic layers each ion is surrounded symmetrically located three ions (Fig. 11)

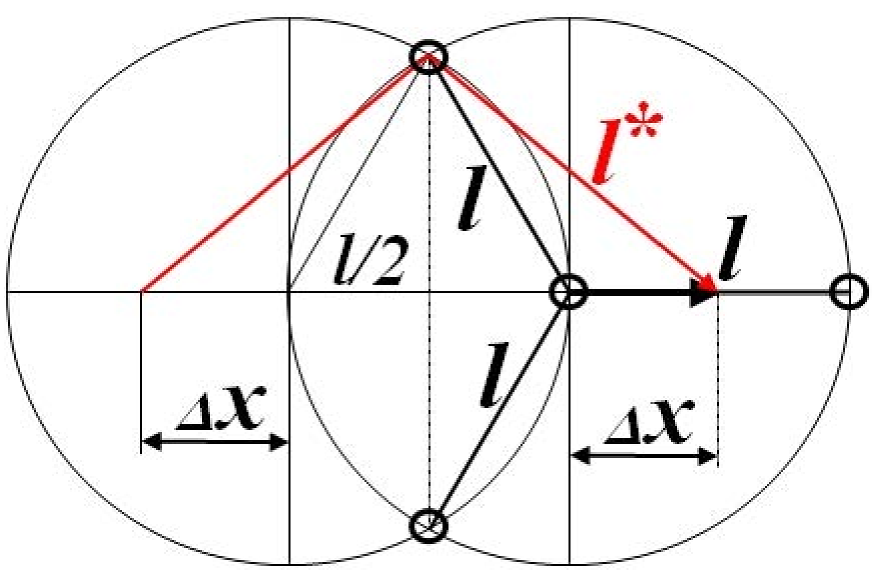

Fig. 11: Geometric construction demonstrating the ratio of displacements and forces

By displacing the central ion along x and reducing the parallel x bond, elementary geometric relations allow us to determine additionally the extension of two other bonds

$$\left(l^*\right)^2=\left(l+\Delta l\right)^2=\left(\Delta x\right)^2+l^2+2\cdot\Delta x\cdot\frac{1}{2}l=l^2+\Delta x\cdot l+\left(\Delta x\right)^2$$

$$\Delta l=\sqrt{l^2+\Delta x\cdot l+\left(\Delta x\right)^2}-l=l\cdot\left(\sqrt{1+\frac{\Delta x}{l}+\left(\frac{\Delta x}{l}\right)^2}-1\right)\approx\frac{\Delta x}{2} \tag{20}$$

And the same to define additional restoring forces due to these connections and their algebraic sum

$$\frac{F_\Sigma^x}{\xi^{\perp C}\cdot\Delta l}=\frac{l+2\Delta l}{l+\Delta l}\rightarrow F_\Sigma^x=\xi^{\perp C}\cdot\Delta l\cdot\left(1+\frac{1}{1+l/\Delta l}\right)\cong\xi^{\perp C}\cdot\Delta l\cdot\left(1+\frac{\Delta l}{l}\right)$$

$$F_\Sigma^x\cong\xi^{\perp C}\cdot\frac{\Delta x}{2}\cdot\left(1+\frac{\Delta x}{2l}\right)\approx\xi^{\perp C}\cdot\frac{\Delta x}{2} \tag{21}$$

So instead of the unbalance shown in f.9 we get

$$\Delta F^x\approx\xi^{\perp C}\cdot\frac{\Delta x}{2}+\xi^{\perp C}\cdot\Delta x=\frac{3}{2}\xi^{\perp C}\cdot\Delta x \tag{22}$$

And, thus, for the frequencies of orthogonal phonons in boron nitride (Fig. 12):

$$\omega_T^{\|C}=757\ \mathrm{cm}^{-1},\ \omega_L^{\|C}=826.5\ \mathrm{cm}^{-1},\ \omega_T^{\perp C}=1372\ \mathrm{cm}^{-1},\ \omega_T^{\perp C}=1618\ \mathrm{cm}^{-1}$$

