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# Physics and Space Science

Gravity General Relativity

Nonlinear Dynamic Systems

Highlights

Multi Dimention Motion

Dependance of Weight for Magnets

Discovering Thoughts, Inventing Future

VOLUME 18 ISSUE 11 VERSION 1.0

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# The Measurements of Directional Dependence of Weight for Magnets

By C. Y. Lo & Li Hua Wang

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*Keywords: current-mass interaction; charge-mass interaction; repulsive gravitation;* $E = mc^2$.

*GJSFR-A Classification: FOR Code: 020107*

THEMEASUREMENTSOFDIRECTIONALDEPENDENCEOFWEIGHTFORMAGNETS

*Strictly as per the compliance and regulations of:*

# The Measurements of Directional Dependence of Weight for Magnets

C. Y. Lo [α] & Li Hua Wang [σ]

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*Keywords: current-mass interaction; charge-mass interaction; repulsive gravitation; $E = mc^2$.*

## I. Introduction

The directional dependence of weight for a permanence magnet is often over-looked because there is magnetic interaction between a magnet and the earth. It was difficult to conceive the small directional dependence of weight from the directional interaction effect between the earth and the magnet. Thus, to measure such a small directional effect on the weight of a magnet, one must first find a way to cancel out the magnetic effect between the earth and the magnet.

In addition, an accurate electronic scale of weight can often be affected when magnetism is involves. Thus, to measure the weight of a magnet, a method of measurement that can essentially avoid such an effect, must be conceived. The confirmation of such a directional effect is necessary to explain the weight reduction of a charged capacitor [1] as due to that the attractive force of current-mass interaction has been changed to a static repulsive charge-mass interaction, which is crucial for Einstein's unification of electromagnetism and gravitation [1, 2]. Moreover, since a discharged capacitor would not immediately recover its previous weight until the previous temperature is recovered [1], the effect of random motion of the electrons is essentially the same as static electrons.

Thus, it is clear that an increment of temperature would lead to a reduction of gravitation. This property has been verified by experiments of heated-up metals [3 - 5]. However, if current-mass interaction can increase weight, a magnet should have directional interaction for weight because the current-mass interaction is directional.

In this paper, to measure magnets and confirm such tiny directional effects, H. W. Li provided an ingenious method. As shown in Figure 1, he simply added a sufficiently long paper tube on the weighting surface of the electronic scale such that the length of the tube would make the influence of the magnet to the scale negligible.

*Figure 1:* A long paper tube is put on the surface of electronic scale to make the influence of the magnet to the scale negligible.

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The magnet with N-up on the left picture and the magnet with S-up is in the right picture.

It has been identified that these effects of reducing or increasing weights are due to the charge-mass and the current-mass interactions.[1)] Li is known as being the first experimental physicist who showed the remarkable temperature dependence of gravitation with a torsion balance scale [4].

A problem of the charge-mass interaction and related experiments is that it cannot be adequately explained with current theories. For example, the lifter (a light capacitor) is able to lift its own weight plus a payload after being charged with a high voltage (about 40 kilovolts), but without continuous supply of electric energy [6].

A lifter could get to work by charging the wire to either a positive or a negative potential although, at the beginning, a thrust is generated by moving the electrons of the lifter with one high voltage charge [6, 7]. From a flat capacitor, it had been speculated that the weigh reduction is in the direction of the electric field [8, 9]. However, the lifter shows that such a weight reduction actually has no direction.

A problem is that such effects of weight reduction cannot be explained with current theories. Perhaps, it is time to remind theorists that the current physical laws are originally obtained from and tested by observations. Thus, the lack of explanation for phenomena is a sign for the birth of new physics.

## II. The Charged Capacitors And The Charge-Mass & The Current-Mass Interactions

It is known that a charged capacitor reduces its weight [1, 2]. However, in a charged capacitor, the only change is the state of some orbital electrons that have become statically concentrated. Since such 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 out by the force generated by the motion of the initially orbital moving charges of the electrons.

However, this repulsive force cannot be proportional to the charge density although it is acting on charged particles due to their charge. We have equal numbers of negatively charged particles (electrons) and positively charged particles (protons) and that would lead to the cancellation of the forces generated by particles of different charges. However, if such a force is proportional to the charge density square, as shown by the solution of the static Einstein equation for a charged particle [10], then these two kinds of forces from different charges would be added up, instead of cancelling out.

Moreover, since a lifter has a limited height, one should expect that this repulsive gravitational force would diminish faster than the attractive gravitational force [6, 7]. 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,

$$F_r \leq KmD_q^2/r^n \quad \text{where} \quad n > 2, \qquad (1)$$

r is the distance between the two particles, and K is the coupling constant. In formula (1), the coupling constant K and n the power of r can be determined by experiments. The simplest case would be n = 3.

Formula (1) is derived from the observations. The experimental facts are that the charged capacitors have reduced weight. This reduced weight is caused by a repulsive force that can lift a device. Thus, such an approach has to be taken because there is little in common between the charge-mass interaction and current theories.[2)]

## III. The Reissner-Nordstrom Metric And The Charge-Mass Interaction

One would immediately recognize that a term similar to Eq. (1) appears in the Reissner-Nordstrom metric [9],

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

for a particle with charge q and mass M [3)], where r is the distance from the center of the particle. The static force that acts on a test particle P with mass m for the first order approximation is

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

since $g^{rr} \cong -1$. Note that the second term is a repulsive force due to the static charge-mass interaction. According to the reaction force being equal to but in the opposite direction of the acting force, the test particle P must create a field $m/r^3$ that couples to $q^2$. This would mean that unification between electromagnetism and gravitation is necessary [2]. In the first term of (3), M is the inertial mass of the charged particle.[3)]

However, the newly discovered force was overlooked until 1997 [11] after it was recognized that the mass is not equivalent to electric energy. This overlooking was due to two misconceptions: 1) Gravity is always attractive;[4)] 2) $E = mc^2$ was incorrectly considered as unconditional [2]. The non-existence of a dynamic solution for the Einstein equation [5)] leads to the discovery that there must be different coupling signs for the dynamic case. This investigation on the non-

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uniqueness of couplings leads to the discovery of the charge-mass interaction [12-14].

The experiments on a charged ball confirm the existence of a repulsive charge-mass interaction (3) [15], and this would confirm the unification of electromagnetism and gravitation. Einstein over-looked the coupling of charge square in the five-dimensional theory [16] because he believed that a new interaction should not be added. Since formula (3) is generated by general relativity and thus is also a crucial test for general relativity [1, 2]. However, Einstein and his peers have mistaken that the electromagnetic energy was equivalent to mass [17].

## IV. The Charge-Mass Interaction And Five-Dimensional Theory

The force on particle *Q* from a test particle with mass m is beyond current theoretical framework of gravitation + electromagnetism. However, although the charge square coupling is beyond general relativity, in the full five-dimensional theory [18] the geodesic equation would include the coupling of $q^2$. As Kaluza [19] proposed, a five-dimensional geodesic is,

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

where $$\Gamma^\mu{}_{\alpha\beta}=\frac{1}{2}(\partial_\alpha g_{\nu\beta}+\partial_\beta g_{\nu\alpha}-\partial_\nu g_{\alpha\beta})g^{\mu\nu}, \qquad (4)$$

and $ds^2=g_{\mu\nu}dx^\mu dx^\nu$, and $g_{\mu\nu}$ ($\mu, \nu$ = 0, 1, 2, 3, 5) are metric elements of a five-dimensional space.

After some algebraic calculation, the geodesic equation (4) can be represented as follows:

$$\frac{d}{ds}\left(g_{ik}\frac{dx^k}{ds}\right)=\frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{ds}\frac{dx^l}{ds}+\left(\frac{\partial g_{5k}}{\partial x^i}-\frac{\partial g_{5i}}{\partial x^k}\right)\frac{dx^5}{ds}\frac{dx^k}{ds}-\Gamma_{i,55}\frac{dx^5}{ds}\frac{dx^5}{ds}-g_{i5}\frac{d^2x^5}{ds^2} \text{ for } i, k, l = 0, 1, 2, 3. \qquad (4'a)$$

and

$$\frac{d}{ds}\left(g_{5k}\frac{dx^k}{ds}+\frac{1}{2}g_{55}\frac{dx^5}{ds}\right)=\Gamma_{k,55}\frac{dx^5}{ds}\frac{dx^k}{ds}-\frac{1}{2}g_{55}\frac{d^2x^5}{ds^2}+\frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{ds}\frac{dx^k}{ds}, \qquad (4'b)$$

The electromagnetism is included by assuming $g_{5\mu} = KA_\mu$ ($\mu$ = 0, 1, 2, 3) where $A_\mu$ is the electric potential, and K is a constant. In Kaluza's theory [19], the five variables are reduced to only four variables. Einstein and Pauli [20] assumed that all the "extra" metric elements are negligible, and thus failed to include new features. In the theory of Lo, Goldstein and Napier [18], because of fewer restrictions, it can accommodate the radiation reaction force and the new charge-mass interaction.

If instead of *s*, $\tau$ ($d\tau^2=g_{kl}dx^k dx^l$; *k*, *l* = 0, 1, 2, 3) is used in (4), the Lorentz force suggests

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

Thus,

$$\frac{dx^5}{d\tau}=\frac{q}{Mc^2}\frac{1}{K},$$

$$K\left(\frac{\partial A_i}{\partial x^k}-\frac{\partial A_k}{\partial x^i}\right)=\left(\frac{\partial g_{i5}}{\partial x^k}-\frac{\partial g_{k5}}{\partial x^i}\right) \quad \text{and} \quad \frac{d^2x^5}{d\tau^2}=0 \qquad (5)$$

where *K* is a constant. It thus follows that

$$\frac{d}{d\tau}\left(g_{ik}\frac{dx^k}{d\tau}\right)=\frac{1}{2}\frac{\partial g_{kl}}{\partial x^i}\frac{dx^k}{d\tau}\frac{dx^l}{d\tau}+\left(\frac{\partial A_k}{\partial x^i}-\frac{\partial A_i}{\partial x^k}\right)\frac{q}{Mc^2}\frac{dx^k}{d\tau}-\Gamma_{i,55}\left(\frac{q}{Mc^2}\right)^2\frac{1}{K^2} \qquad (6a)$$

$$\frac{d}{d\tau}\left(g_{5k}\frac{dx^k}{d\tau}+\frac{1}{2}g_{55}\frac{q}{KMc^2}\right)=\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau}+\frac{1}{2}\frac{\partial g_{kl}}{\partial x^5}\frac{dx^l}{d\tau}\frac{dx^k}{d\tau}. \qquad (6b)$$

For a static case, it follows (6) and (4) that the forces on the charged particle *Q* in the $\rho$-direction are

$$-\frac{mM}{\rho^2}\approx\frac{M}{2}\frac{\partial g_{tt}}{\partial\rho}\frac{dct}{d\tau}\frac{dct}{d\tau}g^{\rho\rho}, \quad \text{and} \quad \frac{mq^2}{\rho^3}\approx-\Gamma_{\rho,55}\frac{1}{K^2}\frac{q^2}{Mc^4}g^{\rho\rho} \qquad (7a)$$

and

$$\Gamma_{k,55}\frac{q}{KMc^2}\frac{dx^k}{d\tau}=0, \quad \text{where} \quad \Gamma_{k,55}\equiv\frac{\partial g_{i5}}{\partial x^5}-\frac{1}{2}\frac{\partial g_{55}}{\partial x^k}=-\frac{1}{2}\frac{\partial g_{55}}{\partial x^k} \tag{7b}$$

in the (*-r)*-direction. Here particle P is at the origin of spatial coordinate system (ρ, θ', φ'). It is interesting that the same force would come from a different type of metric element depending on the test particle used. Thus [21],

$$g_{tt}=1-\frac{2m}{\rho}, \quad \text{and} \quad g_{55}=\frac{mMc^4}{\rho^2}K^2+\text{constant。 or } \left(\frac{1}{MK^2c^4}g_{55}=\frac{m}{\rho^2}+const.\right) \tag{8}$$

Thus, $g_{55}$ is a repulsive potential plus a constant. and $g_{55}/M$ is also a function of the a distant source mass m,

Therefore, this force, though acting on a charged particle, would penetrate electromagnetic screening. Otherwise, there is no repulsive force from a charged capacitor. From (8), it is possible that a charge-mass repulsive potential would exist for a metric based on the mass *M* of the charged particle *Q*. However, since *P* is neutral, there is no charge-mass repulsion force (from $\Gamma_{k,55}$) on *P*.

To address the issue of charge-mass interaction one must have a solid theoretical ground, and thus the details of formula (3) should be completely tested with experiments.

## V. The Current-Mass Interaction

If the electric energy leads to a repulsive force toward a mass according to general relativity, the magnetic energy would lead to an attractive force from a current toward a mass [21, 22]. Due to the fact 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. In other words, 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. Normally, 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 [23] 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! From their findings, the current-mass interaction would generate a force which is perpendicular to the current.

This characteristic would explain why an alternative current on the capacitor would also make a capacitor reduce its weight as in the case of charged capacitors. The alternative current would create an attractive force parallel to the surface of a flat capacitor. However, such current-mass interaction would not cancel the repulsive force that is perpendicular to the surface. It follows that, just as the case of a charged capacitor, there are repulsive forces in the perpendicular direction of the surface. (This weight reduction is directional.) Note that our explanation on the weight reduction of alternative current is self-consistent and very different from current theories [8].

One may ask the formula for what 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 [18]. Thus, we are not ready to derive the current-mass interaction yet.

Nevertheless, we may assume that, for a charged capacitor, the resulting force is the interaction of net macroscopic charges with the mass [24]. The irradiated ball has the extra electrons, and thus reduced its weight [15]. A spinning ring of superconducting material has the electric currents that are attractive to the earth. This also explains a predicted phenomenon, which is also reported by Liu [25] that it takes time for a capacitor to recover its weight after being discharged [3]. This was observed by Liu because his rolled-up capacitors keep heat better. A discharged capacitor needs time to dissipate the heat such that the motion of its charges would recover to normal.

## VI. The Weights Of A Permanent Magnet And Current-Mass Interaction

A permanent magnet, from the view of Maxwell's electromagnetism, is essentially a group of circularly moving currents around parallel axis in the same direction. Note also that before the weighting, we must make sure that the paper tube is long enough that the magnet from such a distance would not affect the reading of the scale

Due to the magnetic effects of the earth, a magnet would have the maximum weight reading from the electronic scale for the perpendicular positions when the north end is up and a smaller weight when the south end is up. The weight average for these two-positions is the weight of the magnet in the perpendicular position without the magnetic effect from the earth.

On the other hand, the magnet would have weight readings when the magnet is in horizontal situations, which are rotated in 180 degree around the horizontal axis. Then we would get two very close weight readings for the magnet. The average weight reading of these two positions is a weight of the magnet in the horizontal position.

We measure three kinds of magnets. As expected, the perpendicular weight of a magnet is always larger than the horizontal weight of the same magnet. Our measurements confirm our conclusions as follows:

*Table 1:* Some directional weight measurements of thee magnets (A, B, C)

| Weight | N-up | S-up | V-average | Horizontal-1 | Horizontal-2 | H-average |
|---|---|---|---|---|---|---|
| A mag. bar | 50.9735g | 50.9595g | **50.9665g** | 50.9625g | 50.9565g | **50.9595g** |
| B mag. ring | 75.9944g | 75.9754g | **75.9849g** | 75.9877g | 75.9814g | **75.9845g** |
| C Small mag. bar | 15.5118g | 15.5079g | **15.5099g** | 15.5093g | 15.5077g | **15.5085g** |

Note that the directional dependence of weight is due to the current-mass interaction, whose existence in necessary for the weight reduction for a charged capacitor. These measurements support the theory.

## VII. Experimental Verification Of The Mass-Charge Repulsive Force

The repulsive force in metric (2) can be detected with a mass. To see the repulsive effect, one must have

$$\frac{1}{2}\frac{\partial}{\partial r}\left(1-\frac{2M}{r}+\frac{q^2}{r^2}\right)=\frac{M}{r^2}-\frac{q^2}{r^3}< 0 \qquad (9)$$

Thus, repulsive gravity would be observed at $q^2/M > r$. For the electron the repulsive gravity would exist only inside the classical electron radius $r_0$ *(= 2.817 ×10*$^{-13}$*cm)*. Thus, it would be difficult to test a single charged particle.

However, for a charged metal ball with mass M and charge Q, the formula can be $0 > M/R^2 - Q^2/R^3$, where R is the distance from the center of the ball [26]. The increased attractive effect in gravity is proportional to mass related to the number of electrons, but the repulsive effect in gravity is proportional to square of the number of electrons. Thus, when the electrons are accumulated numerous enough in a metal ball, the effect of repulsive gravity will be shown in a macroscopic distance.

Consider that Q and M consist of N electrons, i.e., $Q = Ne$, $M = Nm_e + M_0$, where $M_0$ is the mass of the metal ball, $m_e$ and $e$ are the mass and charge of an electron. To have sufficient electrons, the necessary condition is

$$N > \frac{R}{r_0}, \text{ (or } 0 > \left[\frac{Nm_e}{R^2}-\frac{N^2e^2}{R^3}\right]m_p) \quad \text{where} \quad r_0=\frac{e^2}{m_ec^2}=2.817\times10^{-13}\,\text{cm}. \qquad (10)$$

For example, if $R = 10$ *cm*, then it requires $N > 3.550\times10^{13}$. Thus $Q = 5.683\times10^{-7}$ *Coulomb*. Then, one would see the reduction of attractive gravitation when condition (10) is satisfied. For this case, the repulsive force is

$$\frac{Q^2m_p}{R^3} \qquad (11)$$

where $m_p$ is the mass of the testing particle P, and the total force is

$$\left(\frac{M_0+Nm_e}{R^2}-\frac{N^2e^2}{R^3}\right)m_p . \qquad (12)$$

When condition (9) is satisfied for a certain R, the repulsive effect will be observed.

The verification of this formula also disproves the equivalence between mass and electric energy. However, the majority of theorists failed gravity by following Einstein's error. Moreover, before the repulsive effect is detected for the reduction of attractive gravity to be seen requires only $N > R/r_0$. The relation (10) is a much easier condition to be satisfied.

This is why Tsipenyuk & Andreev [15] observed a reduction of weight after a metal ball is sufficiently charged. However, since the repulsive force is normally very small, the interference of electricity would be comparatively large. Thus, it would be desirable to screen the electromagnetic effects out. The modern capacitor is such a piece of simple equipment. When a capacitor is charged, it separates the electron from the atomic nucleus or polarizes the atom, but there is no change of mass due to increase of charged particles.

In case when such a capacitor is charged with high electric potential, it can even lift up [6-8]. This would confirm the mass-charge repulsive force, and thus the unification of electromagnetism and gravitation [1].

One may ask whether the lighter weight of a capacitor after charged could be due to a decrease of mass. Such a speculation is ruled out. Inside a capacitor the increased energy due to being charged would not be pure electromagnetic energy such that, for the total internal energy, Einstein's formula is valid.

In the case of a charged capacitor, 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). This has been verified by the experiments of Musha [4-8]. Thus, the factor of charge density square in heuristic Eq. (1) is correct. It remains to verify the space dependence. However, even the $1/r^3$ factor in Eq. (1) is verified, the calculation would still depend on the detailed modeling because the repulsive force from a metal ball does not simply depend on the distance from the ball (see Appendix A). Also, although the initial thrust is directionally decided by the electric field, the weight reduction effect for charged capacitors is not directional and it stays if the potential does not change. This is also verified by Liu [25], who measured the effect of weight reduction with the roll-up capacitors.

## VIII. Conclusions And Discussions

Here, the most important conclusion is the confirmation of the repulsive charge-mass interaction and attractive current-mass interaction in general relativity. These two interactions are crucial to verify the existence the repulsive gravitation. This repulsive gravitation had been over-looked because $E = mc^2$ has been misinterpreted by Einstein [27] as unconditionally valid.

Nevertheless, the existence of lifters [6, 7] unequivocally announces the existence of repulsive gravitation. It is also clear that the repulsive force of gravity depends on the square of charge density [1] although derivations to specifics are incomplete because of the lack of detailed modeling (see Appendix A). The improvements for such shortcomings need the input of some accurate experimental data as well as better theoretical understanding. The existence of a small directional dependence of weight for a magnet confirms the current-mass interaction.

*Thus, the theoretical progress is often blocked by Einstein's own errors. Moreover, invalid derivations following Einstein's errors [27], were not discovered because of general inadequacy in mathematics*. Two major errors of Einstein are that he failed to see that there is no bounded dynamic solution for the 1915 Einstein equation [12, 28] as Gullstrand suspected [29] and $E = mc^2$ is not valid for the electromagnetic energy [11].[6)] These two errors are intimately related. Thus, the conjecture for the existence of the black holes must be justified anew because the assumptions [28], that validity of the Einstein equation for the dynamic case and gravitation being always attractive are incorrect.

Moreover, these two major errors have subsequently developed into various invalid theories [28]. Fortunately, the new charge-mass and the current-mass interaction provide simple ways to show the errors.

The important conclusions from the weight reductions of charged capacitors are: 1) $E = mc^2$ may not be valid.. 2) Einstein's conjecture of unification is established; 3) Einstein's general relativity is valid only for the static and stable cases, but is invalid for the dynamic case [11, 28]. It remains to be rectified and completed in at least two aspects: a) The exact form of the gravitational energy-stress tensor is not known; and b) The gravitational radiation reaction force is also not known [28].

Note that, due to the gravitational radiation reaction force is not included, considering general relativity as a theory of geometry is invalid [30]. Moreover, since the photons include gravitational energy [31], the unification of gravitation and electromagnetism is necessary. To this end, it is possible for a five-dimensional theory.