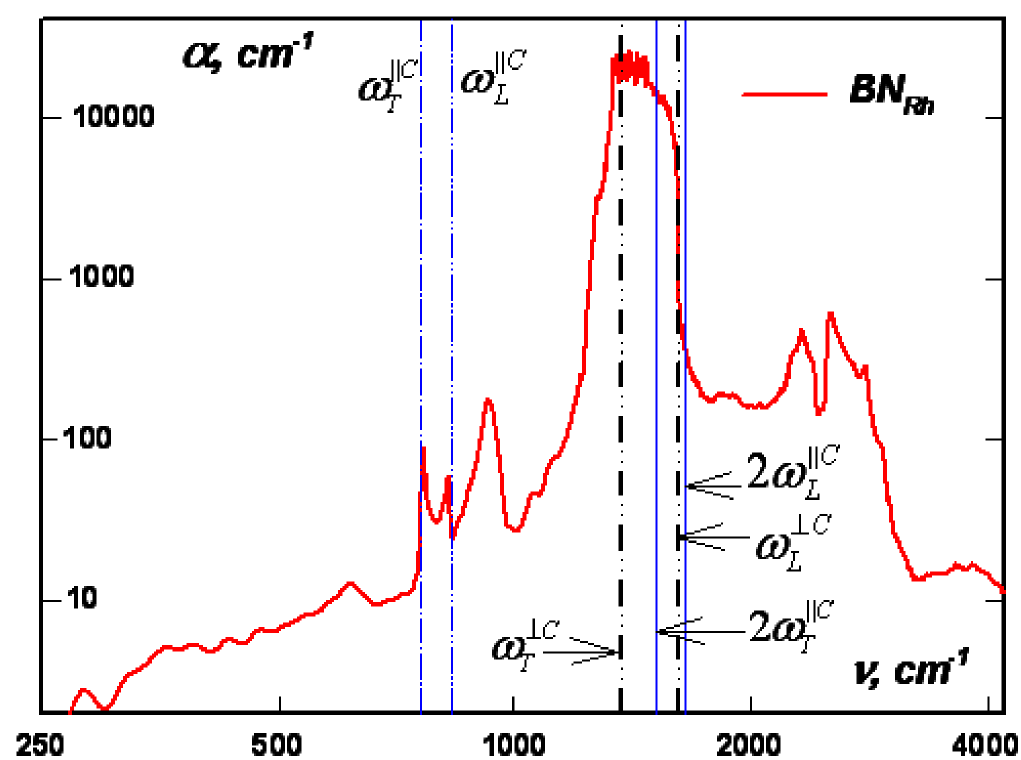

Fig. 12: The spectrum of "absorption" of radiation along the C axis in rhombohedral boron nitride

remembering f.11, we get the ratio

$$\frac{\omega_T^{\perp c}}{\omega_T^{\parallel c}} \simeq \sqrt{\frac{3\xi^{\perp c}}{2\xi^{\parallel c}}} \Rightarrow \frac{\xi^{\perp c}}{\xi^{\parallel c}} \simeq \frac{2}{3}\left(\frac{\omega_T^{\perp c}}{\omega_T^{\parallel c}}\right)^2 \simeq 2.2 \quad (23)$$

The spectrum shown in Figure 12 can be strictly (without any quotation marks) called the absorption spectrum in the entire range shown, except for the anomalous in shape and forbidden by symmetry band between the low-frequency phonons propagating along the C axis. Identified additionally in the experiments described below, its anomalous nature and the feat of strictly conducting the presented theoretical analysis. And along the way, as follows from f.21, it was shown that stiffnesses inside the layer and interlayer bonds differ only two times, which does not correspond to the standard concepts of the Van der Waals interaction between polyatomic layers.

III. Conclusion

Giant anisotropy of the electrical conductivity of graphite samples has pushed theorists to Van der Waals idealization of both graphite and boron nitride (C & BN). But, as was shown earlier, it was determined not by the properties of the graphite crystal itself, but by the texture of the samples. Both the erroneous discovery of “graphene” and the hype around it simply prompted the publication of experimental results and theoretical calculations of the real structure and real properties of C & BN. The real anisotropy of C & BN has nothing to do with theoretical “bad infinities”, but it is large, moreover, it is extremely possible in crystals. And this makes it possible to use C & BN as a model material, in particular for the analysis of lattice vibrations.

On the one hand, the difference in the frequencies of their orthogonal normal lattice modes (parallel and perpendicular to the C axis) almost 2 times makes them weakly coupled in frequency. And this leads practically to the independence of the corresponding spectra of the lattice reflection and! to the rigorous description of each spectrum by its classical, with low attenuation, harmonic oscillator (which, in fact, was analyzed in previous work).

On the other hand, this large difference made it possible to experimentally reliably register at the longitudinal resonant frequency a “forbidden” spectral feature with anomalous properties of the stopband. The theory of parametric interaction developed earlier, although it was consistent with the observed effect, as such, but led to contradictions and questions, but which could not be answered. The analysis carried out in this work showed that there was simply no qualitative idea about the properties of parametric Mathieu solutions, and, therefore, there were not even correct quantitative estimates. And most importantly, this analysis showed that it is at the frequency of orthogonal oscillations equal to the frequency of the longitudinal resonance that this resonance leads to an unlimited (until we go beyond the scope of the model itself) increasing the amplitude of the associated longitudinal-transverse oscillations, which leads to skipping-scattering. A detailed experimental analysis of this “anomaly” will be presented in the next article “Parametric interaction of normal modes in C & BN.

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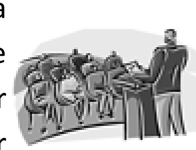

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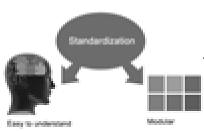

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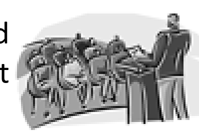

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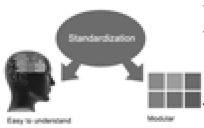

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Authors can submit papers and articles in an acceptable file format: MS Word (doc, docx), LaTeX (.tex, .zip or .rar including all of your files), Adobe PDF (.pdf), rich text format (.rtf), simple text document (.txt), Open Document Text (.odt), and Apple Pages (.pages). Our professional layout editors will format the entire paper according to our official guidelines. This is one of the highlights of publishing with Global Journals—authors should not be concerned about the formatting of their paper. Global Journals accepts articles and manuscripts in every major language, be it Spanish, Chinese, Japanese, Portuguese, Russian, French, German, Dutch, Italian, Greek, or any other national language, but the title, subtitle, and abstract should be in English. This will facilitate indexing and the pre-peer review process.

The following is the official style and template developed for publication of a research paper. Authors are not required to follow this style during the submission of the paper. It is just for reference purposes.

Manuscript Style Instruction (Optional)

- Microsoft Word Document Setting Instructions.
- Font type of all text should be Swis721 Lt BT.
- Page size: 8.27" x 11'", left margin: 0.65, right margin: 0.65, bottom margin: 0.75.
- Paper title should be in one column of font size 24.
- Author name in font size of 11 in one column.
- Abstract: font size 9 with the word "Abstract" in bold italics.
- Main text: font size 10 with two justified columns.
- Two columns with equal column width of 3.38 and spacing of 0.2.
- First character must be three lines drop-capped.
- The paragraph before spacing of 1 pt and after of 0 pt.
- Line spacing of 1 pt.
- Large images must be in one column.
- The names of first main headings (Heading 1) must be in Roman font, capital letters, and font size of 10.
- The names of second main headings (Heading 2) must not include numbers and must be in italics with a font size of 10.

Structure and Format of Manuscript

The recommended size of an original research paper is under 15,000 words and review papers under 7,000 words. Research articles should be less than 10,000 words. Research papers are usually longer than review papers. Review papers are reports of significant research (typically less than 7,000 words, including tables, figures, and references)

A research paper must include:

a) A title which should be relevant to the theme of the paper.
b) A summary, known as an abstract (less than 150 words), containing the major results and conclusions.
c) Up to 10 keywords that precisely identify the paper's subject, purpose, and focus.
d) An introduction, giving fundamental background objectives.
e) Resources and techniques with sufficient complete experimental details (wherever possible by reference) to permit repetition, sources of information must be given, and numerical methods must be specified by reference.
f) Results which should be presented concisely by well-designed tables and figures.
g) Suitable statistical data should also be given.
h) All data must have been gathered with attention to numerical detail in the planning stage.