Moreover, because of inadequate understanding in physics, the space-time singularity theorems of Hawking and Penrose were accepted although they are based on an invalid assumption, the non-existence of the antigravity coupling [28]. Thus, their contribution to physics is essentially zero if not negative. The positive theorem of Yau and Schoen is also misleading [32] because essentially the same invalid assumption was used. [7)] The Field's Medals were awarded to Yau in 1982 and Witten in 1990 because those mathematicians do not understand physics [33]. These errors follow Einstein's mistake of believing in the existence of dynamic solutions for his equation.

According to the position on this issue, journals can be divided into three categories, namely: 1) Agreeing with Gullstrand [29] Chairman of the Nobel Committee for Physics (1922-1929) that there is no dynamic solution for the Einstein equation; 2) Disagreeing with Gullstrand that the Einstein equation has dynamic solutions, but failed to provide even one example; 3) Unable to decide whether the Einstein equation has any dynamic solution. Currently the Physical Review, Proceeding of the Royal Society A, Classical and Quantum Gravity, Gravitation and General Relativity, etc. all are against Gullstrand [29]. On the other hand, journals such as the Astrophysics Journal, Physics Essays, etc have committed to my position by publishing my paper [12-14].

However, some journals such as Annalen der Physik prefer not to fix their position on this. Moreover, currently some still ignore experimental facts such as the existence of lifters [6,7].

Einstein has shown that the photons are equivalent to mass [17] and this is supported by the experimental fact that a $\pi_0$ meson would decay into two light rays ($\pi_0 \rightarrow \gamma + \gamma$). Thus, Einstein had misinterpreted that the electromagnetic energy is equivalent to mass. This is impossible because the electromagnetic energy-stress tensor is traceless, and the addition of electromagnetic energies is still an electromagnetic energy. The fact is however, that the photons include not only electromagnetic energy, but also gravitational energy [31, 34]. Thus, Einstein's proposal of photons is inadequate (see Appendix B).

Einstein [27] claimed that a piece of heated-up metal would have increased weight. Experimentally, however, six kinds of heated-up metals have reduced weight [3]. Because a charged capacitor has reduced weight, it will fall slower than other neutral objects [35]. Thus, Einstein's unification would affect many areas of physics. The charge-mass interaction appears in many areas of physics, but its effects have not been considered. Thus, not only gravitational theories, but also other related physics must be reviewed carefully. Moreover, the charge-mass interaction is also has useful applications because it would lead to a new way of observation [1]. The fact that gravitation would reduced for a heat-up metal would be useful for an accurate super speed missiles trajectory.

Among many potential applications in astrophysics, it is the charge-mass interaction that provides an explanation of NASA's discovery of the Space-Probe Pioneer Anomaly [36], and a new technology of detecting matters under ground and/or under the water [1]. Thus, the discovery of the charge-mass interaction is a big step of progress in modern physics. However, some physicists have irrationally denied such repulsive gravitation.

Einstein's formula $E = mc^2$ is only conditionally valid and its misinterpretation is the source of many errors in general relativity.[8)] Obviously, the current-mass interaction is important in Einstein's unification. However, it has not been adequately addressed, and thus some issues cannot be answered. It is hoped that such work can be completed in the future. It is interesting that since Einstein's unification ia valid, Einstein is still the number one theorist in physics after the rectification of his theory although his general relativity has many problems of being misleading in physics.

Another lesson is that all human institutes are not perfect and can make scientific errors [30, 32, 37, 38]. We respect Nobel laureates for their achievements. However, they could also be incorrect in physics [38-40]. Thus experiments together with careful analysis are still the most reliable source of information. *A reason that Einstein's errors were not confirmed earlier because solid experimental proof was not found* [41]. Who would have conceived that $E = mc^2$ considered as Einstein's major achievement is actually his major error in physics. This shows that we must be more careful in physics.

Currently, a blind faith toward the opinions of Nobel Committee or the Nobel Laureates is a rather common disease.[42] Many seem to forget what Galileo taught us is that Physics must be supported by experiments. Further more, the fact is, however, only the experiment supported part is valid. For instance, Einstein's photo-electric effect shows only that a photon is a quantum of energy, but it did not show the energy is only electromagnetic energy. In addition, the formula $E = mc^2$ is inconsistent with the Einstein equation, which shows that the electromagnetic energy cannot change the curvature.

## Acknowledgements

This paper is dedicated to Professor P. Morrison of MIT for his unfailing guidance over 15 years. The author wishes to express his appreciation to S. Holcombe for valuable suggestions. This publication is supported by Innotec Design, Inc., U.S.A. and the Chan Foundation, Hong Kong.

*APPENDIX A:* Some Remarks on the Charge-Mass Repulsive Force

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

$$F = \frac{q^2 m}{r^3} \qquad \text{(A1)}$$

would behave very differently from a Newtonian force, which is inverse proportional to the square of the distance r.

To illustrate this, let us calculate the force between a charge q and a mass M whose density $\rho$ is uniformly distributed in a sphere of radius R. In a coordinate (r, θ, φ), let s be the distance between the center of the sphere, located at (0, 0, 0) and the charge q is at (s, 0, 0). Let *l* be the distance between the charge q and a mass dm at a point (r, θ, φ). Then we have

$$l^2 = s^2 + r^2 - 2sr\cos\theta, \quad \text{and} \quad dm = \rho(rd\theta)dr(r\sin\theta)d\varphi = \rho r^2 dr\, d(-\cos\theta)d\varphi, \qquad \text{(A2)}$$

where ρ is the mass density. We calculate the force potential, which is locally proportional to $l^{-2}$, and have

$$\int_0^\pi \frac{d(-\cos\theta)}{s^2 + r^2 - 2sr\cos\theta} = \frac{1}{2sr}\int_0^\pi \frac{d(-2sr\cos\theta)}{s^2 + r^2 - 2sr\cos\theta} = \frac{1}{2sr}\ln(s^2 + r^2 - 2sr\cos\theta)\Big|_0^\pi = \frac{1}{sr}\ln(\frac{s+r}{s-r}) \qquad \text{(A3)}$$

Then the total potential *V(s, R)* would be

$$2V(s,R)=\rho\int_0^R 2\pi r^2 dr\frac{1}{sr}\ln(\frac{s+r}{s-r})=\rho\frac{2\pi}{s}\int_0^R rdr\ln(\frac{s+r}{s-r})=\rho\frac{2\pi}{s}\int_0^R rdr2(\frac{r}{s}+\frac{1}{3}(\frac{r}{s})^3+\frac{1}{5}(\frac{r}{s})^5+...+\frac{1}{2n-1}(\frac{r}{s})^{2n-1}+...)$$

$$=\rho\frac{4\pi}{s^2}\int_0^R drr^2[1+\frac{1}{3}(\frac{r}{s})^2+\frac{1}{5}(\frac{r}{s})^4+...+\frac{1}{2n-1}(\frac{r}{s})^{2n-2}+...]$$

$$=\rho[\frac{4\pi R^3}{3}]\frac{1}{s^2}[1+\frac{1}{5}(\frac{R}{s})^2+\frac{3}{5\bullet 7}(\frac{R}{s})^4+...+\frac{3}{(2n-1)(2n+1)}(\frac{R}{s})^{2n-2}+...] \quad \text{(A4)}$$

Note that $[1+\frac{1}{5}+\frac{3}{5\bullet 7}+...+\frac{3}{(2n-1)(2n+1)}+...]=\frac{3}{2}\sum_1^\infty[\frac{1}{2n-1}-\frac{1}{2n+1}]=\frac{3}{2}$, and $M=\rho[\frac{4\pi R^3}{3}]$.

Thus, the repulsive force between the charge q and the mass M is

$$2F(s,R)=2q^2V_s(s,R)=q^2M\frac{d}{ds}\{\frac{1}{s^2}[1+\frac{1}{5}(\frac{R}{s})^2+\frac{3}{5\bullet 7}(\frac{R}{s})^4+...+\frac{3}{(2n-1)(2n+1)}(\frac{R}{s})^{2n-2}+...]\}$$

$$=q^2M\frac{-1}{s^3}[2+\frac{4}{5}(\frac{R}{s})^2+\frac{3\bullet 6}{5\bullet 7}(\frac{R}{s})^4+...+\frac{3(2n)}{(2n-1)(2n+1)}(\frac{R}{s})^{2n-2}+...] \quad \text{(A5)}$$

Note that $\frac{-3}{2s^3}[1+\sum_{n=1}^\infty\frac{1}{2n+1}]$ does not converge.

The close forms of the repulsive potential and the repulsive force are,

$$V(s,R)=\rho\frac{\pi}{s}\int_0^R rdr\ln(\frac{s+r}{s-r})=\rho\frac{\pi}{s}[\frac{R^2-s^2}{2}\ln(\frac{s+R}{s-R})+sR] \quad \text{(A6)}$$

$$F(s,R)=q^2V_s(s,R)=-q^2s\rho\pi\left([1-(\frac{R}{s})^2]\frac{1}{2}\ln(\frac{s+R}{s-R})-\frac{R}{s}\right) \quad \text{(A7)}$$

Now, it is clear that the repulsive force on the charge q is sensitive to the surrounding of the charge.

For a charged object, the repulsive force is sensitive to the arrangements of the charges. Note that the dependence of $r^{-3}$ in (A1) is derived from general relativity. Thus, this force provides another test of general relativity. However, it would be difficult to calculate the effects of this force without the necessary detailed information.

*APPENDIX B:* The Electromagnetic Wave, Photons and Anti-gravity Coupling

For validity of the calculation on light bending, it is necessary that an electromagnetic wave would generate a negligible gravitational wave because this was implicitly assumed in the calculation.

However, for the electromagnetic wave as the source, the related Einstein equation must be modified [31] as:

$$G_{ab}=-K[T(E)_{ab}-T(p)_{ab}], \text{ and } T_{ab}=-T(g)_{ab}=T(E)_{ab}-T(P)_{ab}, \quad \text{(B1)}$$

where $T(E)_{ab}$ and $T(P)_{ab}$ are the energy-stress tensors for the electromagnetic wave and the related photons. Thus, Einstein [43] was wrong, and Einstein's understanding on general relativity needs improvement. Note that the energy-stress tensor of photons has an anti-gravity coupling. The presence of the photonic energy-stress is necessary; otherwise there is no bounded gravitational wave solution for equation (B1) [31, 34].

In Einstein's assumption, the photons consist of only electromagnetic energy because general relativity has not been conceived. Since all the charged particles are massive, it is natural that a gravitational wave should be included. If the photons consist of only electromagnetic energy, there is a conflict since the photonic energy could be equivalent to mass but the electromagnetic energy-stress tensor is traceless. Now. this conflict is resolved since the photonic energy is the sum of electro-magnetic energy and gravitational energy.

Both quantum theory and relativity are based on the phenomena of light. The gravity of photons shows that there is a link between them. It is gravity that makes photons compatible with electromagnetic waves.

It should be noted also that the anti-gravity coupling would appear in where the gravitational wave is present. For instance, it is necessary to appear in the equation for the calculation on the gravitational waves generated by massive sources [12-14]. 9) For massive sources, the 1995 update of the Einstein equation is as follows:

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = - K [T(m)_{\mu\nu} - t(g)_{\mu\nu}], \quad (B2)$$

where $t(g)_{\mu\nu}$ is the energy-stress tensors for gravity. From (B2), the equation in vacuum is,

$$G_{\mu\nu} \equiv R_{\mu\nu} - \frac{1}{2} g_{\mu\nu} R = K\, t(g)_{\mu\nu} . \quad (B3')$$

Note that $t(g)_{\mu\nu}$ is equivalent to $G^{(2)}{}_{\mu\nu}$ in terms of Einstein's radiation formula. When gravitational wave is present, the gravitational energy-stress tensor $t(g)_{\mu\nu}$ is non-zero.

Thus, a radiation of gravitation does carry energy-momentum as physics requires. This explains also that the absence of an anti-gravity coupling is the reason that the Einstein equation is incompatible with radiation [12-14].

Note that eq. (B2) was proposed by Lorentz [44] in 1916 and later by Levi-Civita [45] in the following form,

$$\kappa t(g)_{ab} = G_{ab} + \kappa T_{ab} \quad (B4)$$

where $T_{ab}$ is the sum of other massive energy-stress tensors. This is the Lorentz-Levy-Einstein equation. How-ever, Einstein [46] rejected their proposal because he did not realize that his equation does not have any bounded dynamic solution [12-14].

Nevertheless, Christodoulou 10) and Klainerman [47] had claimed that they have constructed bounded dynamic solutions for the Einstein equation. However, upon close examination, it is found [48] that they actually have not completed the proof for the existence of bounded dynamic solutions, in addition to other errors in mathematics [49]. For these, one must know that the thesis advisor of Christodoulou is J. A. Wheeler, whose mathematics is so inadequate that he made crucial errors in their book [10] even at the undergraduate level [37].

*Endnotes*

1. For a thorough discussion on the mass and the total energy of a particle, one can read the 1989 paper of L. B. Okun [50]. However, Okun [51] did not understand that the electromagnetic energy is not equivalent to mass [10]. Moreover, Einstein's proof for the equivalence of mass and the photonic energy is incomplete [41].
2. Currently a major problem in general relativity is not only that Einstein's errors are over-looked, but also that some theorists [9, 47, 52-55] additionally make their own errors and ignore experimental facts.
3. Due to the popular opinion that gravity is attractive, Herrera, Santos, & Skea [56] argued that M in (2) involves the electric energy. They follow the error of Whittaker [57] and Tolman [58], and interpreted that M in the Riessner-Nordstrom metric includes the electromagnetic energy. Thus, according to their interpretation, an increase of the charge would lead to the increment of weight. Thus, the charge-mass interaction was over-looked. However, their interpretation is rejected by that a charged ball does reduce its weight [14]. Nevertheless, 't Hooft claimed in his Nobel Lecture [39] that the electric energy is part of the physical mass $m_{phys}$ of an electron. Moreover, he claimed this "physical mass" obeys Newton's second law $F = m_{phys}\, a$. Note that such a claim violates special relativity because part of the electric energy is far from the electron and thus cannot react immediately as an inertial mass does. Another Nobel Laureate Wilczek [40] also incorrectly applied $m = E/c^2$ without providing a justification. His problem is that he cannot be distinct about the issue that a type of energy is equivalent to mass is different from that the mass and energy are equivalent.
4. In Newtonian theory, gravitation is always attractive to mass, but in general relativity the situation is different.
5. Misner et al. [10], Wald [52], Christodoulou & Klainerman [47], 't Hooft [59], and etc. claimed to have explicit dynamic solutions, due to various errors in mathematics [28, 37, 59]. Note that journals such a the Physical Review, Proceeding of the Royal Society, Classical and Quantum Gravity, Gravitation and General Relativity, etc. all are against Gullstrand [29] and believed incorrectly that there are bounded dynamic solutions for the Einstein equation [11-13, 60]
6. Recently, it has been found that Einstein's proof [16] of $L = mc^2$ and $E = mc^2$ is also invalid [41].
7. A well-known misleading result is the positive mass theorem of Schoen & Yau [54] (and the positive energy theorem of Witten [55]. Their failure in understanding general relativity properly could be a reason that the lack of progress of the string theory in physics. They were awarded Fields Medals in 1982 and in 1990 because leading mathematicians such as M. F. Atiyah and L. D. Faddeev do not understand the related physics and relativity [32]. This was confirmed by Prof. Peter C. Sarnak, the Chairman of the 2011 Shaw Prize Committee when we met at a conference in Toronto in 2016.
8. I have reported these problems in $E = mc^2$ to MIT President Hockfield and the subsequent President Reif. They have promised to up-grade the related education in gravitation.
9. Hod [61] invalidly claimed to have "A simplified two-body problem in general relativity" because he did

not know that the linearized equation is actually a valid linearization of only the Lorentz-Levy-Einstein equation [12],

10. The 2011 Shaw Prize has mistakenly awarded a half prize in mathematics to Christodoulou for his erroneous work against the honorable Gullstrand [29] Chairman (1922-1929) of the Nobel Committee for Physics. Christodoulou has misled many including the 1993 Nobel Committee [38]. However, his errors are now well-established since they have been illustrated with mathematics at the undergraduate level [30]. Christodoulou claimed in his autobiography that his work is based on two sources: 1) The claims of Christodoulou and Klainerman on general relativity, shown in their book *The Global Nonlinear Stability of the Minkowski Space* [47]; 2) Roger Penrose had introduced, in 1965, the concept of a trapped surface and had proved that a space-time containing such a surface cannot be complete [30]. However, this work of Penrose, which uses an implicit assumption of unique sign for all coupling constants, actually depends on the errors of Christodoulou and Klainerman.

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# Electrization of the Superconductive Windings, and Tori During the Introduction in Them of the Direct Currents

By F. F. Mende

*Abstract-* It was already said, that Maxwell's equations do not include information about power interaction of the current carrying systems. In the classical electrodynamics for calculating such an interaction it is necessary to calculate magnetic field in the assigned region of space, and then, using a Lorentz force, to find the forces, which act on the moving charges. Obscure a question about that remains with this approach, to what are applied the reacting forces with respect to those forces, which act on the moving charges. It is experimentally discovered, that when along the conductor flows the current, it loses electro neutrality and finds around itself radial static electric field; however, classical electrodynamics cannot explain this fact. In the article are given the experimental data, which attest to the fact that around the superconductive windings and the tori, into which is introduced direct current, is formed static electric field. This fact finds its explanation within the framework the concept of scalar-vector potential.

*Keywords: maxwell's equation, lorentz force, newton's law, magnetic field, superconductor, electrization, scalar-vector potential.*

*GJSFR-A Classification: FOR Code: 020302*

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## I. Introduction

It was already said, that Maxwell's equations do not include information about power interaction of the current carrying systems. In the classical electrodynamics for calculating such an interaction it is necessary to calculate magnetic field in the assigned region of space, and then, using a Lorentz force, to find the forces, which act on the moving charges. Obscure a question about that remains with this approach, to what are applied the reacting forces with respect to those forces, which act on the moving charges.

The concept of magnetic field arose to a considerable degree because of the observations of power interaction of the current carrying and magnetized systems. Experience with the iron shavings, which are erected near the magnet poles or around the annular turn with the current into the clear geometric figures, is especially significant. These figures served as occasion for the introduction of this concept as the lines of force of magnetic field. In accordance with third Newton's law with any power interaction there is always a equality of effective forces and opposition, and also always there are those elements of the system, to which these forces are applied. A large drawback in the concept of magnetic field is the fact that it does not give answer to that, counteracting forces are concretely applied to what, since magnetic field comes out as the independent substance, with which occurs interaction of the moving charges.

Is experimentally known that the forces of interaction in the current carrying systems are applied to those conductors, whose moving charges create magnetic field. However, in the existing concept of power interaction of the current carrying systems, based on the concepts of magnetic field and Lorentz force, the positively charged lattice, which is the frame of conductor and to which are applied the forces, it does not participate in the formation of the forces of interaction. That that the positively charged ions take direct part in the power processes, speaks the fact that in the process of compressing the plasma in transit through it direct current (the so-called pinch effect) it occurs the compression also of ions.

## II. Electrization Of The Superconductive Windings And Tori During The Introduction In Them Of The Direct Currents

Let us examine power interaction between two parallel conductors (Fig. 1), along which flow the currents, within the framework the concept of the scalar-vector potential [1-7].

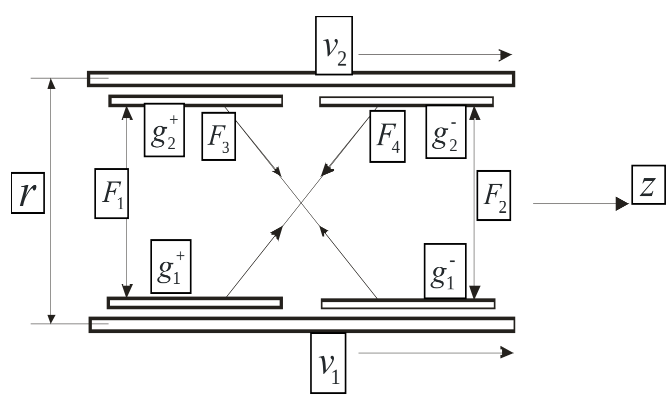


*Fig. 1:* Schematic of power interaction of the current carrying wires of two-wire circuit taking into account the positively charged lattice

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Let $g_1^+$ , $g_2^+$ and $g_1^-$ , $g_2^-$ - linear fixed (the positively charged lattice in the lower and upper conductors) and moving charges, moreover both conductors prior to the start of charges are electrically neutral. In Fig.1 the systems of the mutually inserted opposite charges for convenience in the examination are moved apart along the axis *z*. Subsystems with the negative charge (electrons) can move with the speeds $v_1$ and $v_2$ . The force of interaction between the conductors is equal to the sum of repulsive forces $F_1$ and $F_2$ (them we take with the minus sign) and attracting forces $F_3$ and $F_4$ (with the plus sign).