Design has been recognized to be essential to experiments for a considerable time, and the editor has decided that any paper that appears not to have adequate numerical treatments of the data will be returned unrefereed.

i) Discussion should cover implications and consequences and not just recapitulate the results; conclusions should also be summarized.
j) There should be brief acknowledgments.
k) There ought to be references in the conventional format. Global Journals recommends APA format.

Authors should carefully consider the preparation of papers to ensure that they communicate effectively. Papers are much more likely to be accepted if they are carefully designed and laid out, contain few or no errors, are summarizing, and follow instructions. They will also be published with much fewer delays than those that require much technical and editorial correction.

The Editorial Board reserves the right to make literary corrections and suggestions to improve brevity.

Format Structure

It is necessary that authors take care in submitting a manuscript that is written in simple language and adheres to published guidelines.

All manuscripts submitted to Global Journals should include:

Title

The title page must carry an informative title that reflects the content, a running title (less than 45 characters together with spaces), names of the authors and co-authors, and the place(s) where the work was carried out.

Author details

The full postal address of any related author(s) must be specified.

Abstract

The abstract is the foundation of the research paper. It should be clear and concise and must contain the objective of the paper and inferences drawn. It is advised to not include big mathematical equations or complicated jargon.

Many researchers searching for information online will use search engines such as Google, Yahoo or others. By optimizing your paper for search engines, you will amplify the chance of someone finding it. In turn, this will make it more likely to be viewed and cited in further works. Global Journals has compiled these guidelines to facilitate you to maximize the web-friendliness of the most public part of your paper.

Keywords

A major lynchpin of research work for the writing of research papers is the keyword search, which one will employ to find both library and internet resources. Up to eleven keywords or very brief phrases have to be given to help data retrieval, mining, and indexing.

One must be persistent and creative in using keywords. An effective keyword search requires a strategy: planning of a list of possible keywords and phrases to try.

Choice of the main keywords is the first tool of writing a research paper. Research paper writing is an art. Keyword search should be as strategic as possible.

One should start brainstorming lists of potential keywords before even beginning searching. Think about the most important concepts related to research work. Ask, "What words would a source have to include to be truly valuable in a research paper?" Then consider synonyms for the important words.

It may take the discovery of only one important paper to steer in the right keyword direction because, in most databases, the keywords under which a research paper is abstracted are listed with the paper.

Numerical Methods

Numerical methods used should be transparent and, where appropriate, supported by references.

Abbreviations

Authors must list all the abbreviations used in the paper at the end of the paper or in a separate table before using them.

Formulas and equations

Authors are advised to submit any mathematical equation using either MathJax, KaTeX, or LaTeX, or in a very high-quality image.

Tables, Figures, and Figure Legends

Tables: Tables should be cautiously designed, uncrowned, and include only essential data. Each must have an Arabic number, e.g., Table 4, a self-explanatory caption, and be on a separate sheet. Authors must submit tables in an editable format and not as images. References to these tables (if any) must be mentioned accurately.

Figures

Figures are supposed to be submitted as separate files. Always include a citation in the text for each figure using Arabic numbers, e.g., Fig. 4. Artwork must be submitted online in vector electronic form or by emailing it.

Preparation of Eletronic Figures for Publication

Although low-quality images are sufficient for review purposes, print publication requires high-quality images to prevent the final product being blurred or fuzzy. Submit (possibly by e-mail) EPS (line art) or TIFF (halftone/ photographs) files only. MS PowerPoint and Word Graphics are unsuitable for printed pictures. Avoid using pixel-oriented software. Scans (TIFF only) should have a resolution of at least 350 dpi (halftone) or 700 to 1100 dpi (line drawings). Please give the data for figures in black and white or submit a Color Work Agreement form. EPS files must be saved with fonts embedded (and with a TIFF preview, if possible).

For scanned images, the scanning resolution at final image size ought to be as follows to ensure good reproduction: line art: >650 dpi; halftones (including gel photographs): >350 dpi; figures containing both halftone and line images: >650 dpi.

Color charges: Authors are advised to pay the full cost for the reproduction of their color artwork. Hence, please note that if there is color artwork in your manuscript when it is accepted for publication, we would require you to complete and return a Color Work Agreement form before your paper can be published. Also, you can email your editor to remove the color fee after acceptance of the paper.

Tips for Writing a Good Quality Science Frontier Research Paper

Techniques for writing a good quality Science Frontier Research paper:

1. Choosing the topic: In most cases, the topic is selected by the interests of the author, but it can also be suggested by the guides. You can have several topics, and then judge which you are most comfortable with. This may be done by asking several questions of yourself, like "Will I be able to carry out a search in this area? Will I find all necessary resources to accomplish the search? Will I be able to find all information in this field area?" If the answer to this type of question is "yes," then you ought to choose that topic. In most cases, you may have to conduct surveys and visit several places. Also, you might have to do a lot of work to find all the rises and falls of the various data on that subject. Sometimes, detailed information plays a vital role, instead of short information. Evaluators are human: The first thing to remember is that evaluators are also human beings. They are not only meant for rejecting a paper. They are here to evaluate your paper. So present your best aspect.

2. Think like evaluators: If you are in confusion or getting demotivated because your paper may not be accepted by the evaluators, then think, and try to evaluate your paper like an evaluator. Try to understand what an evaluator wants in your research paper, and you will automatically have your answer. Make blueprints of paper: The outline is the plan or framework that will help you to arrange your thoughts. It will make your paper logical. But remember that all points of your outline must be related to the topic you have chosen.

3. Ask your guides: If you are having any difficulty with your research, then do not hesitate to share your difficulty with your guide (if you have one). They will surely help you out and resolve your doubts. If you can't clarify what exactly you require for your work, then ask your supervisor to help you with an alternative. He or she might also provide you with a list of essential readings.

4. Use of computer is recommended: As you are doing research in the field of science frontier then this point is quite obvious. Use right software: Always use good quality software packages. If you are not capable of judging good software, then you can lose the quality of your paper unknowingly. There are various programs available to help you which you can get through the internet.

5. Use the internet for help: An excellent start for your paper is using Google. It is a wondrous search engine, where you can have your doubts resolved. You may also read some answers for the frequent question of how to write your research paper or find a model research paper. You can download books from the internet. If you have all the required books, place importance on reading, selecting, and analyzing the specified information. Then sketch out your research paper. Use big pictures: You may use encyclopedias like Wikipedia to get pictures with the best resolution. At Global Journals, you should strictly follow here.

6. Bookmarks are useful: When you read any book or magazine, you generally use bookmarks, right? It is a good habit which helps to not lose your continuity. You should always use bookmarks while searching on the internet also, which will make your search easier.

7. Revise what you wrote: When you write anything, always read it, summarize it, and then finalize it.

8. Make every effort: Make every effort to mention what you are going to write in your paper. That means always have a good start. Try to mention everything in the introduction—what is the need for a particular research paper. Polish your work with good writing skills and always give an evaluator what he wants. Make backups: When you are going to do any important thing like making a research paper, you should always have backup copies of it either on your computer or on paper. This protects you from losing any portion of your important data.

9. Produce good diagrams of your own: Always try to include good charts or diagrams in your paper to improve quality. Using several unnecessary diagrams will degrade the quality of your paper by creating a hodgepodge. So always try to include diagrams which were made by you to improve the readability of your paper. Use of direct quotes: When you do research relevant to literature, history, or current affairs, then use of quotes becomes essential, but if the study is relevant to science, use of quotes is not preferable.

10. Use proper verb tense: Use proper verb tenses in your paper. Use past tense to present those events that have happened. Use present tense to indicate events that are going on. Use future tense to indicate events that will happen in the future. Use of wrong tenses will confuse the evaluator. Avoid sentences that are incomplete.

11. Pick a good study spot: Always try to pick a spot for your research which is quiet. Not every spot is good for studying.

12. Know what you know: Always try to know what you know by making objectives, otherwise you will be confused and unable to achieve your target.

13. Use good grammar: Always use good grammar and words that will have a positive impact on the evaluator; use of good vocabulary does not mean using tough words which the evaluator has to find in a dictionary. Do not fragment sentences. Eliminate one-word sentences. Do not ever use a big word when a smaller one would suffice.