For the single section of the two-wire circuit of force, acting between the separate subsystems, will be written down

$$F_1 = -\frac{g_1^+ g_2^+}{2\pi\varepsilon r}, \quad F_2 = -\frac{g_1^- g_2^-}{2\pi\varepsilon r}\mathrm{ch}\frac{v_1 - v_2}{c}, \quad F_3 = \frac{g_1^- g_2^+}{2\pi\varepsilon r}\mathrm{ch}\frac{v_1}{c}, \quad F_4 = \frac{g_1^+ g_2^-}{2\pi\varepsilon r}\mathrm{ch}\frac{v_2}{c}. \qquad (2.1)$$

Let us assume in (2.1) $g_2^+ = 0$ and $v_2 = 0$ (interaction of lower conductor with the current also of the fixed charge of upper conductor $g_2^-$ without the lattice):

$$F_{\Sigma 2} = -g_1 g_2 v_1^2 / \left(4\pi\varepsilon c^2 r\right).$$

It means, when current flows along the conductor, it loses electroneutrality and finds around itself the radial static electric field

$$E_\perp = -g_1 v_1^2 / \left(4\pi\varepsilon c^2 r\right), \qquad (2.2)$$

which is equivalent to appearance on the lower conductor of additional negative potential, which is, in turn, equivalent to appearance on this conductor of the additional specific static charge

$$g = -2 g_1 v_1^2 / c^2 . \qquad (2.3)$$

This fact attests to the fact that the adoption of the concept of scalar- vector potential indicates the acknowledgement of the dependence of charge on the speed. However, up to now no one obtained experimental confirmation the validity of relationships (2.2) and (2.3).

When by Faraday and by Maxwell were formulated the fundamental laws of electrodynamics, to experimentally confirm relationship (2.2) it was impossible, since. the current densities, accessible in the usual conductors, are too small for the experimental detection of the effect in question. Thus, position about the independence of scalar potential and charge from the speed and the subsequent introduction of magnetic field they were made volitional way on the phenomenological basis.

Of current density, which can be achieved in the superconductors, make it possible to experimentally detect the electric fields, determined by relationship (2.2) [5, 6]. If such fields will be discovered, then this means that the scalar potential of charge depends on its relative speed.

Let us examine setting the experiment, which must give answer to the presented questions. The diagram of experiment is depicted in Fig. 2.

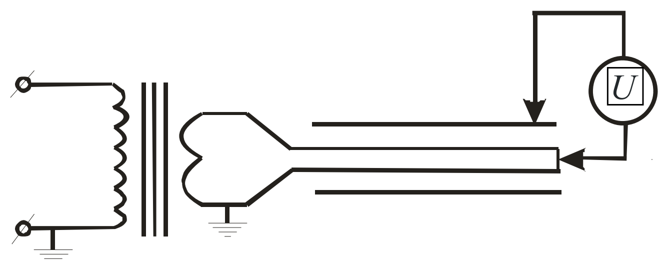


*Fig. 2:* Experimental confirmation of the dependence of the scalar potential of charge on its relative speed

If the folded in half superconductive wire (we will call its bifilar) to surround by the conducting cylinder and to introduce into it current in an induction manner, then in the case the dependence of charge on the speed the electrometer with the high internal resistance, connected between the cylinder and the wire, must show the presence of a potential difference. The noncontact induction introduction of current adapts with that purpose in order to exclude the presence of contact potential differences with the contact introduction of current. The difficulty of conducting this experiment consists in the fact that the input capacitance of the electrometer (usually several ten picofarads) it will be considerably more than the capacity between the bifilar loop and the cylinder. Since we measure not emf, but a potential difference, with the connection to this device of the input capacitance of electrometer the charge, induced on the cylinder to redistribute between both capacities. If we consider that an initial potential difference between the loop and the cylinder was $U_1$, and the capacity between them composed $C_1$, then with the connection between loop and cylinder of the additional tank of the electrometer $C_2$ a potential difference $U_2$ to be determined by the relationship:

$$U_2 = C_1 U_1 / (C_1 + C_2) = k_1 U_1 . \qquad (2.4)$$

In the final analysis it turns out that in order to obtain a maximum voltage drop across electrometer itself should be increased the capacity between the loop and the cylinder, increasing the length of entire construction.

Let us begin from the determination of the expected effect the calculation of the parameters of the measuring system, intended for detecting the expected effect. On both sides from the plane layer of charges with the density $n$ and by thickness $\lambda$ is created the electric field

$$E_{\perp} = ne\lambda / (2\varepsilon_0).$$

Thus far this layer of charges does not move its electric field is completely compensated by the positive charges of lattice. But, when layer begins to move, is created additional electric field equal:

$$\Delta E \cong E_{\perp} v^2 / (2c^2). \qquad (2.5)$$

The magnetic field on its surface of superconductor, equal to specific current, can be determined from the relationship

$$H = nev\lambda .$$

Let us substitute into (2.5) speed obtained from this relationship $v$:

$$\Delta E_{\perp} = H^2 / (2\varepsilon_0 ne\lambda c^2) = \mu_0 H^2 / (2ne\lambda).$$

To calculate the maximum expected value of the effect, the value of the critical field for $H$ a given type of superconductor is taken as the quality.

Let us calculate the maximum magnitude of this effect for the case of superconductive niobium, after assuming $H_c = 1{,}5 \cdot 10^5\ A/m$, $\lambda \cong 10^{-7}$ m, $n \cong 3 \cdot 10^{28} m^{-3}$, we obtain $\Delta E_{\perp} \cong 3 V/m$. We will consider that the diameter of bifilar loop composes the doubled value of the diameter of the utilized superconductive wire with a diameter 0, 25 mm. If we take the diameter of the cylinder equal 10 mm, then a potential difference between the loop and the cylinder will comprise $U = \Delta E_{\perp} (d/2) \ln D(/d) \cong 3mV$. In this case the linear capacity of coaxial will comprise $C_0 = 15\ pF/m$.

In the experiments was used the vibrating reed electrometer with a input capacitance ~ 60 pF and the sensitivity ~1mV. In order to ensure at least the same capacity of the coaxial (in this case a voltage drop across the capacity of electrometer after its connection to the coaxial it will be 1.5 mV) it is necessary to take the length of the coaxial of 4 meters of. Certainly, for the technical reasons it is difficult to cool this coaxial to helium temperatures and furthermore and effect itself proves to be insufficient for its reliable measurement. Therefore the magnitude of effect must be increased at least 100 times. This can be carried out, after increasing a quantity of central cores of coaxial, after bringing it to two hundred, for which to be required 400 meters of wire. Certainly, in this case it is necessary to increase the diameter of its cylindrical part. It is possible to again produce calculation, but use of an experimental model with the coaxial of this size nevertheless unacceptably in view of its unwieldiness, although the possibility of the precise calculation of the expected effect is the great advantage of this solution.

The not so much importantly precise agreement of calculated and experimental data, as to reliably reveal effect itself. Therefore experimental model was created according to another diagram. for the introduction of direct current into the winding was used the cooled to helium temperatures transformer with the iron core. Using as the secondary winding of transformer the superconductive winding, connected with the solenoid, it is possible without the presence of galvanic contacts to introduce current into it. In the transformer was used ring-shaped core made of transformer steel with a cross section 9 $cm^2$. The primary and secondary windings of transformer were wound by niobium-titanium wire with the copper coating and contained 150 and 10 turns respectively. Thus, transformer has a transformation ratio 15. Diameter of wire 2 mm. The secondary winding of transformer is connected in series with the solenoid with the small inductance, which is wound bifilar and contains 2448 turns of the same wire. The overall length of coil – 910 m. The ends of solenoid and secondary winding of transformer are welded with the aid of the laser welding. Solenoid is wound on the body from teflon resin. Inside and outside diameter of the winding of solenoid 35 and 90 mm of respectively, the width of the coil 30 mm. To the midpoint of solenoid is connected internal wiring of the coaxial, which emerges outside cryostat, the same coaxial is connected also to the screen of solenoid. The construction of low-inductive solenoid is shown in Fig. 3.

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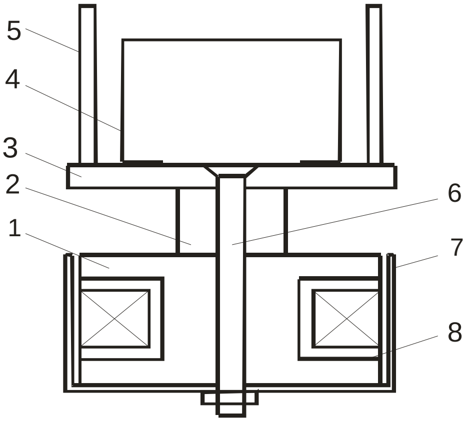


*Fig. 3:* Construction of the low-inductive superconductive solenoid

The following notations are used in the figure:1- aluminum body, 2 -teflon bushing, 3- teflon disk, 4- clamp, 5 - counter, 6- bolt, 7- copper screen, 8 - teflon body is eighth. Solenoid is wound on teflon body 8, which is concluded in aluminum body 1. Outside solenoid is surrounded by copper screen 7, which together with body 1 is the screen of solenoid. To body 1 by means of bolt 6 and teflon bushing 2 is fastened teflon disk 3, on which is installed clamp 4. The turns of the secondary winding of transformer cover clamp 4, through which, without concerning it, is passed the magnetic circuit of transformer. Entire construction is attached to the transformer by means of counters 5. Transformer together with the solenoid is placed in the tank of helium cryostat.

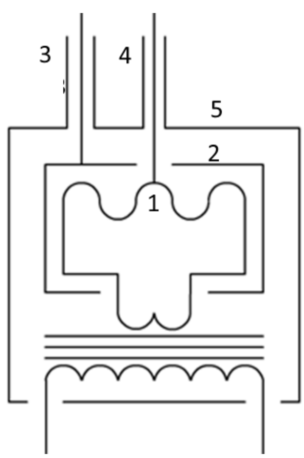


*Fig. 4:* Diagram of connection of the low-inductive solenoid

The diagram of the connection of coaxials to the solenoid is shown in Fig. 4.

In Fig. 4 are indicated: 1 - solenoid, 2 - screen of solenoid, 3, 4 - coaxials, 5 - common screen, which the helium tank is. Resistance between the grounded elements, the screen of solenoid and solenoid itself composes not less than $10^{14}$ Ohm. Capacities relative to the earth of the elements of the construction: coaxial 3 - 44 pF, coaxial 4 - 27 pF, capacity the screen- earth is 34 pF, capacity screen- solenoid is 45 pF. As the electrometer was used by capacitive vibrating reed electrometer with a input capacitance 60 pF and the input resistance $10^{14}$ Ohm.

This construction of the superconductive solenoid and surrounding screen makes it possible to establish the presence of effect itself without the precise electrodynamic calculation of electrostatic fields on around the solenoid.

With the measurements electrometer was connected directly to the screen by means of coaxial 4, and the midpoint of the superconductive solenoid by means of coaxial 3 was grounded. Current into the primary winding of transformer was introduced from the source of direct current, indication of electrometer in this case they did not depend on direction of flow. With the strengths of introduced current ~ 9 A occurred the spontaneous discharge of the indications of electrometer. This means that the current in the winding of solenoid reached its critical value, and winding converted to normal state. Iron core in this case seized magnetic flux, also, with the decrease of the current introduced into the solenoid, the curve of the dependence of the measured potential on the current was repeated, and potential reached its maximum value with current zero.

The dependence of the measured potential difference is given in Fig. 5

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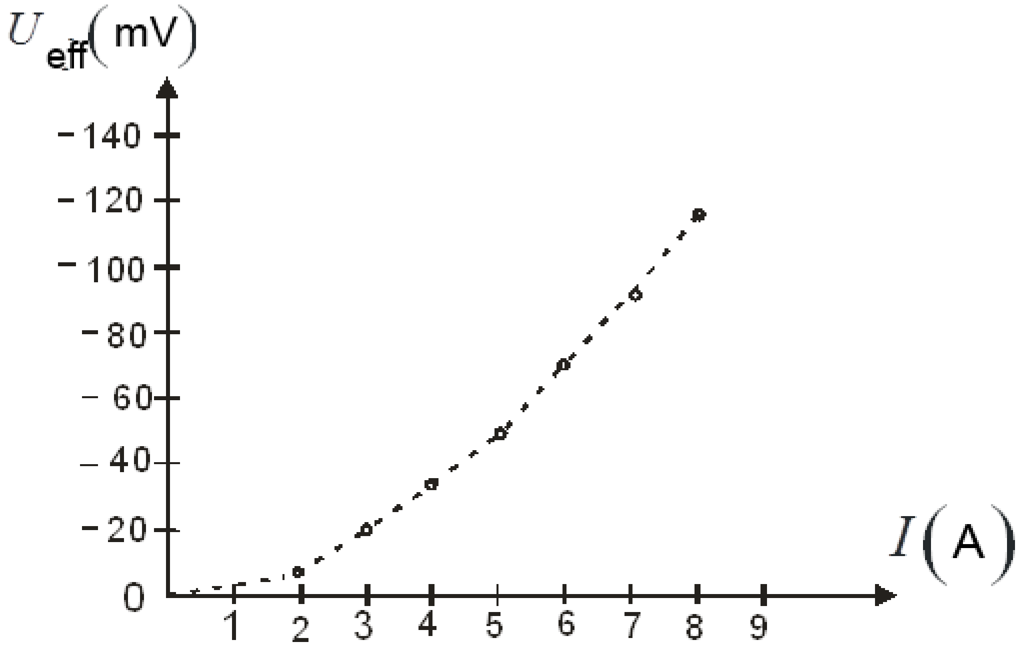


*Fig. 5:* Dependence of the given potential difference between the screen and the low-inductive solenoid on the current in its winding

*Table 1:* Experimental data are given in the table

| $I(A)$ | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|---|---|---|---|---|---|---|---|---|
| $I_1(A)$ | 15 | 30 | 45 | 60 | 75 | 90 | 105 | 120 |
| $H\left(A/м\right)\cdot 10^4$ | 1.91 | 3.82 | 5.73 | 7.64 | 9.55 | 11.5 | 14.6 | 15.3 |
| $-U_2(мB)$ | - | 2 | 6 | 10 | 15 | 21 | 27 | 35 |
| $-U_1(мB)$ | - | 7 | 20 | 34 | 50 | 71 | 90 | 117 |
| $U_{эф}/I^2\left(мB/A\right)$ | - | 1.75 | 2.22 | 2.13 | 2.00 | 1.94 | 1.84 | 1.83 |

In the first graph of table are given the values of the introduced current o $I$ . In the second graph are given the values of the current $I_1$ in the winding of solenoid, calculated on the basis of the value of the transformation ratio of equal to 15. In this case it is assumed that in entire range of the introduced currents the magnetization of core remains proportional to current. In the third graph are given the values of magnetic fields on on the surface of the superconductive wires of winding. In the fourth - of the indication of electrometer. In the fifth - are given the effective values of a potential difference, which would be between the solenoid and the screen to the connection to the latter of the total capacitance of coaxial and electrometer. In the sixth - coefficient $k = U_{эф}/I^2$, which indicates the deviation of the obtained dependence on the quadratic law. The coefficient $k_1$ composed value 3.35, it was calculated, on the basis of the fact that the capacity between screen and solenoid of $C_1 =$ 45 pF, and the total capacitance $C_2$, connected to the capacity $C_1$ and which consists of the capacity of coaxial and capacity of electrometer, was equal to 111 pF. The root-mean-square relative deflection of the coefficient $k$ from its average value equal to 1.93 composes 0.13, which gives relative root-mean-square error 7%. Thus, the obtained dependence between the current and the measured value of potential is very close to the quadratic law. It is also evident from the table that with the values of current in the conductors of solenoid on the order 120 A, the field strength on their surface reaches its critical value, which for the utilized superconductor composes $1.5\cdot 10^5$ A/m, with which and is connected the discharge of the indications of electrometer with reaching of these currents. Thus, experimental results indicate that the value of scalar potential, and, therefore, also charge depends on speed.

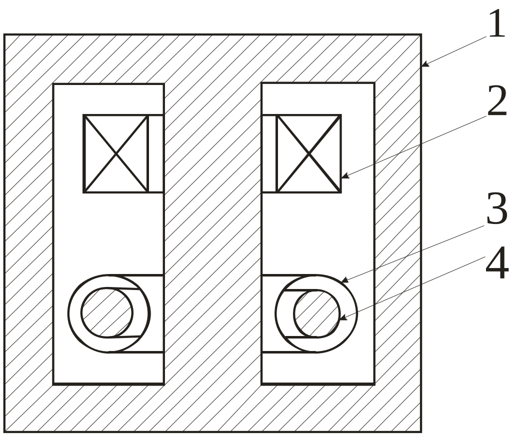


*Fig. 6:* Diagram of experiment with the superconductive torus

However in this diagram of experiment occurs the direct galvanic connection of electrometer to the superconductive solenoid. This can cause questions, but are not the reason for the appearance of a potential difference between the solenoid and the screen some contact phenomena in the place of the contact of wire, which connects electrometer with the solenoid? The experiments with the superconductive niobium torus were carried out for the answer to this question (Fig. 6).

If we inside the conducting screen arrange the second conducting screen, and between them let us connect electrometer, then charge when will appear inside the internal screen, a potential difference will appear between the internal and external screen. In the experiment, as external screen 1, the yoke of transformer, made from transformer steel, was used. On the central rod of this yoke was located primary winding with 2, wound by niobium-titanium wire, which contains 1860 turns. Torus-shaped metal screen 3, made from copper, was located on the same rod. Torus 4, made from niobium, was located inside this screen. The outer diameter of niobium torus was 76 mm, and internal 49 mm. Transformer was placed in the tank of helium cryostat and was cooled to the helium temperature, in this case the yoke of transformer and helium tank were grounded.

Direct current was induced during the introduction of direct current into the primary winding of transformer in the superconductive torus, and electrometer fixed the appearance between screen 3 and yoke of transformer a potential difference $U$. The constant value current in the superconductive torus 1860 times exceeded the current, introduced into the primary winding of transformer. The dependence $U$ a potential difference of on the current $I$, introduced into the primary winding of transformer, it is shown in Fig. 7.

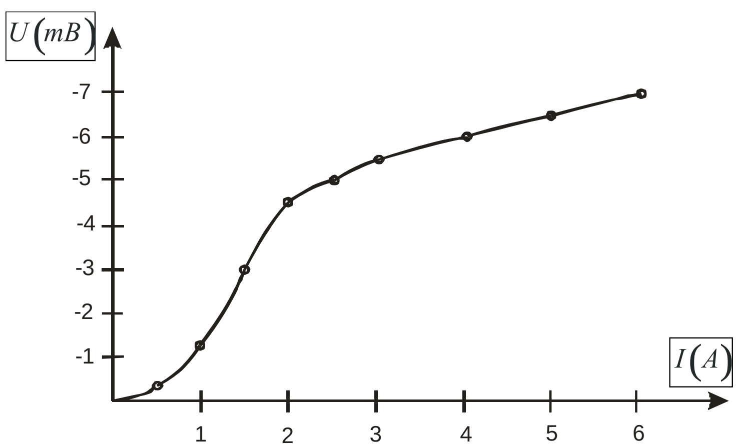


*Fig. 7:* Dependence of a potential difference boundary by screen 3 by the yoke of transformer 1 on the current, introduced into the primary winding of transformer

Data of the value of a potential difference are considerably less than for the superconductive wire winding, since. the surface of torus is considerably less than wire winding. The form of the dependence of a potential difference on the introduced current also strongly differs. Quadratic section is observed only in the very small initial section up to the values of currents into 2 amperes, introduced into the primary winding. Further this dependence is rectilinear with the small inclination toward the X-axis. It was not observed moreover of stalling the indications of electrometer in this case.

With which are connected such differences? In the case of wire solenoid the superconductive current is evenly distributed over the surface of wire and reaches its critical value in all its sections of surface simultaneously, with which and is connected the simultaneous passage of the entire winding of solenoid into the normal state, with the reaching in the wire of the critical value of current.

In the case of torus the process of establishing the superconductive current on its surface occurs differently. That introduced into the direct current superconducting torus is very unevenly distributed over its surface. Maximum current densities occur on the internal surface of torus, and they are considerably less on the periphery. With this is connected the fact that the internal surfaces of torus begin to convert to normal state earlier than external. The process of passing the torus into the normal state occurs in such a way that with an increase of the current in the torus into the normal state pass the first interior and normal phase begins to be moved from the interior to the external. Process lasts until entire torus passes into the normal state. But why in this case up to the moment of passing the torus into the normal state does not occur the discharge of current, as it takes place in the case of wire solenoid? This niobium is connected with the fact that the superconductor of the second kind. This niobium is connected with the fact that the superconductor of the second kind, and it immediately abruptly does not convert to normal state, but he has the sufficiently significant region of current densities, with which it is in the mixed state, when Abrikosov's vortices penetrate inside the massive conductor. The circumstance that the indications of electrometer do not have a discharge of indications, he indicates that the superconductive torus is in the mixed state, but the presence of the vortex of the structures in it, which also present the superconductive currents, they lead to the fact that the torus ceases to be electrically neutral. From this it is possible to draw the conclusion that the vortices bear on themselves not only magnetic-flux quanta, but still electric charges.

With other direction of flow in the primary winding is repeated the dependence, similar to Fig. 7, but with strong hysteresis. This is connected with the fact that the vortices, which penetrated into the depths of the superconductor, they are attached on the stacking faults, falling into potential wells, that also leads to hysteresis.

Thus, the results of the carried out experiments unambiguously indicate the dependence of scalar potential and magnitude of the charge from their speed, which was predicted still in the work [8,9] and it is experimentally confirmed in the works [10,11]. All experiments indicated were carried out in the beginning of the 90's in LGC Scientific Research Institute of the cryogenic instrument manufacture FTINT NAN Ukraine.