Verbs have to be in agreement with their subjects. In a research paper, do not start sentences with conjunctions or finish them with prepositions. When writing formally, it is advisable to never split an infinitive because someone will (wrongly) complain. Avoid clichés like a disease. Always shun irritating alliteration. Use language which is simple and straightforward. Put together a neat summary.

14. Arrangement of information: Each section of the main body should start with an opening sentence, and there should be a changeover at the end of the section. Give only valid and powerful arguments for your topic. You may also maintain your arguments with records.

15. Never start at the last minute: Always allow enough time for research work. Leaving everything to the last minute will degrade your paper and spoil your work.

16. Multitasking in research is not good: Doing several things at the same time is a bad habit in the case of research activity. Research is an area where everything has a particular time slot. Divide your research work into parts, and do a particular part in a particular time slot.

17. Never copy others' work: Never copy others' work and give it your name because if the evaluator has seen it anywhere, you will be in trouble. Take proper rest and food: No matter how many hours you spend on your research activity, if you are not taking care of your health, then all your efforts will have been in vain. For quality research, take proper rest and food.

18. Go to seminars: Attend seminars if the topic is relevant to your research area. Utilize all your resources.

19. Refresh your mind after intervals: Try to give your mind a rest by listening to soft music or sleeping in intervals. This will also improve your memory. Acquire colleagues: Always try to acquire colleagues. No matter how sharp you are, if you acquire colleagues, they can give you ideas which will be helpful to your research.

20. Think technically: Always think technically. If anything happens, search for its reasons, benefits, and demerits. Think and then print: When you go to print your paper, check that tables are not split, headings are not detached from their descriptions, and page sequence is maintained.

21. Adding unnecessary information: Do not add unnecessary information like "I have used MS Excel to draw graphs." Irrelevant and inappropriate material is superfluous. Foreign terminology and phrases are not apropos. One should never take a broad view. Analogy is like feathers on a snake. Use words properly, regardless of how others use them. Remove quotations. Puns are for kids, not grunt readers. Never oversimplify: When adding material to your research paper, never go for oversimplification; this will definitely irritate the evaluator. Be specific. Never use rhythmic redundancies. Contractions shouldn't be used in a research paper. Comparisons are as terrible as clichés. Give up ampersands, abbreviations, and so on. Remove commas that are not necessary. Parenthetical words should be between brackets or commas. Understatement is always the best way to put forward earth-shaking thoughts. Give a detailed literary review.

22. Report concluded results: Use concluded results. From raw data, filter the results, and then conclude your studies based on measurements and observations taken. An appropriate number of decimal places should be used. Parenthetical remarks are prohibited here. Proofread carefully at the final stage. At the end, give an outline to your arguments. Spot perspectives of further study of the subject. Justify your conclusion at the bottom sufficiently, which will probably include examples.

23. Upon conclusion: Once you have concluded your research, the next most important step is to present your findings. Presentation is extremely important as it is the definite medium though which your research is going to be in print for the rest of the crowd. Care should be taken to categorize your thoughts well and present them in a logical and neat manner. A good quality research paper format is essential because it serves to highlight your research paper and bring to light all necessary aspects of your research.

Informal Guidelines of Research Paper Writing

Key points to remember:

- Submit all work in its final form.
- Write your paper in the form which is presented in the guidelines using the template.
- Please note the criteria peer reviewers will use for grading the final paper.

Final points:

One purpose of organizing a research paper is to let people interpret your efforts selectively. The journal requires the following sections, submitted in the order listed, with each section starting on a new page:

The introduction: This will be compiled from reference matter and reflect the design processes or outline of basis that directed you to make a study. As you carry out the process of study, the method and process section will be constructed like that. The results segment will show related statistics in nearly sequential order and direct reviewers to similar intellectual paths throughout the data that you gathered to carry out your study.

The discussion section:

This will provide understanding of the data and projections as to the implications of the results. The use of good quality references throughout the paper will give the effort trustworthiness by representing an alertness to prior workings.