## III. Dynamic Potentials And The Field Of The Moving Charges

With the propagation of wave in the long line it is filled up with two forms of energy, which can be determined through the currents and the voltages or through the electrical and magnetic fields in the line. And only after wave will fill with electromagnetic energy all space between the generator and the load on it it will begin to be separated energy. I.e. the time, by which stays this process, generator expended its power to the filling with energy of the section of line between the generator and the load. But if we begin to move away load from incoming line, then a quantity of energy being if rated on it will decrease, since. the part of the energy, expended by source, will leave to the filling with energy of the additional length of line, connected with the motion of load. [12]. If load will approach a source, then it will obtain an additional quantity of energy due to the decrease of its length. But if effective resistance is the load of line, then an increase or the decrease of the power expendable in it can be connected only with a change in the stress on this resistance. Therefore we come to the conclusion that during the motion of the observer of those of relatively already existing in the line fields on must lead to their change. The productivity of this approach with the application of conversions of Galileo will be demonstrated in this chapter.

The fields, which are created in this inertial frame of reference(IFR) by the moving charges (for example, magnetic field around the moving charges) and by the moving sources of electromagnetic waves, let us name dynamic as already mentioned, in the classical electrodynamics be absent the rule of the conversion of electrical and magnetic fields on upon transfer of one inertial system to another. This deficiency removes special theory of relativity (SR), using instead of the conversions of Galileo conversions of Lorenz. With the entire mathematical validity of this approach the physical essence of such conversions up to now remains unexplained.

In this division will made attempt find the precisely physically substantiated ways of obtaining the conversions fields on upon transfer of one IFR to another, and to also explain what dynamic potentials and fields can generate the moving charges. First step in this direction, demonstrated into {1, 13}- the introduction of the symmetrical laws of magneto electric and electromagnetic induction, written in the form [14-18]:

$$\oint \mathbf{E}'d\mathbf{l}' = -\int \frac{\partial \mathbf{B}}{\partial t}d\mathbf{s} + \oint [\mathbf{v}\times\mathbf{B}]d\mathbf{l}'; \quad \oint \mathbf{H}'d\mathbf{l}' = \int \frac{\partial \mathbf{D}}{\partial t}d\mathbf{s} - \oint [\mathbf{v}\times\mathbf{D}]d\mathbf{l}' \quad (3.1)$$

or

$$\operatorname{rot}\mathbf{E}' = -\frac{\partial \mathbf{B}}{\partial t} + \operatorname{rot}[\mathbf{v}\times\mathbf{B}]; \quad \operatorname{rot}\mathbf{H}' = \frac{\partial \mathbf{D}}{dt} - \operatorname{rot}[\mathbf{v}\times\mathbf{D}]. \tag{3.2}$$

For the constants fields on these relationships they take the form:

$$\mathbf{E}' = [\mathbf{v}\times\mathbf{B}]; \quad \mathbf{H}' = -[\mathbf{v}\times\mathbf{D}]. \tag{3.3}$$

In relationships (3.1-3.3), which assume the validity of the Galileo conversions, stitched system and not stitched system values present fields and elements in moving and fixed IFR respectively. It must be noted, that conversions (3.3) earlier could be obtained only from the Lorenz conversions.

The relationships (3.1-3.3), which present the laws of induction, do not give information about how arose fields in initial fixed IFR. They describe only laws governing the propagation and conversion fields on in the case of motion with respect to the already existing fields.

The relationship (3.3) attest to the fact that in the case of relative motion of frame of references, between the fields $\mathbf{E}$ and $\mathbf{H}$ there is a cross coupling, i.e., motion in the fields $\mathbf{H}$ leads to the appearance fields $\mathbf{E}$ and vice versa. From these relationships escape the additional consequences, which were for the first time examined in the work [3]. If the charged rod has linear charge $g$, its electric field $E = g/(2\pi\varepsilon r)$ it diminishes according to the law $1/r$, where $r$ - the distance from the central axis of rod to the observation point.

If we in parallel to the axis of rod in the field of begin to move with the speed of another IFR, then in it will appear the additional magnetic field of. If we now with respect to already moving IFR move third with the speed $\Delta v$, that already due to the motion in the field $\Delta H$ will appear additive to the electric field $\Delta E = \mu\varepsilon E(\Delta v)^2$, etc. Is obtained the number, which gives the value of electric field $E'_v(r)$ in moving IFR with reaching of speed $v = n\Delta v$, when $\Delta v \to 0$, and $n \to \infty$. In the final analysis, in moving IFR the value of dynamic electric field will prove to be more than in the initial, and depending on normal component $v_\perp$ charge rate to the vector, which connects the moving charge and observation point:

$$E'(r, v_\perp) = \frac{g\operatorname{ch}(v_\perp/c)}{2\pi\varepsilon r} = E\operatorname{ch}(v_\perp/c).$$

The electric field of a single charge is determined by the relation:

$$E'(r, v_\perp) = \frac{e\operatorname{ch}(v_\perp/c)}{4\pi\varepsilon r^2}.$$

The scalar potential $\varphi'(r, v_\perp)$ can be named scalar- vector, since it depends not only on the absolute value of charge, but also on speed and direction of its motion with respect to the observation point. It is expressed as the scalar potential $\varphi(r)$ of fixed charge by the equality

$$\varphi'(r, v_\perp) = \frac{e\operatorname{ch}(v_\perp/c)}{4\pi\varepsilon r} = \varphi(r)\operatorname{ch}(v_\perp/c). \tag{3.4}$$

Maximum value this potential has in the direction normal to the motion of charge itself. It determines even electric fields, induced by the accelerated charge.

It is analogous, we have for the case of moving the charge in the magnetic field:

$$H'(v_\perp) = H\operatorname{ch}(v_\perp/c).$$

where $v_\perp$ - speed normal to the direction of the magnetic field.

We will obtain this result by another method. Let us designate field variables in the fixed frame of reference without the prime, and in the mobile – with the prime. In the differential form let us write down the formulas of the mutual induction of electrical and magnetic fields on in the mobile frame of reference:

$$dH' = \varepsilon E' dv_\perp, \tag{3.5}$$

$$dE' = \mu H' dv_\perp \tag{3.6}$$

or, otherwise,

$$dH'/dv_\perp = \varepsilon E', \tag{3.7}$$

$$dE'/dv_\perp = \mu H', \tag{3.8}$$

where (3.7) it corresponds (3.5), and (3.8) it corresponds (3.6).

After dividing equations (3.7) and (3.8) on $E$ $H$, we will obtain respectively:

$$\frac{d(H'/E)}{dv_\perp} = \varepsilon\frac{E'}{E}, \tag{3.9}$$

$$\frac{d\left(E'/E\right)}{dv_{\perp}} = \mu \frac{H'}{H}. \qquad (3.10)$$

Differentiating both parts (3.10), we have:

$$\frac{d^2\left(E'/E\right)}{d^2 v_{\perp}} = \mu \frac{d\left(H'/E\right)}{dv_{\perp}}. \qquad (3.11)$$

After substituting (3.9) in (3.11), we will obtain:

$$\frac{d^2\left(E'/E\right)}{d^2 v_{\perp}} = \mu\varepsilon \frac{E'}{E}. \qquad (3.12)$$

The function is the general solution (3.12) of differential equation

$$E'/E = C_2\,\mathrm{ch}\left(v_{\perp}/c\right) + C_1\,\mathrm{sh}\left(v_{\perp}/c\right), \qquad (3.13)$$

where $c$ – the speed of light on Wednesday, $C_1$, $C_2$ – arbitrary constants.

Since with $v_{\perp} = 0$ must be made $E' = E$, that from (3.13) we will obtain:

$$C_2 = 1. \qquad (3.14)$$

After substituting (3.14) in (3.13), we finally have the general solution, into which enters one arbitrary constant $C_1$:

$$E'/E = \mathrm{ch}\left(v_{\perp}/c\right) + C_1\,\mathrm{sh}\left(v_{\perp}/c\right).$$

Selecting $C_1 = 0$, we obtain

$$E' = E\,\mathrm{ch}\left(v_{\perp}/c\right).$$

In connection with to electromagnetic wave, introducing the parallel $E_{\uparrow}$, $H_{\uparrow}$ and normal $E_{\perp}$, $H_{\perp}$ speeds IFR of component fields on, we have [ 9]:

$$\mathbf{E}'_{\uparrow} = \mathbf{E}_{\uparrow}; \quad \mathbf{E}'_{\perp} = \mathbf{E}_{\perp}\,\mathrm{ch}\frac{v}{c} + \frac{Z_0}{v}\left[\mathbf{v}\times\mathbf{H}_{\perp}\right]\mathrm{sh}\frac{v}{c};$$
$$\mathbf{H}'_{\uparrow} = \mathbf{H}_{\uparrow}; \quad \mathbf{H}'_{\perp} = \mathbf{H}_{\perp}\,\mathrm{ch}\frac{v}{c} - \frac{1}{vZ_0}\left[\mathbf{v}\times\mathbf{E}_{\perp}\right]\mathrm{sh}\frac{v}{c}, \qquad (3.15)$$

where $Z_0 = \sqrt{\mu_0/\varepsilon_0}$ - impedance of free space, $c = 1\big/\sqrt{\mu_0\varepsilon_0}$ - speed of light.

Conversions fields on (3.15) they are called the Mendeconversions.

Such means of the field of the moving charges they are characterized by from fields on fixed charges, that also leads to the electrization of the superconductive windings and tori, that also is confirmed experimental.

We will obtain these conversions by matrix method.

Let us examine the totality IFR of such, that IFR$K_1$moves with speed $\Delta v$ relative to IFR KIFR$K_2$moves with the same speed $\Delta v$ relative to $K_1$and so forth. If the module of speed $\Delta v$ is small (compared to the speed of light c), then for the transverse components of the fields in IRF$K_1K_2$, we have:

$$\mathbf{E}_{1\perp} = \mathbf{E}_{\perp} + \Delta\mathbf{v}\times\mathbf{B}_{\perp} \qquad \mathbf{B}_{1\perp} = \mathbf{B}_{\perp} - \Delta\mathbf{v}\times\mathbf{E}_{\perp}/c^2$$
$$\mathbf{E}_{2\perp} = \mathbf{E}_{1\perp} + \Delta\mathbf{v}\times\mathbf{B}_{1\perp} \qquad \mathbf{B}_{2\perp} = \mathbf{B}_{1\perp} - \Delta\mathbf{v}\times\mathbf{E}_{1\perp}/c^2 \qquad (3.16)$$

where of the field of and relate to current IFR. Directing the Cartesian axis of along, let us rewrite (3.17) in the components of the vector o

$$\Delta\mathbf{E} = \Delta\mathbf{v}\times\mathbf{B}_{\perp}, \qquad \Delta\mathbf{B} = -\Delta\mathbf{v}\times\mathbf{E}_{\perp}/c^2, \qquad (3.17)$$

$$\Delta E_y = -B_z\Delta v, \qquad \Delta E = B_y\Delta v, \qquad \Delta B_y = E_z\Delta v/c^2 \qquad (3.18)$$

Relationship (3.18) can be represented in the matrix form

$$\Delta U = AU\Delta v \qquad \begin{pmatrix} 0 & 0 & 0 & -1 \\ 0 & 0 & 1 & 0 \\ 0 & 1/c^2 & 0 & 1 \\ -1/c^2 & 0 & 0 & 0 \end{pmatrix} \qquad U = \begin{pmatrix} E_y \\ E_z \\ B_y \\ B_z \end{pmatrix}$$

If one assumes that the speed of system is summarized for the classical law of addition of velocities, i.e. the speed of final IFR $K' = K_N$ relative to the initial $K$ is $v = N\Delta v$, then we will obtain the matrix system of the differential equations

$$dU(v)/dv = AU(v) \qquad (3.19)$$

with the matrix $A$ the system of independent of the speed $v$. The solution of system is expressed as the matrix exponential curve $\exp(vA)$:

$$U' \equiv U(v) = \exp(vA)U, \qquad U = U(0). \qquad (3.20)$$

Here $U$ - matrix column fields on in the system $K$, and $U'$ - matrix column fields on in the system $K'$. Substituting (3.20) in the system (3.19), we are convinced, what $U'$ is actually the solution of the system (3.19):

$$\frac{dU(v)}{dv} = \frac{d\left[\exp(vA)\right]}{dv} U = A\exp(vA)U = AU(v).$$

It remains to find this exponential curve by its expansion in the series:

$$\exp(va) = E + vA + \frac{1}{2!}v^2A^2 + \frac{1}{3!}v^3A^3 + \frac{1}{4!}v^4A^4 + \dots,$$

where o $E$ - unit matrix with the size $4\times 4$. It is convenient to write down for this matrix $A$ in the unit type form

$$A = \begin{pmatrix} 0 & -\alpha \\ \alpha/c^2 & 0 \end{pmatrix}, \qquad \alpha = \begin{pmatrix} 0 & 1 \\ -1 & 0 \end{pmatrix}, \qquad 0 = \begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}.$$

then

$$A^2 = \begin{pmatrix} -\alpha^2/c^2 & 0 \\ 0 & -\alpha/c^2 \end{pmatrix}, \qquad A^3 = \begin{pmatrix} 0 & \alpha^3/c^2 \\ -\alpha^3/c^4 & 0 \end{pmatrix},$$

$$A^4 = \begin{pmatrix} \alpha^4/c^4 & 0 \\ 0 & \alpha^4/c^4 \end{pmatrix}, \qquad A^5 = \begin{pmatrix} 0 & -\alpha^5/c^4 \\ \alpha^5/c^6 & 0 \end{pmatrix}$$

And the elements of matrix exponential curve take the form

$$\left[\exp(vA)\right]_{11} = \left[\exp(vA)\right]_{22} = I - \frac{v^2}{2!c^2} + \frac{v^4}{4!c^4} - \dots,$$

$$\left[\exp(vA)\right]_{21} = -c^2\left[\exp(vA)\right]_{12} = \frac{\alpha}{c}\left(\frac{v}{c}I - \frac{v^3}{3!c^3} + \frac{v^5}{5!c^5} - \dots\right),$$

where $I$ - the unit matrix $2\times 2$ . It is not difficult to see that $-\alpha^2=\alpha^4=-\alpha^6=\alpha^8=....=I$ , therefore we finally obtain

$$\exp(vA)=\begin{pmatrix} I\,\mathrm{ch}(v/c) & -c\alpha\,\mathrm{sh}(v/c) \\ (\alpha\,\mathrm{sh}(v/c))/c & I\,\mathrm{ch}(v/c)\end{pmatrix}=\begin{pmatrix} \mathrm{ch}(v/c) & 0 & 0 & -c\,\mathrm{sh}(v/c) \\ 0 & \mathrm{ch}(v/c) & c\,\mathrm{sh}(v/c) & 0 \\ 0 & (\mathrm{ch}(v/c))/c & \mathrm{ch}(v/c) & 0 \\ -(\mathrm{sh}(v/c))/c & 0 & 0 & \mathrm{ch}(v/c)\end{pmatrix}.$$

Now we return to (3.20) and substituting there, we find

$$E'_y=E_y\,\mathrm{ch}(v/c)-cB_z\,\mathrm{sh}(v/c),\quad E'_z=E_z\,\mathrm{ch}(v/c)+cB_y\,\mathrm{sh}(v/c),$$
$$B'_y=B_y\,\mathrm{ch}(v/c)+(E_z/c)\mathrm{sh}(v/c),\quad B'_z=B_z\,\mathrm{ch}(v/c)-(E_y/c)\mathrm{sh}(v/c)$$

Or in the vector record

$$\mathbf{E}'_\perp=\mathbf{E}_\perp\,\mathrm{ch}\frac{v}{c}+\frac{v}{c}\mathbf{v}\times\mathbf{B}_\perp\,\mathrm{sh}\frac{v}{c},\quad \mathbf{B}'_\perp=\mathbf{B}_\perp\,\mathrm{ch}\frac{v}{c}-\frac{1}{vc}\mathbf{v}\times\mathbf{E}_\perp\,\mathrm{sh}\frac{v}{c} \tag{3.21}$$

This is conversions (3.15)

## IV. Conclusion

It was already said, that Maxwell's equations do not include information about power interaction of the current carrying systems. In the classical electrodynamics for calculating such an interaction it is necessary to calculate magnetic field in the assigned region of space, and then, using a Lorentz force, to find the forces, which act on the moving charges. Obscure a question about that remains with this approach, to what are applied the reacting forces with respect to those forces, which act on the moving charges. It is experimentally discovered, that when along the conductor flows the current, it loses electroneutrality and finds around itself radial static electric field; however, classical electrodynamics cannot explain this fact. In the article are given the experimental data, which attest to the fact that around the superconductive windings and the tori, into which is introduced direct current, is formed static electric field. This fact finds its explanation within the framework the concept of scalar- vector potential.

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# Vector Potential of a Strongly Inductive Impedance Media

By Vasiliy K. Balkhanov & Yuriy B. Bashkuev

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*GJSFR-A Classification:* *FOR Code: 020399*

# Vector Potential of a Strongly Inductive Impedance Media

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*Abstract-* Introduced the concept of a strongly inductive impedance media. Vector potential such media expressed in the wave zone as Sommerfeld integrals. This integral is calculated for strongly inductive media, which implies the existence of surface electromagnetic wave. Electrical properties of double-layer strongly inductive media described one size - listed surface impedance. Article vector potential in free space and in underlying media expressed through impedance. It is shown that an electromagnetic wave is exponentially fades in free space and in the bottom layer, and live freely distributed the first dielectric layer. Therefore it is called surface electromagnetic wave. The impedance values for some areas strongly inductive Earth surface.

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## I. Introduction

The task of the electromagnetic wave propagation along Earth's surface more than 100 years ago first considered A. Sommerfeld. This task is expressed in the form of a Sommerfeld integrals complex, computation of which still causes great mathematical difficulty [1-6]. Sommerfeld's decision considered homogeneous media. However, there is a need to consider the diverse impedanse media, multi-layered or gradient. We consider the following to the complexity of the object - of the two media. Our consideration is that compute the vector potential in each media. Knowing him, it will be easy to find the rest of the components of the electromagnetic (EM) field.

First, we introduce the basic values needed in the course of computing, and evaluate their order of magnitude relative to each other. We assume that we have a free space where the emitter - is a vertically orientated dipole Hertz, and the receiver in the form of a vertical metal antennas. If you designate a circular frequency $\omega$, the speed of light *c*, the square wave number $k_0$ in free space would be

$$k_0{}^2 = \frac{\omega^2}{c^2} . \qquad (1)$$

Subscript will number media. Underlying media is double layered. For definiteness, we assume that the first layer thickness *h* is a dielectric in dielectric permeability $\varepsilon$, for example, the pack ice of the Arctic Ocean. Square wave number $k_1$ in this case, you will

$$k_1{}^2 = k_0{}^2 \ \varepsilon . \qquad (2)$$

Bottom, infinite depth layer believe conducting, with electrical conductivity $\sigma$ (or resistivity $\rho = 1/\sigma$). This media may be salt water in the Arctic Ocean. Square wave number $k_2$ in conductivity will

$$k_2{}^2 = k_0{}^2 \ \frac{i\sigma}{\varepsilon_0 \ \omega} . \qquad (3)$$

In here $\varepsilon_0$ - permittivity of vacuum.

In general, the square of the wave number is defined as [7]

$$k^2 = \frac{\omega^2}{c^2}\left(\varepsilon + \frac{i\sigma}{\varepsilon_0 \omega}\right). \qquad (4)$$

That ratio (2) and (3), a frequency range. For example, if the ice to take $\varepsilon = 40$, and salt water $\rho = 1$ Ohm·m, the equality of

$$\varepsilon_0 \ \varepsilon \ \omega \ \rho = 1$$

find frequency $\omega / 2\pi = 4.5 \cdot 10^8$ Hz. The result means that formulas (2) and (3) you can use up to frequencies, smaller 450 MHz (or length of an electromagnetic wave, large ~ 1 m). In this frequency range

$$k_2 \gg k_1 \gg k_0 . \qquad (5)$$

In this task, together with wave number appear several more units, for example,

$$\mu = \sqrt{\chi^2 - k^2} \ , \ \chi = k_0 \sqrt{1 - \delta^2} . \qquad (6)$$

In here $\delta$ - powered surface impedance (furthermore, impedance). The usefulness of introducing impedance can be seen from the fact that it is directly measurable. By definition, the impedance module $|\delta|$ a small value. You can take that [8] $|\delta|$ < 0.3. Then, using the (1) to (3), we get

$$\mu_0 = i \ k_0 \ \delta , \qquad (7)$$

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$$\mu_1 = i\, k_0\, \sqrt{\varepsilon}\,, \qquad (8)$$

$$\mu_2 = i\, k_0\, \frac{1-i}{\sqrt{2\varepsilon_0\, \varepsilon\, \omega\, \rho}}\,, \qquad (9)$$

And took that $\sqrt{-i} = (1-i)/\sqrt{2}$. Of inequalities (5) that

$$\mu_2 >> \mu_1 >> \mu_0\,. \qquad (10)$$

In addition to the above, during the computations appear two more values:

$$\Omega_{10} = \frac{\mu_1\, k_0^{\;2}}{\mu_0\, k_1^{\;2}}\,, \qquad \Omega_{12} = \frac{\mu_1\, k_2^{\;2}}{\mu_2\, k_1^{\;2}}\,, \qquad (11)$$

Estimates show that $\Omega_{10}$ ~ $\sqrt{\varepsilon_0 \omega \rho}$ << 1, $\Omega_{12}$ ~ $1/\sqrt{\varepsilon_0 \omega \rho}$ >> 1.

Entered values and their assessments may be needed in the course of further research.

## II. Fourier Images Of Vector Potential

We assume that the point dipole of Hertz is located at distance $z = l$ from a flat border $xy$ section "atmosphere - terrestrial two-layer media". In the interval from $z = -h$ before $z = 0$ the first layer is located. Because the boundary conditions $z = 0$ and $z = -h$ do not depend on time, frequency in all sectors will be one and the same. Therefore, temporary multiplier $\exp(-i\omega\, t)$ you can explicitly do not prescribe.

Since Hertz dipole vector, directed along the *z* axis, we have only one non-zero z-components of the vector potential $A_z = A$, which gives the following integral

$$A(x,y,z) = \frac{1}{4\pi}\int_{-\infty}^{\infty} A_\chi(z)\; H_0(\chi\; R)\; \chi\; d\chi\,. \qquad (12)$$

Here is the radial coordinate of the $R = \sqrt{x^2 + y^2}$. In the wave zone where $\chi\; R$ >> 1, function Hankel $H_0(\chi\; R)$ has the asymptotic view

$$H_0(\chi\; R) = \sqrt{\frac{2}{\pi\; i\; \chi\; R}}\exp(i\; \chi\; R)\,. \qquad (13)$$

Fourier image $A_\chi$ obeys the wave equation with source:

$$\frac{d^2 A_\chi}{d\; z^2} - \left(\chi^2 - k^2\right) A_\chi = -4\pi\; J_0\; \delta(z - l)\,. \qquad (14)$$

In here $J_0 = \mu_0\; J\; a / 4\pi$, *J* –current dipole, *a* – dipole length, $\mu_0$ - magnetic constant, $\delta(z-l)$ - the Dirac function. Integral (12) function (13) is called the Sommerfeld integral.

Integrating (14) by $dz$ from $-\infty$ to $+\infty$, find that when $z = l$

$$A_\chi\; \Big|_{l-0}^{l+0} = 0\,, \quad \frac{dA_\chi}{d\; z}\; \Big|_{l-0}^{l+0} = -4\pi J_0\,. \qquad (15)$$

The first equality have condition continuity vector potential. Record, for example, $A_\chi\; \Big|_{l-0}^{l+0} = 0$, means that $A_\chi(l+0) - A_\chi(l-0) = 0$. Condition (15) we have excluded $\delta(z-l)$ - the Dirac function, how would adding additional border in free space. For the rest of the borders $z = 0$ and $z = -h$ we have the normal boundary conditions:

$$A_\chi\; \Big|_{-0}^{+0} = 0\,, \quad \frac{1}{k^2}\frac{dA_\chi}{d\; z}\; \Big|_{-0}^{+0} = 0\,. \qquad (16)$$

$$A_\chi\; \Big|_{-h-0}^{-h+0} = 0\,, \quad \frac{1}{k^2}\frac{dA_\chi}{d\; z}\; \Big|_{-h-0}^{-h+0} = 0\,. \qquad (17)$$

Because inside each limited layer wave extends in both directions, the Fourier-image of the vector potential in each layer will be

$A_\chi = W\; \exp(-\mu_0 z)$ when *z* > *l*, (18)

$A_\chi = M\; \exp(-\mu_0 z) + C\exp(\mu_0 z)$ when *l* > *z* > 0, (19)

$A_\chi = D\; \exp(\mu_1 z) + E\exp(-\mu_1 z)$ when 0 > *z* > -*h*, (20)

$A_\chi = F\; \exp(\mu_2 z)$ when -*h* > *z*. (21)

In here $\mu_{012} = \sqrt{\chi^2 - k_{012}^{\;\;2}}$. Choice of characters in exponential is associated with the condition that the field at infinity vanishes. Substituting potentials (18)-(21) boundary conditions (15)-(17), we obtain the six equations. Simple steps allows you to write out their decision. If you enter values (11) and

$$L_- = (1+\Omega_{10})(\Omega_{12}+1) + (1-\Omega_{10})(\Omega_{12}-1)\exp(-2\mu_1 h)\,, \qquad (22)$$

$$L_+ = (1-\Omega_{10})(\Omega_{12}+1) + (1+\Omega_{10})(\Omega_{12}-1)\exp(-2\mu_1 h)\,, \qquad (23)$$

the decision will be presented in the following explicit expressions:

$$W = \left( \frac{L_-}{L_+} + \exp(2\mu_0 l) \right) \frac{2\pi\ J_0}{\mu_0} \exp(-\mu_0 l) . \quad (24)$$

$$M = \frac{L_-}{L_+} \frac{2\pi\ J_0}{\mu_0} \exp(-\mu_0 l) . \quad (25)$$

$$C = \frac{2\pi\ J_0}{\mu_0} \exp(-\mu_0 l) ; \quad (26)$$

$$D = \frac{2(\Omega_{12} + 1)}{L_+} \frac{2\pi\ J_0}{\mu_0} \exp(-\mu_0 l - 2\mu_1 h) , \quad (27)$$

$$E = \frac{2(\Omega_{12} + 1)}{L_+} \frac{2\pi\ J_0}{\mu_0} \exp(-\mu_0 l) , \quad (28)$$

$$F = \frac{4\Omega_{12}}{L_+} \frac{2\pi\ J_0}{\mu_0} \exp(-\mu_0 l - \mu_1 h + \mu_2 h) . \quad (29)$$

Substituting (24)-(29) in (12) get of Sommerfeld integrals, calculation who now represents the big mathematical difficulties. For example, even for a media homogeneous Sommerfeld integral method cannot pass calculated in the wave zone in only three cases, for direct, reflected and lateral EM waves.

## III. Strongly Inductive Impedance Media

It is convenient to introduce the concept of effective media, when for each frequency $\omega$ media has an effective value of dielectric permittivity $\tilde{\varepsilon}$ and electrical conductivity $\tilde{\sigma}$. Then the impedance $\delta$ will have the following known species [7]:

$$\delta = \left(1 + \tilde{\varepsilon} + i\tilde{\sigma} / \varepsilon_0\ \omega\right)^{-1/2} . \quad (30)$$

Square effectively wave number $\tilde{k}$ EM waves in this media

$$\tilde{k}^2 = \frac{\omega^2}{c^2} \left( \tilde{\varepsilon} + \frac{i\tilde{\sigma}}{\varepsilon_0 \omega} \right) . \quad (31)$$

Transmitter and receiver are often above ground, in free space. As we have informed, the wave number of the EM field in free space would be $k_0 = \omega / c$. Combining (30) and (31), we get:

$$\tilde{k} = k_0 \sqrt{1 - \delta^2} / \delta . \quad (32)$$

In this form the formula apply to any underlying media - homogeneous, layered or gradient. It should be noted that $\tilde{k}$ expressed through directly measurable value - impedance $\delta$.

From the formula (30) see that the impedance is a complex number, which is written in two forms. Or as $\delta = |\delta| \exp(i\varphi_\delta)$, where is $|\delta|$ - module and $\varphi_\delta$ impedance phase. Either $\delta = \mathrm{Re}\,\delta + i\,\mathrm{Im}\,\delta$, where is $\mathrm{Re}\,\delta$ - the real and $\mathrm{Im}\,\delta$ the imaginary part of impedance. On Earth many media are strongly inductive whose impedance phase $-45.1^0 < \varphi_\delta < -89.9^0$. This year-round pack ice on the salt water of the Arctic Ocean, is also a year-round forest vegetation, the current millennium, permafrost in the northern regions and the salt lakes of Siberia in winter-spring period. In the permafrost area for one of the radiotrass on the frequency $f = 255$ kHz impedance was installed [9] $\delta = 0.028 - i\ 0.085$, from where $|\delta|^2 = 0.008$, $\varphi_\delta = -71.3^0$. It is (30) easy to extend

$$\tilde{\varepsilon} = \cos(2\varphi_\delta) / |\delta|^2 - 1 ,$$

$$\tilde{\rho} = 1/\tilde{\sigma} = (1/\varepsilon_0 \omega)|\delta|^2 / \sin(-2\varphi_\delta) .$$

From where

$$\tilde{\varepsilon} = -101 , \ \tilde{\rho} = 950 \text{ Ом·м.}$$

Interesting, what $\tilde{\rho}$ adopted value between 0 (electrical conductor) и ∞ (air). For dielectric permittivity concept of average is not suitable. Here for air $\varepsilon = 1$, for conductor $\varepsilon \approx 5$, and the average $\tilde{\varepsilon} = -101$. Because $1/\varepsilon_0 \omega\rho = 1.325$, then on the frequency

$$\tilde{k}^2 = \frac{\omega^2}{c^2} \left(-100 + i\ 1.325\right) .$$

Here is the real part of the square of the effective wave number significantly more imaginary part.

In winter-spring period on one of the salt lakes of Siberia were measured surface electromagnetic wave [10]. The results of these measurements at a frequency of 10 MHz impedance has been restored $\delta = 0.063 - i\ 0.139$. For this case $\tilde{\varepsilon} = -29$ and $\tilde{\rho} = 55$ Ohm·m. From where

$$\tilde{k}^2 = \frac{\omega^2}{c^2} \left(-29 + i\ 32\right) .$$

We see here that the real and imaginary parts of a square wave effectively number one order. Examples of shows that the impedance

$$\delta = \mathrm{Re}\,\delta + i\,\mathrm{Im}\,\delta = \mathrm{Re}\,\delta - i|\mathrm{Im}\,\delta| , \ |\mathrm{Im}\,\delta| > \mathrm{Re}\,\delta . \quad (33)$$

Natural media with an impedance (33) are called strongly inductive impedanse media.

## IV. Surface Electromagnetic Wave

A happy addition to the above three cases the calculation of the integral Sommerfeld are surface EM waves (SEW). And here there is a significant difference. To determine the trajectory of the direct, documented and side EM is possible to apply the principle of wave farm, which allows you to determine the setting for the Sommerfeld integral integration in particular point $\chi_0$, where the integral is evaluated and pass method [11,12]. But for SEW this principle no. This wave propagates in a narrow dielectric layer, unable to escape neither the atmosphere nor bottom electrical conductor media. This means, as we shall see below, that Sommerfeld integrals and electrical conductor layer exponentially damped.

In the wave zone, away from the emitter, emitter location height *l* is almost invisible. So you can put $l = 0$. Because the dimension EM is happening in fields near the surface layer, the Sommerfeld integral in this case takes the form:

$$A_{SEW} = \frac{J_0}{\sqrt{2\pi\ i\ R}} \int_{-\infty}^{\infty} \frac{L_-}{L_+} \frac{\sqrt{\chi}}{\mu_0} \exp(-\mu_1 z + i\chi R)\ d\chi . \tag{34}$$

Larger values of *R* has a way of integrating into the lower half-plane $\chi$, where near integral expression decreases rapidly. It should be reminded that great *R* meets the wave zone. At offset must bypass all zeroes of the denominator of the function $L_- / L_+$ and its branching point. As a result, the integral will be proportional to the $\exp f(-\mu_1(\chi_0) + \chi_0 R)$, where is $\chi_0$ - closest to the real axis is one of the singular points. A special point of particularly easy to find in the case $h = 0$. Equating denominator zero function $L_- / L_+$, it is easy to find $\chi_0 = k_0 k_2 / \sqrt{k_0^{\ 2} + k_2^{\ 2}}$. If you put $h = \infty$, you also find $\chi_0 = k_0 k_1 / \sqrt{k_0^{\ 2} + k_1^{\ 2}}$. When the final *h*, according to the concept of effective media, you can put

$$\chi_0 = \frac{k_0\ \tilde{k}}{\sqrt{k_0^{\ 2} + \tilde{k}^{\ 2}}} . \tag{35}$$

Recall, $\tilde{k}$ - the effective wave number. Using its value (32), finally find a particular point Sommerfeld integral (34):

$$\chi_0 = k_0 \sqrt{1 - \delta^2} . \tag{36}$$

We will be interested in the spatial characteristics of the vector potential, its dependence on coordinates *R* and *z*. For this purpose it is necessary to substitute the special point (36) in the exponential (34). Next, you need to distinguish between vector potential $A_{z0}$ in free space and vector potential $A_z$ in impedance media. As a result, first have to free space:

$$A_{z0} = \frac{K_0}{\sqrt{R}} \exp\left(-i\ k_0 \delta\ z + i\ k_0 \sqrt{1 - \delta^2}\ R\right). \tag{37}$$

And the vector potential in impedance media:

$$A_z = \frac{K}{\sqrt{R}} \exp\left(-i\ k_0 \frac{1 - \delta^2}{\delta}\ z + i\ k_0 \sqrt{1 - \delta^2}\ R\right). \tag{38}$$

Both terms all exponential phase components are expressed through impedance laying media. This is one of the manifestations of the beneficial properties of the introduction of the impedance.

Substituting the expression (33) in the formula (37) and (38), we get:

$$A_{z0}(R, z, t) = \frac{K_0}{\sqrt{R}} \exp[\ -i \operatorname{Re}\delta\ k_0 z - |\operatorname{Im}\delta|\ k_0 z\ + \\ + (ik_0 R - i\omega\ t) - \operatorname{Re}\delta\ |\operatorname{Im}\delta|\ k_0 R\ ]. \tag{39}$$

$$A_z(R, z, t) = \frac{K}{\sqrt{R}} \exp[\ -i \frac{\operatorname{Re}\delta}{\operatorname{Re}^2\delta + \operatorname{Im}^2\delta}\ k_0 z + \frac{|\operatorname{Im}\delta|}{\operatorname{Re}^2\delta + \operatorname{Im}^2\delta}\ k_0 z\ + \\ + (ik_0 R - i\omega\ t) - \operatorname{Re}\delta\ |\operatorname{Im}\delta|\ k_0 R\ ]. \tag{40}$$

Here is obviously pasted $\exp(-i\omega\ t)$, not to forget, that are considering wave motion.

Of the solutions should be that the vector potential in free space fades as

$$\exp\left(-|\operatorname{Im}\delta|\ k_0 z\right).$$

In a strongly inductive media vector potential fades as

$$\exp\left(+\frac{|\operatorname{Im}\delta|}{\operatorname{Re}^2\delta + \operatorname{Im}^2\delta}\ k_0 z\right).$$

We remind that the *z* coordinate in impedance media takes negative values. The results mean that SEW cannot "go deep" in impedanse media, and may not "escape" in free space. In general, SEW in its distribution in dielectric layer as "creeps" along the Earth's surface, not looking up from her. Therefore it is called SEW. It can be said that the existence of SEW obliged to our choice of characters in exhibitors Fourier images (18)-(21).

Now a simple differentiation of easy to install all components of EM in the field media. As we have informed, in the cylindrical coordinate system, the only non-zero component of magnetic induction

$$B_\varphi = \left(\nabla \times \vec{A}\right)_\varphi = \frac{\partial A_r}{\partial\ z} - \frac{\partial A_z}{\partial\ r}.$$

We have $B_\varphi = B_y$, and vector potential has only one non-zero component $A_z$. It is therefore in our legend horizontal component of magnetic induction will

$$B_y(R,z) = -\frac{\partial A_z(R,z)}{\partial\ R}. \qquad (41)$$

Because at the border $z = 0$ horizontal magnetic induction components are equal, then it follows that permanent multipliers $K_0$ and $K$ in (37) and (38) equal to each other. When finding all non-zero component of the EM field to differentiate on *R* just exponential multiplier. If you differentiate before exponential multipliers, you will see small components $1/\chi\ R$, you can delete without prejudice. Clearly write the components EM will not fields, they are listed in our article [13]. Here write the absolute values of the components fields. So, for non-zero components of the magnetic field *H* in impedance media get:

$$\left|H_y(r,z)\right| = K\frac{1}{\sqrt{r}}\exp\left(-k_0\ \mathrm{Re}\,\delta\ \left|\mathrm{Im}\,\delta\right|\ r + \frac{k_0\ \left|\mathrm{Im}\,\delta\right|}{\left|\delta\right|^2}\ z\right). \qquad (42)$$

And for free space:

$$\left|H_{0y}(r,z)\right| = K\frac{1}{\sqrt{r}}\exp\left(-k_0\ \mathrm{Re}\,\delta\ \left|\mathrm{Im}\,\delta\right|\ r - k_0\ \left|\mathrm{Im}\,\delta\right|\ z\right). \qquad (43)$$

Similarly, for non-zero values component of the electric field *E* find:

$$\left|E_z(r,z)\right| = -\mu_0\ c\ \left|\delta\right|^2\ \left|H_y(r,z)\right|, \qquad (44)$$

$$\left|E_r(r,z)\right| = -\mu_0\ c\ \left|\delta\right|\ \left|H_y(r,z)\right|, \qquad (45)$$

$$\left|E_{0z}(r,z)\right| = -\mu_0\ c\ \left|H_{0y}(r,z)\right|, \qquad (46)$$

$$\left|E_{0r}(r,z)\right| = -\mu_0\ c\ \left|\delta\right|\ \left|H_{0y}(r,z)\right|. \qquad (47)$$

## V. Conclusion

Installed the Fourier images of vector potential for double-layer media. Vector potentials themselves are expressed as integrated Sommerfeld integrals. It has been established that these integrals can be calculated in the wave zone for heavily inductive underlying the Earth's surface. The results are expressed in terms of real, measurable value is the surface impedance.

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# Quantum Scalar Gravity General Relativity, Quantum Mechanics, the Life Force and Multi-Dimensional Motion of Objects within a Cosmic Scalar Flow

By Timothy Fulton Johns DDS

*Abstract-* The unification of Newton's/ Einstein's Gravity and Quantum Mechanics is truly a focus of science with great promise for our increased understanding of the cosmos. So to find a theory that explains the connection of these two concepts of our reality is indeed an exciting prospect. This paper attempts to do that and explain how life is a contributing force which appears to be an essential part of the complete picture. It may require further reading about the details of the evolving Cosmic Dark Matter Fractal Field Theory (CDMFFT) to better understand the full concept but those links are provided to previous foundational work published by GJSFR for your review. The other theories that attempt to unify gravity and quantum mechanics such as String Theory have completely left out the explanation of the Life Force and its connection to the unification of gravity and quantum mechanics.

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# Quantum Scalar Gravity General Relativity, Quantum Mechanics, the Life Force and Multi-Dimensional Motion of Objects within a Cosmic Scalar Flow

Timothy Fulton Johns DDS

*Abstract-*

The Cosmic Dark Matter Fractal Field Theory

The unification of Newton's/ Einstein's Gravity and Quantum Mechanics is truly a focus of science with great promise for our increased understanding of the cosmos. So to find a theory that explains the connection of these two concepts of our reality is indeed an exciting prospect. This paper attempts to do that and explain how life is a contributing force which appears to be an essential part of the complete picture. It may require further reading about the details of the evolving Cosmic Dark Matter Fractal Field Theory (CDMFFT) to better understand the full concept but those links are provided to previous foundational work published by GJSFR for your review. The other theories that attempt to unify gravity and quantum mechanics such as String Theory have completely left out the explanation of the Life Force and its connection to the unification of gravity and quantum mechanics. How could any theory that leaves out life claim to be a unification theory of our universe which ignores the very source that asks such questions. This new theory is now explaining how the neglected Life Force joins the other four known accepted forces of nature and gives strong indication of a cosmos with design and intention. A conclusion the late Steven Hawking arrived at about a year prior to his death in this press release of February 2016, "The English theoretical physicist and cosmologist, Stephen Hawking, surprised the scientific community last week when he announced during a speech at the University of Cambridge that he believed that 'some form of intelligence was actually behind the creation of the Cosmos.' This strange phenomenon which he names the God factor, would be at the origin of the creation process and would have played a great role in determining the actual form of the Cosmos."

What this paper will reveal is that what appears to be natures indifference at our local scalar level is in fact seen more clearly as what appears to be intentional design when considered from a cosmic multi-scalar perspective.

*See link for details:*

http://therismosfoundation.org/2016/02/07/breaking-news-hawking-admits-god-does-exist/#.W-jO_JNKi00

YouTube Lecture link "The Great Cosmic Sea of Reality" below:

https://www.youtube.com/watch?v=R-DLHuiGgy8

## I. May The Five Forces Be With You!

The Earth, like the nucleus of an atom, exists within the cosmos both at different scales, both seemingly adrift in an abyss of the cosmic sea under its control and both are a very small part of a much larger evolutionary process of our reality yet in constant motion in multiple vectors. Our cosmos is vast and the closest thing to infinity that our mind can comprehend so possibly time spent discussing the incredible scale of our reality will be helpful.

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Consider the nucleus of an atom and let's take the simplest one…. hydrogen, the atomic fuel of our sun and all of the stars in the universe. It consists of one proton and one neutron in the central nucleus with one highly energized electron orbiting the nucleus. The scale of this example is important to understand because all atoms exist at this scalar layer approximately 1x10^-15 meters below our layer but more important to understand is just how empty occupied space truly is. The number of protons and neutrons in the nucleus and the number of orbiting electrons only increases with higher elements from the hydrogen atom up through the heavier 118 elements of the periodic table but the emptiness of space within the atomic scale changes very little because of the weak and the strong nuclear force. While the weak and the strong nuclear force are out of our direct unawareness at our scale the electromagnetic force is evident and easily observed, as is gravity the fourth known force of our reality. The fifth force is the ignored force this theory is proposing, the life force with its force and tenacity becoming more and more evident as science progresses.

## II. Why Then Is Space So Empty?

Space is mostly void at all scales, it is unbelievably empty much more than you can even imagine and that is where gravity comes into play as quantum scalar gravity (QSG). That means even though gravity is considered the weakest of the cosmic forces because it, like our perception of time, is relative to the scale being considered, as well as, the mass relative to that scale and speed of scalar motion in any given layer. But let's not get ahead of ourselves, let's first get a handle on understanding scalar dimensions or layers of reality. I will provide some examples to help illustrate this little understood realm. Let's start with some illustrations of scale of very large numbers and let's use the dollar bill as our example. The dollar is about 1 millimeter in thickness; if I were to count out a million dollars or said

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another way 1x 10^6 dollars using one dollar bills counting and stacking one every second the stack would be 358 feet tall; that's about as high as a thirty story building and it would take me twelve days to complete the task. If I did the same thing with one billion dollar bills or 1x10^9 the stack would be 68 miles high and take me 32 years to complete. If I did it with one trillion dollars or 1x10^12 it would be 67,666 miles high and take 32,000 years to complete. That is called exponential scale of growth. Taken in reverse or negative scale to microscopic levels that is called micro scale reduction. The known continuum of that range in our universe is 1x10^-35 meters the smallest layer called the Planck scale; to the very large 1x10^-35 meters called the macroscale; the size of the unbelievably large super massive black holes thought to exist at the center of all of the over 100 billion galaxies in the observable universe.