Writing a research paper is not an easy job, no matter how trouble-free the actual research or concept. Practice, excellent preparation, and controlled record-keeping are the only means to make straightforward progression.

General style:

Specific editorial column necessities for compliance of a manuscript will always take over from directions in these general guidelines.

To make a paper clear: Adhere to recommended page limits.

Mistakes to avoid:

- Insertion of a title at the foot of a page with subsequent text on the next page.
- Separating a table, chart, or figure—confine each to a single page.
- Submitting a manuscript with pages out of sequence.
- In every section of your document, use standard writing style, including articles ("a" and "the").
- Keep paying attention to the topic of the paper.
- Use paragraphs to split each significant point (excluding the abstract).
- Align the primary line of each section.
- Present your points in sound order.
- Use present tense to report well-accepted matters.
- Use past tense to describe specific results.
- Do not use familiar wording; don't address the reviewer directly. Don't use slang or superlatives.
- Avoid use of extra pictures—include only those figures essential to presenting results.

Title page:

Choose a revealing title. It should be short and include the name(s) and address(es) of all authors. It should not have acronyms or abbreviations or exceed two printed lines.

Abstract: This summary should be two hundred words or less. It should clearly and briefly explain the key findings reported in the manuscript and must have precise statistics. It should not have acronyms or abbreviations. It should be logical in itself. Do not cite references at this point.

An abstract is a brief, distinct paragraph summary of finished work or work in development. In a minute or less, a reviewer can be taught the foundation behind the study, common approaches to the problem, relevant results, and significant conclusions or new questions.

Write your summary when your paper is completed because how can you write the summary of anything which is not yet written? Wealth of terminology is very essential in abstract. Use comprehensive sentences, and do not sacrifice readability for brevity; you can maintain it succinctly by phrasing sentences so that they provide more than a lone rationale. The author can at this moment go straight to shortening the outcome. Sum up the study with the subsequent elements in any summary. Try to limit the initial two items to no more than one line each.

Reason for writing the article—theory, overall issue, purpose.

- Fundamental goal.
- To-the-point depiction of the research.
- Consequences, including definite statistics—if the consequences are quantitative in nature, account for this; results of any numerical analysis should be reported. Significant conclusions or questions that emerge from the research.

Approach:

- o Single section and succinct.
- o An outline of the job done is always written in past tense.
- o Concentrate on shortening results—limit background information to a verdict or two.
- o Exact spelling, clarity of sentences and phrases, and appropriate reporting of quantities (proper units, important statistics) are just as significant in an abstract as they are anywhere else.

Introduction:

The introduction should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable of comprehending and calculating the purpose of your study without having to refer to other works. The basis for the study should be offered. Give the most important references, but avoid making a comprehensive appraisal of the topic. Describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will give no attention to your results. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here.

The following approach can create a valuable beginning:

- Explain the value (significance) of the study.
- Defend the model—why did you employ this particular system or method? What is its compensation? Remark upon its appropriateness from an abstract point of view as well as pointing out sensible reasons for using it.
- Present a justification. State your particular theory(-ies) or aim(s), and describe the logic that led you to choose them.
- Briefly explain the study's tentative purpose and how it meets the declared objectives.

Approach:

Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done. Sort out your thoughts; manufacture one key point for every section. If you make the four points listed above, you will need at least four paragraphs. Present surrounding information only when it is necessary to support a situation. The reviewer does not desire to read everything you know about a topic. Shape the theory specifically—do not take a broad view.

As always, give awareness to spelling, simplicity, and correctness of sentences and phrases.

Procedures (methods and materials):

This part is supposed to be the easiest to carve if you have good skills. A soundly written procedures segment allows a capable scientist to replicate your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order, but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt to give the least amount of information that would permit another capable scientist to replicate your outcome, but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section.

When a technique is used that has been well-described in another section, mention the specific item describing the way, but draw the basic principle while stating the situation. The purpose is to show all particular resources and broad procedures so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step-by-step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

Materials may be reported in part of a section or else they may be recognized along with your measures.

Methods:

- Report the method and not the particulars of each process that engaged the same methodology.
- Describe the method entirely.
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures.
- Simplify—detail how procedures were completed, not how they were performed on a particular day.
- If well-known procedures were used, account for the procedure by name, possibly with a reference, and that's all.