If you were to enlarge the size of the atom to the size of a football stadium and place the nucleus of the hydrogen atom in the center of the field at the 50-yard line it would be about the size of a large concord grape. The electron that orbits it would be 1/100,000th the size of the grape and whizzing around the grape at the speed of light at a distance of somewhere in the top rows of a 50,000 seat stadium. It was this model of the atom developed by Nobel Laureate's Earnest Rutherford and later Niels Bohr at the turn of the previous century that revealed the fractal nature of the atomic structure as self-similar to that of the planetary system of Saturn, or our solar system and the thousands of other exoplanet solar systems being discovered within it currently every year. While that is not exactly what the model of the atom is now thought to look like it is a good representation of the fractal nature of our reality. This is clearly a fractal framework in play! However, this work would also reveal the extreme emptiness of the internal structure of the atom. To take this scalar example further to give a better understanding of what all of this emptiness means let's consider all of the atoms in a person.

If you removed all of the vacuum space in the hundreds of trillions of atoms in a human the condensed mass would be about the size of a grain of salt. If you took all of the 6 billion people on our planet and combined them in like manner the entire mass would be about the size of a large apple. So even occupied space is very empty! The same ratio of vast emptiness is repeated in our solar system, our galaxy and especially in the web-like formation of multiple galactic star systems of deep space and beyond, again fractal. Yet within this emptiness of vacuum space resides enough energy in a volume the size of a coffee cup to vaporize all of the water in all the oceans of our planet. How could this be true? Through the work of scientist like Hendrik Casimir discovering the Casimir Effect and Nobel Laureate Willis Lamb for the Lamb Shift both scientist working to uncover the energy of quantum fluctuations and their work revealed the tremendous energy of vacuum space which was experimentally verified, more on the source of that energy later.

## III. The Great Cosmic Sea And Dimensional Space-Time

Almost three-quarters of our globe is home to another world we are only beginning to understand. Yet, what has been very obvious from our earliest investigation of the sea is that it reveals a complex reality alien to us. The sea is a world in and of itself. Though it provides the very fabric of existence of the life it sustains, the combined network of oceans that blankets our planet which is approximately seventy percent of the Earth's surface goes unnoticed by its inhabitants due to its scale and the fact that these waters are the very space (i.e., fluid) these life-forms live in and navigate through moment by moment. As it is with the sea life, so it is in our universe. We, like our marine counterparts, fail to notice the sea of our own reality. The space we occupy and live in is empty to our everyday sensory perceptions, however, this abyss of space-time at all scales is not exactly as empty as it seems from a scalar perspective. This is where the Great Cosmic Sea resides and the fluid-like flow of space-time occurs.

## IV. The Confirmation Of Aether

There is a constant interaction always taking place within the Great Cosmic Sea we all live in moment by moment. The cosmic sea I speak of is part of our environment and contains what I believe cosmologist now call dark matter/dark energy. It is what early investigators called another name the vacuum space, ground state, or zero-point field. This empty space is where many scientist in the past believed a substance called Aether existed. My preference, a more descriptive name, is the cosmic dark matter fractal field (CDMFF) for reasons that will become obvious. This is where I think dark matter exists in the form of these CDMFF's that make up the unseen Aether predicted by many scientists of the past two century, however, we are talking about the same phenomenon. This CDMFF is part of a scalar flow which emanates from the Planck level at1x10^-35 meters and occurs throughout occupied and non-occupied space-time. A constant flow throughout this massive energetic Great Cosmic Sea up to the most super massive objects of our universe as all objects of occupied space move at high velocities within the body of this sea of CDMFF's or Aether.

Constant motion in many vectors is the standard operation of our cosmos at all scales. We don't have an awareness of our motion as we sit or go about our daily life. Our senses cannot detect the high speeds of that actual motion of our rotating planet at

1000 mph or our orbital speed around the sun at 66,000 mph due to the tremendous difference of the scales involved. However, Earth and the great distances of the other celestial objects within the vast emptiness of space between Earth and these objects give us a hint as you watch their movement in the night skies. Our awareness of up or down tends to stop at the ground we stand on or the top of a skyscraper or a cloud or mountain or the moon in our night sky but remember that is our perception in our layer. This limited awareness of the up/down dimension changes drastically when we realize that this up/down, right/left and front/back direction only makes since in a particular frame of reference which occurs within our scalar layer. When you are standing on a surface like earth or a spacecraft both are equally valid and provide orientation to your three dimensions but the context changes, as well as, the strength of gravity you experience. While we always retain the three dimensions of space at any scale layer they lose meaning for example from the perception of an astronaut floating in deep space in a frame of reference that has no other object as an opposing comparison frame of reference.

North, south, east and west only extends 25,000 miles where we stand, the circumference of our planet, that's how far you would travel before you return to the very same spot where you now stand or as Einstein envisioned it "If you could see forever you would see the back of your head". The magnitude of this third dimension, up and down is much the same but seemingly stops at the ground we stand on and the sky scrapers above us or the moon above us, a vastly different perspective when considering space beyond our planet but within view of our scale layer. It is the concept of layers of scale of the very small and the very large that we must come to understand. The extent of the scalar dimension is much greater and we sit just about right in the middle of a continuum of that dimensional scale which is a zone described as a scalar layer; a continuum that extends in two extremes from 1x10^35 meters toward the largest super massive objectives in the heavens to 1x10^-35 meters the smallest, well past the atomic scale to what is known as the Planck scale but each layer has those three dimensions also, conceivably with limited perception. That is the most important thing to comprehend in order to understand the new implications of this theory and the attempt to lead our awareness to a new understanding of our reality.

## V. Relativity And The Concept Of Aether

Albert Einstein in 1920: "We may say that according to the general theory of relativity space is endowed with physical qualities; in this sense, therefore, there exists an Aether. According to the general theory of relativity space without Aether is unthinkable; for in such space there not only would be no propagation of light, but also no possibility of existence for standards of space and time (measuring-rods and clocks), nor therefore any space-time intervals in the physical sense. But this Aether may not be thought of as endowed with the quality characteristic of ponderable media, as consisting of parts which may be tracked through time. The idea of motion may not be applied to it."[13] as per Wikipedia.

This last sentence is where the CDMFFT differs from the way Einstein viewed Aether within space-time. It is essential that this Great Cosmic Sea move and flow through the continuum of scalar layers of dimension in order to produce the energy of empty space-time as well as its fabric, form and function. This is the media that carries the gravity waves predicted by Einstein and now found to actually exist using the new gravity wave detectors such as the two LIGO detectors in the United States and VIRGO in Italy.

Paul Dirac wrote in 1951:[7] "Physical knowledge has advanced much since 1905, notably by the arrival of quantum mechanics, and the situation about the scientific plausibility of Aether has again changed. If one examines the question in the light of present-day knowledge, one finds that the Aether is no longer ruled out by relativity, and good reasons can now be advanced for postulating an Aether ... We have now the velocity at all points of space-time, playing a fundamental part in electrodynamics. It is natural to regard it as the velocity of some real physical thing. Thus with the new theory of electrodynamics [vacuum filled with virtual particles] we are rather forced to have an Aether". as per Wikipedia. See my paper on Origin of Virtual Particles https://journalofscience.org/index.php/GJSFR/article/view/2104/1965 Like Einstein, Paul Dirac is hinting that there is something else there in space-time we aren't detecting but if he had any suspicions of something like dark matter he kept it to himself. This missing mass represents the very threads of the fabric of space-time these brilliant men intuitively suspected to exist. The first hint of Dark Matter/Dark Energy presence was perhaps in 1905 from Albert Einstein's work on relativity. He was confronted by what he thought was a mistake at first. His calculations on general relativity were indicating increasing mass/gravity which he thought was predicting an eventual collapse of the universe. This was not in line with a static universe which was a prevailing, widely known and agreed upon cultural "fact" as well as the foundations of then current scientific culture and the previous centuries of scientific thinking. This led Einstein to add, presumably because of cultural pressure, what some called a fudge factor to his calculations. He called it the cosmological constant which brought the results back to a static model of the universe, the mass was then negated by this mathematical alteration of Einstein. He would in later

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years regret that decision calling it the biggest blunder of his career because as we now know our cosmos is far from isolated or static and possess much still unexplained mass.

We are in fact moving at high velocity in at least three different vectors through the Aether as a part of a complex web of over 100 billion galaxies in our highly dynamic universe. The presence of DM/DE has emerged very recently with more clarity out of the long shadows of a progressive era of amazing science while looking for answers to many questions about our reality. Even Isaac Newton believed that something like Aether must be present as a medium, “a great sea of form and substance to propagate light energy”. The Cosmic Dark Matter Fractal Field is the “waters” of this great sea and what The CDMFFT substantiates as the missing mass these men hinted at; that is the Aether long believed to exist and provides the hidden mass therefore the energy of vacuum space!

John Bell in 1986, interviewed by Paul Davies in "The Ghost in the Atom" has suggested that an Aether theory might help resolve the EPR paradox or “entanglement” by allowing a reference frame in which signals go faster than light. He suggests Lorentz contraction is perfectly coherent, not inconsistent with relativity, and could produce an aether theory perfectly consistent with the Michelson-Morley experiment. Bell suggests the aether was wrongly rejected on purely philosophical grounds: "what is unobservable does not exist" [p. 49]. Einstein found the non-aether theory simpler and more elegant, but Bell suggests that doesn't rule it out. Besides the arguments based on his interpretation of quantum mechanics, Bell also suggests resurrecting the aether because it is a useful pedagogical device. That is, many problems are solved more easily by imagining the existence of an aether.[citation needed] as per Wikipedia.

## VI. As It Turns Out The CDMFFT May Prove Bell To Be Right!

There is another factor to be considered now concerning the proofs of the Michelson-Morley experiment of 1887 which seemed to negate the presence of Aether but should be revisited to reconsider the conclusions. According to the CDMFFT there is an actual scalar flow,a current of Aether, occurring that contains Dark Matter Fractal Fields that give the fabric of space-time a scalar gravitational stability due to the dark matter framework of all fractal fields. This would allow for a stable speed and direction of the light photons regardless of the direction it is projected through space-time with the exception of proximity to extreme mass. Also, the flow of the Aether of the great cosmic sea is scalar not directional as the experiment parameters where setup and designed to measure the speed of light. Einstein remarked "God does not play dice with the Universe” and those agreeing with him are looking for a classical, deterministic aether theory that would imply quantum-mechanical predictions as a statistical approximation, a hidden variable theory. The CDMFFT is in many ways providing a new foundation to the De Broglie-Bohm theory as well as the Hidden Variable theory of Einstein regarding the implications of the measurement problem of quantum mechanics and the Copenhagen interpretation.

“In particular, Gerard 't Hooft[14] who recently conjectured that: ‘We should not forget that quantum mechanics does not really describe what kind of dynamical phenomena are actually going on, but rather gives us probabilistic results. To me, it seems extremely plausible that any reasonable theory for the dynamics at the Planck scale would lead to processes that are so complicated to describe, that one should expect apparently stochastic fluctuations in any approximation theory describing the effects of all of this at much larger scales. It seems quite reasonable first to try a classical, deterministic theory for the Planck domain. One might speculate then that what we call quantum mechanics today, may be nothing else than an ingenious technique to handle these dynamics statistically.’ In their paper Blasone, Jizba and Kleinert "have attempted to substantiate the recent proposal of G. ’t Hooft in which quantum theory is viewed as not a complete field theory, but is in fact an emergent phenomenon arising from a deeper level of dynamics. The underlying dynamics are taken to be classical mechanics with singular Lagrangians supplied with an appropriate information loss condition. With plausible assumptions about the actual nature of the constraint dynamics, quantum theory is shown to emerge when the classical Dirac-Bergmann algorithm for constrained dynamics is applied to the classical path integral” [...]. as per Wikipedia.

These well-known and respected scientists have all, in their own way, held fast to the rationale for the need of a medium they called Aether to exist for the reasonable and proper functioning of our quantum and classical reality. This Aether is an essential component of the space-time model of Einstein’s relativity theories that requires an actual dynamic fabric of our cosmic sea. It is important that we consider that our reality may be more life-like than mathematical or mechanical; more organic than inorganic. We should also consider that our language, at least at this point in time in our evolution, may not have the ability to convey this concept for proper understanding of what science is now revealing.

Nature has a personality, a character that emerges naturally out of this Aether and cannot be corrupted but only recognized for what it is. A highly dynamical system that is in constant motion, therefore, the attempts of theoretical physicists to use mathematics based on static paradigms is not likely to give a logical conclusion that can be explained in a

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rational way. The use of applying mathematical techniques like Lagrangian and Stochastic methods cannot provide an accurate model to capture the depth of holistic continuity embedded within The Great Cosmic Sea. It is whole, connected and complete; it is constructed from the dark matter fractal fields of recursive scalar quantum architecture derived from the collective archetype blueprints of the Dark Matter/Dark Energy cosmos.

The ever repeating construct of emergent galactic nurseries of highly dynamic stellar solar systems that undergo nature's fractal birthing process called accretion disk emergence occurs from the never ending continuous inertial motion of our life giving cosmos. This accretion disk process appears to be scalar, therefore, is active and working at many scales; which tells me it should be a focused target of future research to uncover proofs of this theory.

See my previous paper "Mind Fields, Consciousness and Biocognitive Morphogenetic Fields") https://globaljournals.org/GJSFR_Volume18/E-Journal_GJSFR_(A)_Vol_18_Issue_5.pdf

## VII. The Seeds Of Our Universe, Dark Matter Fractal Fields The Strange Attractor

It is a foundational prediction of the Cosmic Dark Matter Fractal Field Theory (CDMFFT) that the Aether these scientists speak of and believe must exist is in fact Dark Matter/Dark Energy in the form of various morphic fields that emerge within the Aether at many scales all around us. These fields are enumerable and ubiquitous throughout our cosmos but imperceptible to our senses and detection devices except for their gravitational effects at large scales and possibly at much smaller scales. These fields contain the memory of nature in many forms of both animate and inanimate form and function, both morphogenetic and biocognitive that are so essential for the life force to function in all biospheres across the universe. These various morphic fields exist at many scales and are the literal "threads" of the fabric of space-time.

When the conditions are right it is the prediction of the CDMFFT that scalar coherent domains (SCD) begin to form possibly with the appropriate morphic field emerging and an accretion process starts with these SCD's as a response to resonant quantum electrodynamics that directs the subatomic and the ultimate atomic structure directed by the fractal gravitational effects of the blueprint of the Dark Matter based morphic field (DMMF). This process has been done with the DNA molecule in the laboratory of several scientists following the protocol of Nobel Prize winning scientist Luc Montagnier.

"Nobel laureate Luc Montagnier, by careful protocol, proved that the DNA of certain virus and bacteria could emit electromagnetic signals (EMS) and transmit the information to duplicate the DNA into a separate vile of sterile water. This amazing discovery was first rejected over ten years ago when Montagnier and his research team reported it. These results have since been repeated by all the different researchers you see below, and even more remarkable was the digitized electromagnetic signal (EMS) of the DNA being sent to other labs over the internet by e-mail, which was then used to duplicate the results of Luc Montagnier and his team. One key element was always critical for success that the tubes of sterile water were always exposed to the Schumann resonance, 7.83 Hz, Earth's EMS pulse, the well-known electromagnetic pulse of Earth created by dynamic tension between the magnetic field of the Earth and the highly electrically charged ionosphere layer of our atmosphere. Luc Montagnier used 7 Hz in his experiments.

## VIII. Transduction Of DNA Information Through Water And Electromagnetic Waves

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*Theoretical Analysis:* Our formerly reported experiments (Fig. 2 and ref. (Montagnier, Aïssa, Lavallee, et al., 2009)) indicate that the ability of EMS production can be transmitted from tube 1 containing an emitter DNA dilution to tube 2 of "naive" water, provided the system is excited overnight by electromagnetic waves of a minimal frequency of 7 Hz. Presumably tube 1 transmits waves to the water in tube 2, which did not originally contain any trace of the DNA at the origin of the signals. In the previous Section we have reported the experimental observation that EMS can be emitted by diluted aqueous solutions of bacterial and viral DNA under proper conditions. Moreover, it has been observed that duplication of the emitting DNA segment can be obtained by using pure water exposed to the corresponding DNA EMS and, upon addition of enzymes, primers, etc., submitted to PCR (Polymerase Chain Reaction) cycles. Such a transduction process has been observed to occur also in EMS exposed living cells of tumor origin. These experimental observations suggest that long range molecular interaction must be at work in water so to allow the observed properties. Indeed, since in the transduction process the high level of sequential ordering among several hundreds of nucleotides entering the transduced DNA chain is obtained, we are clearly in the presence of collective molecular dynamical behavior of water. In quantum field theory (QFT) it is known that the ordering of the elementary components of a system is achieved as a result of the spontaneous breakdown of symmetry and constitutes the observable manifestation of coherence (Blasone, Jizba and Vitiello, 2011; Fröhlich, 1977; Umezawa, 1993; Vitiello, 1998).

These groundbreaking original studies present many implications, but the most important question is, how did the atoms that make up the DNA in vile #2 align and form in the previous experiment by Montagnier? Water contains only two atoms, hydrogen and oxygen. That's a long way from deoxyribonucleic acid. However, the nucleotides added to vile #2 by the PCR enzymes provided the needed atoms but no structure or instructions for assembly.

*The Cosmic Dark Matter Fractal Field theory explains it this way:*

The field of the DNA was projected or transmitted to the second vile of water that had been tuned to a receptive resonate frequency (7 Hz), the electromagnetic pulse of this planet. The morphogenetic field of the DNA was projected from the first vile to the water of the second vile, which received it as a radio-like signal imprinting this transmitted DNA morphogenetic field attractor now present in the water by breaking the bipolar symmetry of the water creating the coherent domain (CD) of the morphogenetic field of the DNA molecule. This allowed elemental particles to be attracted to the correct position to create the molecular bonds necessary for the nitrogen, phosphorus, and carbon atoms to be attracted to the correct position in the right orientation as needed. This occurred through quantum electrodynamics (QED) according to the DNA field blueprint now present in the second vile presumably by way of scalar resonate coherence filling in the DNA quantum field in the required positions. This elemental particle alchemy formed through molecular phase locking of the nitrogen, phosphorus, and carbon atoms in the sterile water, creating the molecular form directed by the scalar CD of the DNA Dark Matter Fractal Field molecular pattern that had been transmitted to the second vilecausing this resonant Dark Matter Fractal Field DNA blueprint to emerge from the Aether to guide the DNA formation in the sterile water.

Once again, this shows how a field in this case of electromagnetic energy working with the strange attractor (Morphogenetic Fields) can direct, shape, and form matter at the BM/CDMFF interface. All of which implies an underlying substructure out of our detection but clearly providing the exact blueprint for the assembly of life-giving DNA evidenced by the work of Montagnier et al. If you think about the astounding results of Luc Montagniera's experiment in the context of the CDMFFT the reach of the Life Force is ubiquitous throughout our galactic universe and implies extraterrestrial life.

## IX. Occupied and Non-Occupied Space-Time Dynamics and Relativistic Implications E=mc^2 and[ER=EPR]

One of the not so well understood meanings of E=mc^2 is our reality exist in three different phases, from energy to mass and finally from mass to coherent domains CD. (When I say CD you think invisible fields like the ones that form and direct schools of fish or flocks of birds flying in formations) as directed by morphic fields you cannot see or feel yet they are the unseen influence that gives all form and shape even function at multiple scales. This is much like the magnetic fields you may have seen at some point in your life and exposed to your awareness by placing a magnet under white notebook paper and a magical pattern appears when iron filings are sprinkled on top of the notebook paper except with Morphic Fields these fields are in a harmonious functional dynamic motion.

In the concept of the CDMFFT the main difference in what this theory brings to our awareness is that scalar flow is the defining element of the occupied places in space by accretion and the gravitational focus or choke points where the scalar flow begins to concentrate and channel, like water flowing into a canyon during a heavy rain fall. This is the concentrating cherode (cherode) model of quantum scalar gravity (QSG) that produces mass in sufficient quantities to produce objects of all sizes and masses by formative causation throughout the scalar layers in the expansive continuum of our reality. (SeeC H Waddington) This action of the scalar flow of Dark Matter Fractal Fields is responsible for all of the baryonic matter derived objects in our Universe and the derived gravitational actions proportional to the mass of each object at each scalar layer. However, we must never forget that in each of these forms it is always energy! The Cosmic Dark Matter Fractal Field is definitely foundational to all of this.

## X. Listen To The Conclusions Of A Study By HAL Puthoff et. al.

"Hal and Bernie also realized that their discovery had a bearing on Einstein's famous equation E = mc^2. The equation has always implied that

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energy (one distinct physical entity in the cosmos) turns into mass (another distinct physical entity). They now saw that the relationship of mass to energy was more a statement about the energy of quarks and electrons in what we call matter caused by interaction with the Zero Point Field fluctuations. What they were all getting at, in the mild-mannered, neutral language of physics, was that matter is not a fundamental property of physics. The Einstein equation was simply a recipe for the amount of energy necessary to create the appearance of mass. It means that there aren't two fundamental physical entities—something material and another immaterial—but only one: energy. Everything in your world, anything you hold in your hand, no matter how dense, how heavy, how large, on its most fundamental level boils down to a collection of electric charges interacting with a background sea of electromagnetic and other energetic fields—a kind of electromagnetic drag force. As they would write later, mass was not equivalent to energy; mass was energy. Or, even more fundamentally, there is no mass. There is only charge."

McTaggart, Lynne. The Field: The Quest for the Secret Force of the Cosmos, loc: 193–196, Kindle (HarperCollins, updated edition). 4 McTaggart, loc: 193–196. 5 McTaggart, loc: 824–825.

"This paper by Hal Puthoff et al. implies that our reality is a result of a type of phase transition from energy to mass. They leave out the last step, and that is matter and its transformation to an organized condensate whole producing emergent properties of form and function presumably by way of quantum fields. These quantum fields (QFT) are then organized by way of quantum electrodynamics (QED) and then, I believe, propagated by way of CDMFFs, creating cascades of fractal iterations of coherent domains at multiple scale levels in nested recursive fashion, forming what we know as ordinary matter. However, this transition occurs at the very heart of the interface between the two worlds, oneof ordinary matter and the other an unknown world of dark matter / dark energy the CDMFF. Listen to what James Gleick says about this possibility in his amazing book 'Chaos: The Making of a New Science'.

The march of phase transition research had proceeded along stepping stones of analogy: a nonmagnet-magnet phase transition proved to be like a liquid-vapor phase transition. The fluid-super fluid phase transition proved to be like the conductor-superconductor phase transition. The mathematics of one experiment applied to many other experiments.

By the 1970s the problem had been largely solved. A question, though, was how far the theory could be extended. What other changes in the world, when examined closely, would prove to be phase transitions?"

Fulton Johns, Timothy. The Great Cosmic Sea of Reality (Kindle Locations 243-244). Page Publishing, Inc.. Kindle Edition.

What the CDMFF theory reveals is what I call general relativistic phase transitions (GRPT). The simple way to understand that statement is what each of us knows about water………!Water is a very simple molecule with very special qualities so let's talk about emergent properties first. The water molecule consists of two atoms of hydrogen and one atom of oxygen both are gases you can't see or feel, ingested individually they are necessary and support life. Yet when combined the water molecule is an emergent property and forms a liquid you can both see, feel and drink. Water is required for life to exist; your body is over 75% water which must be replaced constantly to maintain homeostasis. Another example of emergence within our reality is salt. Salt is made of one sodium atom a solid and one chloride atom a gas. If you ingest either one of these by themselves they are toxic and will kill you, yet when combined in a sodium chloride molecule you get tasteful life-sustaining salt with an emergent property which also is essential for life.

Water as a molecule is known to exist in three different phases based on pressure and temperature; a solid as ice, a liquid as water and gas sometimes visible as steam or fog. The same molecule is always present in every case just in a different phase or form but always water. An interesting fact of this emergent characteristic of our reality; when salt is added to water as it is in your body chemistry it changes the physical properties of the freezing point of water which improves the resistance to freezing of biologic life. Therefore, this combination of salt with water improves the survival parameters of life during frigid environmental conditions.

## XI. General Relativistic Phase Transition (grpt) Within er=epr

The ER=EPR reference is representative of a new understanding of the work of the men these letters represent. The E stands for Einstein the R for Rosen, one of his colleagues, who wrote a very famous paper with him called the "Particle Problem in the General Theory of Relativity". This paper was written in 1935 some 20 years after his work on relativity. This new insight emerged concerning the implication of what is known as the general relativity field equations of the famous E=mc^2 equation, which included a prediction of a strange existence never before seen or even imagined later named black holes by physicist John Wheeler.

Black holes are a place in space where, very much like a sink-hole or a drain in the bottom of a bathtub, a formation occurs of an unexpected vortex of the fabric of space-time; but this vortex was in space itself. This paper was introducing the possibility of BH's existing as a prediction of Einstein's General Relativity Theory (GR) and a consequence of the BH, what became known as Einstein-Rosen bridges also known as wormholes that were the extended progression of the BH's. The evidence is strong that this dynamic of our reality exists.

We also have evidence that these BH's exist at both extremes of our continuum, is it possible they also exist in the vast arena of inner empty space? There is good evidence that they exist in outer space as Rogue Solo Black Holes [RSBH) in multiplicity at many different sizes/scales with different gravitational strengths. There is also recent verifiable evidence that these BH's merge and create more massive BH's producing a large gravitational "splash" in our cosmic sea measured by gravitational wave detectors when this occurs at very large scales. What would we expect to see if this were true across the cosmos at very small scales? What possibilities are conceivable if there was a ubiquitous presence of BH's at many different layers of our scalar reality? It is a prediction of the CDMFFT that BH's exist at many different scalar levels and act as a focal point of gravity that begins the ubiquitous process of the "drain hole" accretion action in non-occupied space-time. This local scalar action forms the accretion disk that attracts the morphic fields that provide the blueprint detail instructions which attract the virtual particles, that form the needed atoms, which form the required molecules to produce the SCD of both animate and inanimate objects. This fractal process occurs throughout The Great Cosmic Sea including occupied space-time in the appropriate way as directed by evolution and archetype influences of morphic fields. The black hole/white hole dynamics provide the hidden engine underlying this process of scalar functional dynamics in this ongoing cyclical process.

White holes exist most likely at the Planck scale possibly at the BM/CDMFF/Interface, both are predicted to exist from general relativity field equations. Black holes (BH) appear to be the incinerator of baryonic matter (BM) as they sit at the center of all galaxies and exist elsewhere at different scales known as rogue solo black holes (RSBH). The BH at the center of our galaxy is estimated to be 3 billion solar masses and it is not the largest of the BH family in our universe; any two colliding BH's seem to always produce a larger one. However, there are limits to stellar derived BH's and it is the influx of DM/DE into this process that could solve the mystery as to the massive and super massive BH's common to galactic centers and elsewhere throughout the cosmos. This produces extreme density of focal concentrated mass/gravity and larger and larger BH's through BH collision dynamics. There appears to be production of growing extreme gravity along with influence of DM/DE input at the BM/CDMFF/I during the super nova phase of Chandrasekhar limit stars as well as BH collision. All BH's have what is known as an event horizon also known as the Schwarzschild radius which is larger as the size of the BH's grow. The Schwarzschild radius is a zone around the BH that is the point of no return once BM crosses this theorized line. The prediction of the CDMFFT is that all BH's also have a Planck level as well and a BM/CDMFF/I where the cycle of our reality emerges and returns. This may explain the mystery of the supper massive BH's found to exist in our cosmos. See the paper on this prediction of CDMFFT: https://globaljournals.org/GJSFR_Volume18/1-Dark-Matter-May-be-a-Possible.pdf

The BM will be consumed within the BH core space-time singularity and according to the CDMFFT changed to something else that conserves and carries the information contained within into this great vortex of immense energetic gravity and recycled as the memory of morphic fields at the Planck scale at the BM/CDMFF/I of all BH's.

See Possible Origin of Virtual Particles:- https://globaljournals.org/GJSFR_Volume17/1-Possible-Origins-of-Virtual.pdf

This highly energetic thermodynamic zone seems to exhibit reverse entropy as Planck Virtual Black Holes (PVBH) produce cyclical energy/information as BM is consumed, conserved, and recycled through WH dynamics creating a memory of nature through a feedback loop process I call biomorphic trans radiation. See my paper on Reverse Entropy: https://globaljournals.org/GJSFR_Volume18/1-Entropy-is-Not-a-One.pdf

## XII. The White Hole or an Interface?

The CDMFFT predicts that white holes are more like an interface (WH/I) with wormhole dynamics within the foam-like Planck interface as described by the late Prof. Steven Hawking in his work on (BH) dynamics at the Planck scale (October 6, 1994 paper entitled 'Virtual Black Holes'):

"It seems that topological fluctuations on the Planck scale should give space-time a foam-like structure. The wormhole scenario and the quantum bubbles picture are two forms this foam might take. They are characterized by very large values of the first and second Betti numbers respectively. I argued that the wormhole picture didn't really fit with what we know of black holes. On the other hand, pair creation of black holes in a magnetic field or in cosmol ogy is described by instantons with topology S2 ×S2. This shows that one can interpret S2×S2 topological fluctuations as closed loops of virtual black holes".

More recently this Black Hole/White Hole /Wormhole model has been given more plausibility from such evidence as seen in this paper:

Hal M. Haggard∗ and Carlo Rovelli† Aix-Marseille Universit´e and Universit´e de Toulon, CPT-CNRS, Luminy, F-13288 Marseille (Dated: Fourth of July, 2014):

"We show that there is a classical metric satisfying the Einstein equations outside a finite space - time region where matter collapses into a black hole and then emerges from a white hole. We compute this metric explicitly. We show how quantum theory determines the (long) time for the process to happen. A black hole can thus quantum-tunnel into a white hole. For this to happen, quantum gravity should affect the metric also in a small region outside the horizon: we show that contrary to what is commonly assumed, this is not forbidden by causality or by the semi-classical approximation, because quantum effects can pile up over a long time. This scenario alters radically the discussion on the black hole information puzzle."

*They further state this:*

"Surprisingly, we find that such a metric exists: it is an exact solution of the Einstein equations everywhere, including inside the Schwarzschild radius, except for a finite—small, as we shall see—region, surrounding the points where the classical Einstein equations are likely to fail. It describes in-falling and then out-coming matter."

This seems to be describing a Planck singularity within PVBH's. The zone where classical general relativity and Einstein equations break down and a reverse singularity emerges as does reverse entropy. Furthermore, this is evidence that a cosmic macro-scale BH singularity is the same as a Planck level PVBH singularity. Which makes perfect sense because even the largest object in the universe has a Planck scale.

*They conclude:*

## XIII. "Relation With A Full Quantum Gravity Theory

We have constructed the metric of a black hole tunneling into a white hole by using the classical equations outside the quantum region, an order of magnitude estimate for the onset of quantum gravitational phenomena, and some indirect indications on the effects of quantum gravity. This, of course, is not a first principle derivation. For a first principle derivation a full theory of quantum gravity is needed. However, the metric we have presented poses the problem neatly for a quantum gravity calculation. The problem now can be restricted to the calculation of a quantum transition in a finite portion of space-time. The quantum region that we have determined is bounded by a well defined classical geometry. Given the classical boundary geometry, can we compute the corresponding quantum transition amplitude?

Since there is no classical solution that matches the in and out geometries of this region, the calculation is conceptually a rather standard tunneling calculation in quantum mechanics. Indeed, this is precisely the form of the problem that is adapted for a calculation in a theory like covariant loop quantum gravity [26, 27]. The spin-foam formalism is designed for this. Notice that the process to be considered is a process that takes a short time and is bounded in space"

EPR previously mentioned above stands for the names of the scientists plus Podolsky another physicist and collaborator of Einstein which wrote another paper with Einstein and Rosen. This paper relates to the quantum world presenting what became known as the EPR Paradox. This paper introduced theories concerning the now known unusual effect called Entanglement later proven to occurby the theoretical work of John Bell and experimental confirmation by French physicist Alan Aspect. Entanglement, like the cosmic dark matter fractal field, is an essential factor in the ubiquitous nature of the influence dark matter / dark energy has on the entire cosmos. The paradox of EPR is that particle pairs being created within the space-time continuum seem to be linked in such a way that when a change in the dynamic of one occurs the linked or "Entangled" partner instantly has a corresponding but reverse or mirror image dynamic change no matter the distance between them. Therefore, this could produce information transfer faster than the speed of light which conflicted with Special Relativity. However, CDMFFT may provide a clue to the origin of the entanglement phenomenon Einstein called "spooky action at a distance." It is a prediction of the CDMFFT that Entanglement is a phenomenon that links Dark Matter/Dark Energy with our Baryonic world because both worlds are linked by Dark Matter derived quantum gravity through Dark Matter Fractal Fields. Therefore, the gravity link first recognized by astronomers at the macroscale of galactic formation Is, according to the implications of this theory, also connecting everything throughout space-time down to the microscale at the Plank Baryonic Matter/Cosmic Dark Matter Fractal Field/Interface (BM/CDMFF/I) making our baryonic matter (4%) reality contiguous with DM/DE (96%) through dark matter derivedquantum scalar gravity (QSG).

Future research may very well point to dark matter/dark energy influences being responsible for entanglement observations of ordinary matter as well as a type of gravity shift that occurs at the BM/CDMFF/I because of the dark matter framework that is the foundation of Morphic Fields, like the refractive index deflection illusion that occurs with light as a stick dipped in a body of water seems to bend when placed into the interface of our atmosphere and a body of water.

In a fractal scalar way, this same phenomenon might even cause measurement errors in our cosmological observations, leading us to false conclusions of the dynamics of the cosmos, including but not limited to its predicted active expansion believed to occur in the cosmos. Our BM world is the stick immersed into the great cosmic sea of DM/DE, creating a false reading because of a tremendous disparity of gravity, a gravity shift! See https://globaljournals.org/GJSFR_Volume18/2-The-Universe-is-Flowing.pdf

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Entanglement, as described by the theory of Irish physicist John Bell and experimental proofs of French physicist Alain Aspect et al., which also have been repeated by many others (https://arxiv.org/ftp/quantph/papers/0402/0402001.pdf.), entanglement is clearly involved in our reality and calls into question our understanding of space-time. But remember, these proofs are only dealing with 4% of the entire cosmos; the other 96% is doing something I suspect we can't predict with any accuracy yet. This also implies that CDMFF's escapes the bounds of time and possibly holds the clue to deep space travel throughout our cosmos. This could open the doors to plausible travel to any other Earth-like twin for exploration and possible colonization. This theory implies that there must be other worlds in our cosmos that contain a very similar biosphere as our planet.

The CDMFFT predicts that there is an imperceptible scalar flow that is occurring that is crucial to the form and function of our cosmos as well as the need to possibly revise General Relativity (GR) in light of this possibility. If this is true it changes many of the concepts that we hold as axioms of our understanding of our reality. This new theory provides a framework to begin to understand what the fabric of space-time consist of and its connection to the largest energy source of our cosmos, Dark Energy. This paradigm of our cosmos describes that the vast majority of our cosmos is composed of Dark Matter/Dark Energy (DM/DE) 96% according to most advocates of this concept. That gravitational connection has substantial implications for improving our understanding of Cosmic General Relativity (CGR) or said another way Scalar General Relativity (SGR) yet to be considered. This concept brings gravity into the quantum realm. According to this theory there is a direct connection between this vast reservoir of cosmic Dark Energy and our Universe. That connection involves Morphic fields made of Dark Matter (DMMF) derived mass/gravity that freely flows through the zone of demarcation of the baryonic world and the DM/DE world at an interface I call Baryonic Matter/Cosmic Dark Matter Fractal Field/Interface (BM/CDMFF/I).

"There are several ways to resolve the EPR paradox. The one suggested by the original EPR paper is that quantum mechanics, despite its success in a wide variety of experimental scenarios, is actually an incomplete theory. In other words, there is some yet undiscovered theory of nature to which quantum mechanics acts as a kind of statistical approximation (albeit an exceedingly successful one). Unlike quantum mechanics, the more complete theory contains variables corresponding to all the "elements of reality". There must be some unknown mechanism acting on these variables to give rise to the observed effects of "non-commuting quantum observables", i.e. the Heisenberg uncertainty principle. Such a theory is called a hidden variable theory". [13]:334[19]:357–358 This Statement Is taken from Wikipedia.

The Cosmic Dark Matter Theory is possibly that "hidden variable theory" all of these scientists could not have known about DM/DE but intuitively believed there was a hidden element which must exist to explain Aether, as well as, the other conundrums of quantum mechanics like the "measurement problem" of the wave function collapse. The many elements of this theory and the paradigm shift of understanding the way our baryonic world interacts with a previously unknown mass have enormous implications with many new research avenues. Our baryonic world which makes up about 4% exists in an oil mixed with water-like relationship with the 96% predominant dark matter/dark energy within our cosmos. The constant movement across that interface occurs presumably due to the constant motion of our dynamic baryonic world as it moves in a dynamo-like relationship within the DM/DE zone of our cosmos is where the tremendous energy of vacuum space is generated that produces the Casimir Effect mentioned earlier.

## XIV. What Is The Now Of Time?

What is time really? Let's consider time as we experience it in the now. What is now… and is your now the same as my now? Have you ever experienced time distortion where it seems to speed up or slow down? If you are old enough to be over the age of five, the answer will most likely be yes. That experience is based on the difference of perceived time not time measured by a clock. It seems to me that time is a human construct based on how many times one planet rotates on its virtual axis in relation to its orbit around its star according to the definition we learn but is subject to distortion. This means time as we experience it only means something to us as a measurement of events specific to us. It is a random measuring devise to better understand our reality and our existential concerns. Relativity however, puts this subject in direct connection to the dynamic of our existential scale of interest and it puts the meaning of our concept of now into question. Time is not only relative to the higher speeds you are traveling compared to another observer which slows the way you experience personal time as you approach the speed of light according to special relativity. Time is also relative to your proximity to a large massive object like earth or a black hole which also slows time for you as in general relativity due to the extreme curvature of space-time. In fact, when you consider all of these variables time is different on every planet in our solar system, as well as, presumably all of the other planets in the cosmos. One thing is for sure about time, it is not a constant; the existence of time zones should be proof enough of that, time is relative based on your location, frame of reference and a number of variables.

The CDMFFT reveals it is consistent with GR to include what I call Scalar General Relativity (SGR) which says the degree of curvature of space-time is related to the scale of the observation being considered and the amount of mass accumulated at any point in space-time within any particular scalar level coherent domain (SCD) as described by Newton's law of gravity as well as Einstein's General Relativity. The actual curvature of space-time at any scale is likely responsible for the actual shaping of the ubiquitous scalar accretion process that causes the well-known circular accretion formation at all scales. It therefore follows that the flow of time should also be affected by scale. A basic axiom of GR is that the more accumulated mass the slower time flows so at smaller scales time should flow faster than we experience it at our scale. That is why at the Schwarzschild radius of black hole's time slows drastically at the close proximity to the extreme mass of the unbelievably dense black hole, some say it even stops at the surface of a black hole which may hold true also for the Planck Virtual Black Hole's. Therefore, there is not one time there are many times, many now's!

So it further holds that as we consider a new understanding of time. This new theory of Cosmic Dark Matter Fractal Field's reveals that time moves exceeding fast at the Plank scale where there is very low mass by comparison to our scale layer but may slow to a stop at Plank Virtual Black Holes (PVBH) as black hole dynamics come into play at the baryonic matter/dark matter zone. So it is the premise of CDMFFT that all black holes share a common end point at their singularity because even a super massive black hole has a Planck level BM/CDMFF/I that occurs at the Planck scale and time is canceled or just becomes irrelevant at some point in this zone of black holes regardless of scale. The CDMFF's continue to flow like a vast current in the Great Cosmic Sea starting at this Planck BM/CDMFF/I junction and continues too and through the BH dynamics at all scales throughout our Universe and returns to the Planck level junction at the BM/CDMFF/I at all black hole singularities. This scalar flow of The Great Cosmic Sea from one extreme to the other of the continuum of our cosmos represents the necessary unseen, unacknowledged dynamic that is a cyclical timeless model which seems to be explaining and opening up new understanding of many heretofore unknown concepts of our universe still being investigated.

## XV. Conclusions

The unification of Newton's/Einstein's gravity and quantum mechanics is still and has been long sought after. The search for a quantum gravity theory is truly a missing element of a complete understanding of science and its attempt to explain our reality. So to find a theory that explains the connection of the two concepts of the macro and the micro scale of our reality is indeed an exciting prospect. The concept of dark matter as the predominant source of gravity of the cosmos and now possibly integrated with our baryonic world through acting as the substructure of morphic fields which form our reality is not only profound but is a total paradigm shift in cosmic perspective.

It also explains why we don't experience the weird quantum effects at our scalar layer that the particle/wave duality of the double slit experiment seems to predict; Einstein was so disturbed by the absurd notion that the moon was only there when you are looking at it proclaiming "that God does not play dice with the Universe". However, he did not have the evidence we now have for the missing gravity that his work on General and Special Relativity revealed in his day. These effects of particle duality are negated by the quantum scalar gravity (QSG) influence of the Dark Matter/Dark Energy derived gravity in morphic and morphogenetic fields of all types responsible for the scalar coherent domains of our baryonic world and not subject to disappearing when you turn away.

The entire concept of morphic fields as the "strange attractor" of scalar coherent domains (SCD) is that their unique attractive potential comes from the theory that these fields are made of dark matter/dark energy. They seem to freely flow between the interface of this baryonic/dark matter zone as a formative structure of both morphogenetic and biocognitive fields. Which, through Entanglement (EPR), connect with a vast reservoir of information stored in some as yet unknown way, like a vast "cosmic database", within the predominant DM/DE zone. This allows CDMFF's to carry or transfer information needed to produce form, function and life. This information retains previous evolutionary trial and error messages which have proven successful in similar environments in the cosmic past. It is the gravitational effects at multiple scales of that extreme gravity of DM/DE that produces the local curvature of space-time creating the accretion phenomena that starts the accumulations of needed virtual particles at all scales which attract information archetypes by resonant fluctuations of the fabric of space-time producing the needed scalar coherent domains (SCD) that starts and eventually builds the correct atom, the molecule and ultimately the correct form as directed by the memory of nature. Through a process much like the theory of the "collective unconscious" Carl Jung predicted and wrote about in the early 1900's. (See my paper on Mind Fields) https://globaljournals.org/GJSFR_Volume18/4-Mind-Fields-Consciousness.pdf

What I have found is that the Cosmic Dark Matter Fractal Field Theory comes closer to achieving unification than any theory currently under consideration and the only one that incorporates the long forgotten misplaced life force seemingly ignored in this quest.