Approach:

It is embarrassing to use vigorous voice when documenting methods without using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result, when writing up the methods, most authors use third person passive voice.

Use standard style in this and every other part of the paper—avoid familiar lists, and use full sentences.

What to keep away from:

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings—save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part as entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Use statistics and tables, if suitable, to present consequences most efficiently.

You must clearly differentiate material which would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matters should not be submitted at all except if requested by the instructor.

Content:

- Sum up your conclusions in text and demonstrate them, if suitable, with figures and tables.
- In the manuscript, explain each of your consequences, and point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation of an exacting study.
- Explain results of control experiments and give remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or manuscript.

What to stay away from:

- Do not discuss or infer your outcome, report surrounding information, or try to explain anything.
- Do not include raw data or intermediate calculations in a research manuscript.
- Do not present similar data more than once.
- A manuscript should complement any figures or tables, not duplicate information.
- Never confuse figures with tables—there is a difference.

Approach:

As always, use past tense when you submit your results, and put the whole thing in a reasonable order.

Put figures and tables, appropriately numbered, in order at the end of the report.

If you desire, you may place your figures and tables properly within the text of your results section.

Figures and tables:

If you put figures and tables at the end of some details, make certain that they are visibly distinguished from any attached appendix materials, such as raw facts. Whatever the position, each table must be titled, numbered one after the other, and include a heading. All figures and tables must be divided from the text.

Discussion:

The discussion is expected to be the trickiest segment to write. A lot of papers submitted to the journal are discarded based on problems with the discussion. There is no rule for how long an argument should be.

Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implications of the study. The purpose here is to offer an understanding of your results and support all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of results should be fully described.

Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact, you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved the prospect, and let it drop at that. Make a decision as to whether each premise is supported or discarded or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."

Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work.

- You may propose future guidelines, such as how an experiment might be personalized to accomplish a new idea.
- Give details of all of your remarks as much as possible, focusing on mechanisms.
- Make a decision as to whether the tentative design sufficiently addressed the theory and whether or not it was correctly restricted. Try to present substitute explanations if they are sensible alternatives.
- One piece of research will not counter an overall question, so maintain the large picture in mind. Where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

When you refer to information, differentiate data generated by your own studies from other available information. Present work done by specific persons (including you) in past tense.

Describe generally acknowledged facts and main beliefs in present tense.

The Administration Rules

Administration Rules to Be Strictly Followed before Submitting Your Research Paper to Global Journals Inc.

Please read the following rules and regulations carefully before submitting your research paper to Global Journals Inc. to avoid rejection.

Segment draft and final research paper: You have to strictly follow the template of a research paper, failing which your paper may get rejected. You are expected to write each part of the paper wholly on your own. The peer reviewers need to identify your own perspective of the concepts in your own terms. Please do not extract straight from any other source, and do not rephrase someone else's analysis. Do not allow anyone else to proofread your manuscript.

Written material: You may discuss this with your guides and key sources. Do not copy anyone else's paper, even if this is only imitation, otherwise it will be rejected on the grounds of plagiarism, which is illegal. Various methods to avoid plagiarism are strictly applied by us to every paper, and, if found guilty, you may be blacklisted, which could affect your career adversely. To guard yourself and others from possible illegal use, please do not permit anyone to use or even read your paper and file.

Criterion for Grading a Research Paper (Compilation) by Global Journals

Please note that following table is only a Grading of "Paper Compilation" and not on "Performed/Stated Research" whose grading solely depends on Individual Assigned Peer Reviewer and Editorial Board Member. These can be available only on request and after decision of Paper. This report will be the property of Global Journals.

Topics	Grades		
	A-B	**C-D**	**E-F**
Abstract	Clear and concise with appropriate content, Correct format. 200 words or below	Unclear summary and no specific data, Incorrect form Above 200 words	No specific data with ambiguous information Above 250 words
Introduction	Containing all background details with clear goal and appropriate details, flow specification, no grammar and spelling mistake, well organized sentence and paragraph, reference cited	Unclear and confusing data, appropriate format, grammar and spelling errors with unorganized matter	Out of place depth and content, hazy format
Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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