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How could any theory that leaves out life claim to be the Theory of Everything? I leave the conclusion to those that take the time to research such important discoveries and my hope is you will take time to study the full presentation of this theory which now includes six papers all published by GJSFR all derived from the now published book "The Great Cosmic Sea of Reality the Dark Matter Fractal Field Theory". The accretion of scalar coherent domains seems to be the best place to experimentally prove the presence of Dark Matter Morphic Fields as there must be a very small and very large general relativity scalar curving of space-time involved at the micro/macro-scalar levels producing first cause of cosmic birth of our reality at all scales in our baryonic world. However, gravity is such a weak force at small scales it will be a monumental task. This ability to evaluate the General Relativity effects at quantum scales may well be within our reach soon with the developing of quantum computing technology.

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# Macroscopic Crystallization of Magnetic Moments in the Ferrite Rings

By F. F. Mende

*Abstract-* Ferrite is soft-iron material and therefore it cannot be magnetized. However, the rings, made from ferrite, can be magnetized in the assigned direction. This special feature of the magnetization of such rings did not have, until now, of physical substantiation. In the article are examined the processes of the magnetization of the models of different configuration, including annular. It is shown that the magnetization of ferrite rings can be considered as the forced crystallization of magnetic moments.

*Keywords: magnetic field, magnetic moment, ferromagnetic material, ferrite, magnetic bubble.*

*GJSFR-A Classification: FOR Code: 020404*

# Macroscopic Crystallization of Magnetic Moments in the Ferrite Rings

F. F. Mende

*Abstract-* Ferrite is soft-iron material and therefore it cannot be magnetized. However, the rings, made from ferrite, can be magnetized in the assigned direction. This special feature of the magnetization of such rings did not have, until now, of physical substantiation. In the article are examined the processes of the magnetization of the models of different configuration, including annular. It is shown that the magnetization of ferrite rings can be considered as the forced crystallization of magnetic moments.

*Keywords: magnetic field, magnetic moment, ferromagnetic material, ferrite, magnetic bubble.*

## I. Introduction

Soft-iron materials these are the materials, which possess the properties the ferromagnetic material or the ferrimagnet, moreover of them the coercive force by the induction comprises not more than 4 kA/m. Such materials also possess the high by magnetic permeability and by low losses on hysteresis. In connection with the smallness of coercive force such materials cannot be magnetized and lose magnetization after the removal from them of magnetic field.

Soft-iron materials are used as the cores the transformers, electromagnets, in the meters and in other cases, where it is necessary with the smallest expenditure of energy to reach the greatest the induction. For decreasing the losses on the eddy currents in the transformers soft-iron materials with that increased are used they are commonly used, by resistivity in the form magnetic circuits, the assembled from separate isolated from each other thin sheets. Sheets are insulated by varnish from each other. This performance of core is called charged.

The soft-iron materials include ferrites, which possess high specific resistance, and they can work at the high frequencies.

However, from the above-indicated rule there are exception. It occurs that the rings, made from soft-iron materials, they can be magnetized, preserving in itself the magnetic induction, with which magnetic lines of force compose the annular circles, inserted in the material of ring. In this case depending on the prehistory of magnetization the direction of magnetic lines of force can be directed both to one and to other side.

The idea of the memory unit in the form of ferrite core matrix for the first time arose in 1945 to the year u John Prespera Ekerta, its report widely circulated among the American computer specialists. In 1949 to the year Van An and In Vo Vaydun - the young colleagues Harvard University Chinese origin- they invented the shift register on the magnetic cores (Van named it pulse transfer controlling device) and the principle "record - readout- restoration", which made it possible to use cores, whose process of readout destroys information. In October 1949 the year of Vans it gave patent application, and was obtained it in 1955 the year [1]. To the middle of the 1950 of past century the magnetic-core storage already received wide acceptance. Van gave to the law court to IBM, and IBM it was necessary to redeem patent in Van after $500 000.

Meanwhile, Jay Forrester in Massachusetts Institute of Technology it worked at the computer system Whirlwind ("Vortex"). In 1949 the year, just as in Van, in Forrester arose the idea about the magnetic-core storage. According to the assertions of Forrester himself, it arrived at this solution independent of Van. In March 1950 the year Forrester with his command developed the ferrite memory, which works according to the principle of the agreement of currents; the proposed by them diagram with four sensing wires - X, Y, prohibition - became conventional. In May 1951 the year Forrester gave patent application, and was obtained it in 1956 the year [2].

## II. Properties Of Ferrite Cores And Their Use As The Memory Elements

The physical properties of ferrite cores are critically important for the functioning of memory; therefore it is very important to understand them. The diagram of the functioning of memory element on the ferrite core is depicted in Fig. 1.

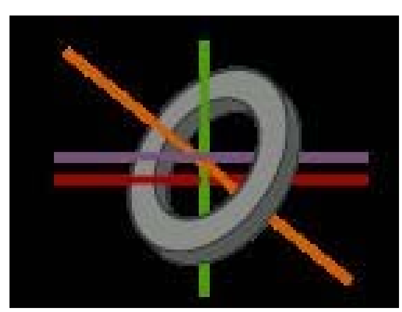

*Fig. 1:* Diagram of the functioning of memory element on the ferrite core

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The conductors, passing through the core, have the following designation: X, *Y,* - the wire of excitation, *S* - readout, *Z* - prohibition.

If heavy current is passed along the wire through the core, then core will be magnetized in accordance with the direction of flow (on to the right-hand rule ). Current in one direction will write down into the core "unit", current will in the opposite direction cause opposite magnetization and will write down into the core "zero".

The very important parameter of core is its giserezis: current must exceed the specific threshold in order to influence the magnetization of core. Low current will show no effect, but the current of higher than the specific threshold will lead to the passage into the magnetized state in accordance with the direction of flow.

The property of hysteresis makes the selection of concrete core in the memory system possible. "Half" current is sent along the appropriate wire of excitation X, and "Half" current - on the appropriate wire of the excitationY. Thus, only this only core among thousands of rest will obtain the current, sufficient for changing its state.

Last important property consists in the fact that when the core changes the direction of magnetization, it induces current in the sensing wire, passing through this core. If the direction of magnetization does not change, then there is no current there. This induced current is used for the readout of the state of the bit of memory. As consequence, with the readout of information from the core information is erased and must be rewritten. In Fig. 2 is depicted memory matrix on the magnetic cores.

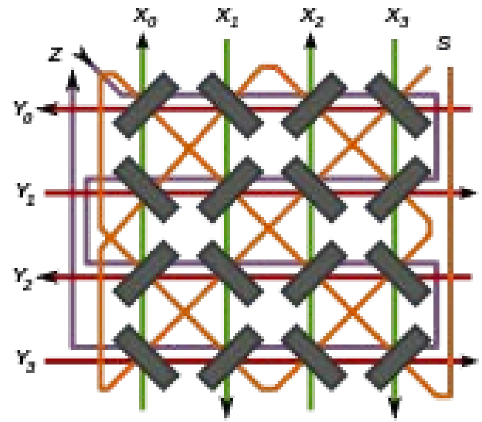


*Fig. 2:* Memory matrix on the magnetic cores

Memory elements on the magnetic cores received wide acceptance in the 60- tenth years of past century. The matrices of ferrite memory and their use in the composition of computers are depicted in Fig. (3-5).

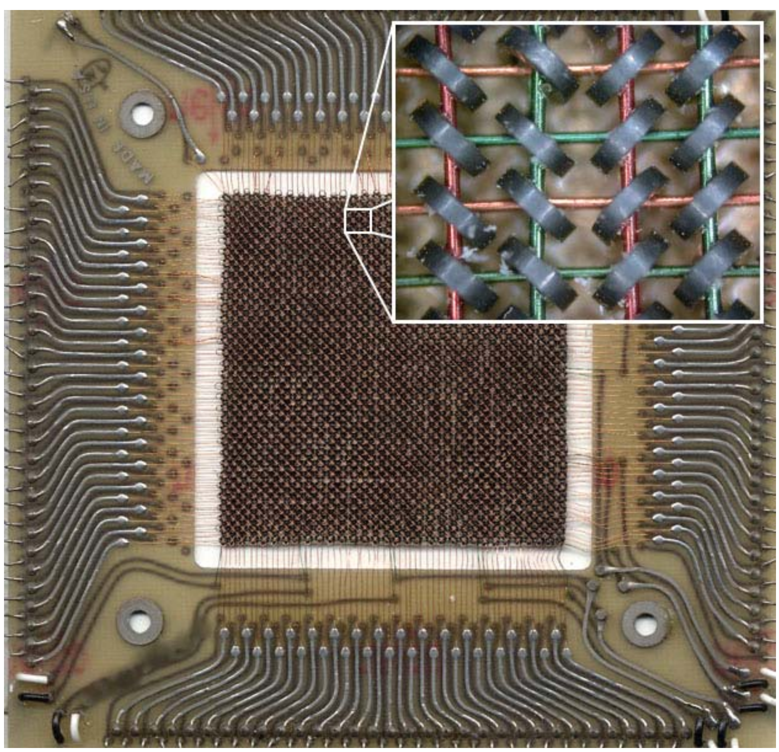

*Fig. 3:* Matrix of the ferrite memory of the super-computer CDC 6600 (1964). Size 10,8×10,8cm, the capacity 4096 the bit

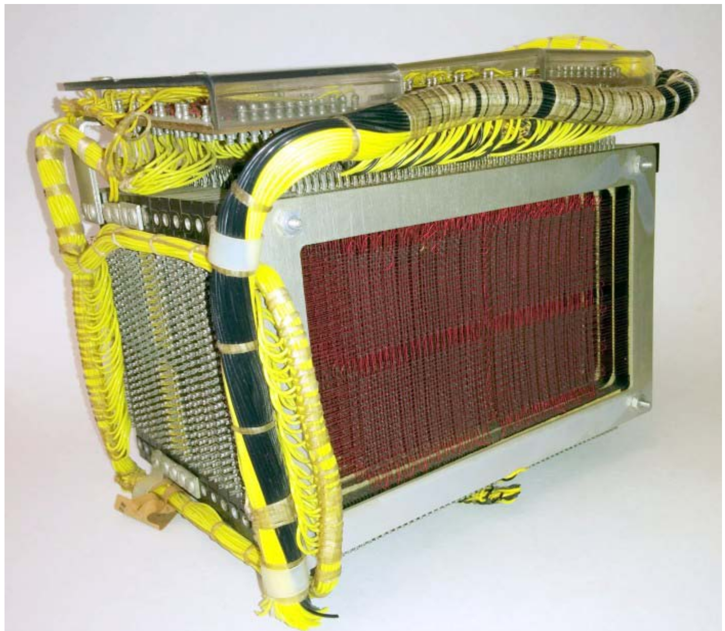

*Fig. 4:* Module of ferrite memory on 4000 symbols in meynfreyme IBM 1401

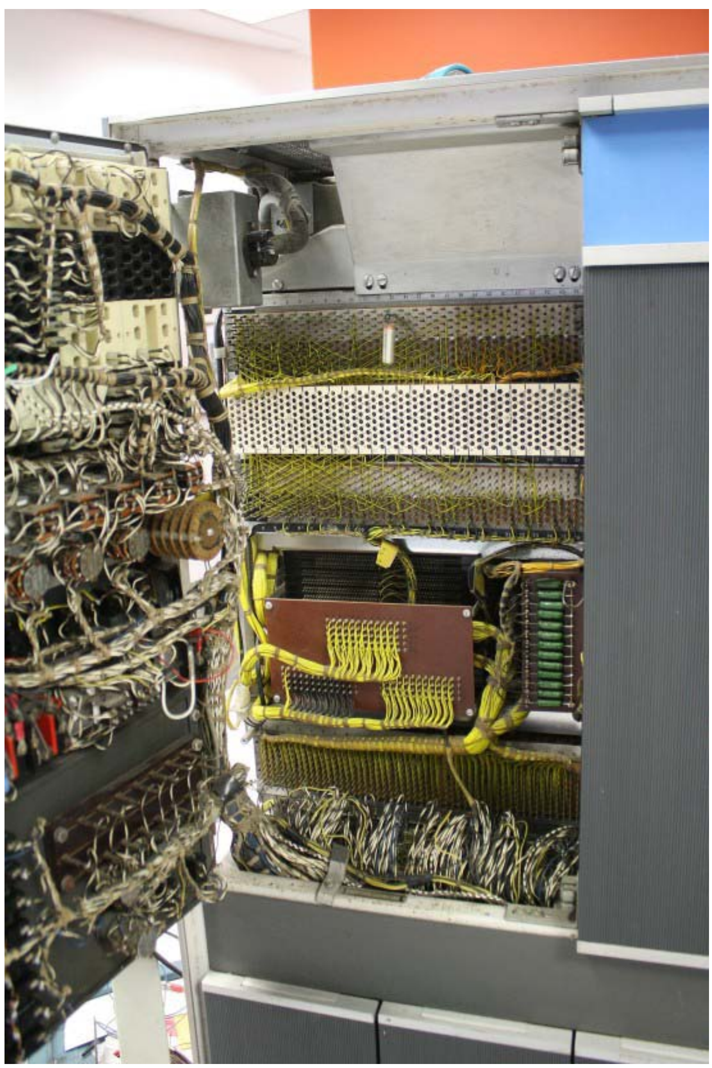

*Fig. 5:* Module of magnetic-core storage (in the center) on meynfreyme 1401

Meynfreym IBM 1401 was developed in 1959 the year, and it became to the middle of the 60th by the most popular computer in the world, considerably anticipating competitors. Special demand it enjoyed in the average and large business, in view of its cheapness. The key factor of success 1401 was its magnetic-core storage (ferrite memory) on 4000 the symbols, where the data were stored on the tiny ferrite rings.

It should be noted that, until now, it is not clear in conclusion, why the ferrite cores, made from soft-iron material, can be magnetized in the determinate direction and the physical mechanism of this process, until now, is not opened.

## III. Self-Induction And Energy Of The Magnetic field

Self-induction it is an important special case of the electromagnetic induction, when the changing magnetic flux, which causes the electromotive force (EMF) of induction, is created by current in the outline itself. If current in the outline for some reasons in question changes, then changes the magnetic field of this current, and, therefore, also its own magnetic flux, which penetrates outline. In the outline appears emf of self-induction, which accordingly to Lentz's rule it prevents a change of the current in the outline.

Its own the magnetic flux Φ, the penetrating outline or coil with the current, is proportional to current strength *I*:

$$\Phi = LI \ .$$

Constant of proportionality *L* in this formula it is called by the coefficient of the self-induction or by the inductance coil. As an example let us calculate the inductance of the long solenoid, which has, *N* turns, sectional area *S* and the length *l*. The magnetic field of solenoid is determined by the formula

$$B = \mu_0 n I \ ,$$

where *I* – current in the solenoid, $n = N/l$ - the number of turns per unit of the length of solenoid.

Magnetic flux, which penetrates everything *N* the turns of solenoid, it is equal

$$\Phi = BSN = \mu_0 n^2 S l I \ .$$

Consequently, the inductance of solenoid is equal

$$L = \mu_0 n^2 S l = \mu_0 n^2 V \ ,$$

where $V = Sl$ – the volume of the solenoid, in which is concentrated the magnetic field. The obtained result does not consider edge effects; therefore it is approximately valid only for the sufficiently long solenoids. If solenoid is filled with substance s by magnetic permeability μ, that with the assigned current *I* the induction of magnetic field grows on the module μ ; therefore the inductance of coil with the core also increases μ :

$$L_\mu = \mu L = \mu_0 \mu n^2 V \ .$$

EMF of self-induction, appearing in the coil with the constant value of inductance, accordingly Faraday law it is equal

$$EMF_{ind} = EMF_L = -\frac{\Delta\Phi}{\Delta t} = -L\frac{\Delta I}{\Delta t} \ .$$

Magnetic field possesses energy. Similarly, as in the charged capacitor there is it stored up electrical energy, in the coil, over turns of which the current flows, there is it stored up magnetic energy. If we switch on electric lamp in parallel to coil with the large inductance in the electrical direct-current circuit, then with breaking of key is observed short-term flash lamp (Fig. 6). Current in circuit appears under the action emf of self-induction. The source of the energy, which separates in this case in the electrical chain, the magnetic field of coil is.

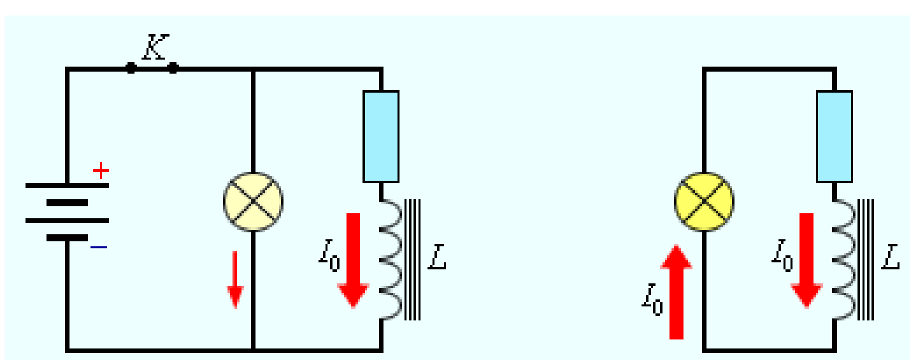


*Fig. 6:* With closing of key k the lamp vividly flares up

It follows from the law of conservation of energy that entire energy, stored up in the coil, will be isolated in the form Joule heat. If we designate through *R* the impedance of chain, then in the time $\Delta t$ a quantity of the heat will be isolated $\Delta Q = I^2 R \Delta t$ .

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Current in circuit is equal

$$I = \frac{EMF_L}{R} = -\frac{L}{R}\frac{\Delta I}{\Delta t}.$$

Expression for $\Delta Q$ it is possible to write down in the form

$$\Delta Q = -LI\Delta I = -\Phi(I)\Delta I.$$

In this expression $\Delta I < 0$, and current in circuit gradually diminishes from the initial value $I_0$ to zero. A total quantity of heat, which was isolated in the chain, can be obtained, after performing the operation of integration in the limits from $I_0$ to zero. This it gives

$$Q = \frac{LI_0^2}{2}.$$

Thus, the energy $W_M$ the magnetic field of coil with the inductance $L$, created by the current $I$, it is equal

$$W_M = \frac{\Phi I}{2} = \frac{LI^2}{2} = \frac{\Phi^2}{2L}.$$

Let us apply the obtained expression for the energy of coil to the long solenoid with the magnetic core. Using the formulas for the coefficient of the self-induction given above

$L_\mu$ solenoid and for the magnetic field $B$, created by the current $I$, it is possible to obtain:

$$W_M = \frac{\mu_0 \mu n^2 I^2}{2} V = \frac{B^2}{2\mu_0\mu} V,$$

where $V$ – the volume of solenoid. This expression shows that magnetic energy is localized not in the turns of the coil, over which the current flows, but it is distributed throughout entire volume, in which is created the magnetic field. Physical quantity

$$W_0 = \frac{B^2}{2\mu_0\mu}$$

equal to energy of magnetic field per unit of volume, is called with the bulk density of the magnetic energy.

## IV. The Mechanical Analog Of The Self-Induction

In the previous division it was shown that the presence of ferromagnetic core in the coil essentially increases its inductance. But physics of this process is nowhere described.

It was considered Until now that energy is determined by those magnetic fields, which are connected with the inductance. Let us describe the mechanism, which explains this phenomenon (Fig. 7).

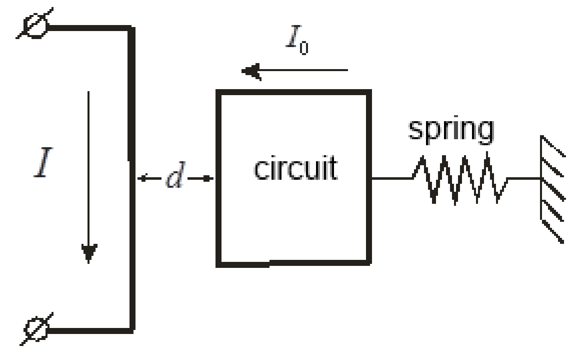


*Fig. 7:* Outline with the frozen current near the conductor, along which flows the current

Let us assume that we have the superconductive outline, in which is frozen the current $I_0$ (which is equivalent to the magnetic moment of atom in the ferromagnetic material), located at a distance $d$ from the conductor, along which flows the current $I$. Outline with the frozen current is fixed with the aid of the spring to the rigid base. If we carry the current through conductor, then outline with the frozen current will begin to it to be attracted, extending spring and thus, stocking in the spring energy. Moreover, the greater the current in the outline will be, the stronger it will be attracted to the wire, and the greater the energy will be accumulated in the spring. Therefore with one and the same values of current in the conductor, the energy, spent for the tension of spring, will be different and there will be it to zavisettakzhe, also, from the current in the short-circuited outline. The system examined is equivalent to inductance with the only difference that energy in this inductance will be equivalent accumulated not in the magnetic field, but in the spring. Moreover inductance in this case will depend also on the distance between the outline and the conductor, and from the current, which flows along the conductor also of the current, frozen in the outline. The characteristic property of the system examined is the fact that the approximation of outline with the frozen current to the wire, along which flows the current, will lead to the excitation it the currents, opposite to initial current. Thus, the resulting current will prove to be less than that current, which would take place in the absence of outline with the frozen current. This behavior of summed current testifies about loading of wire, along which flows the current. If we rapidly turn off current in the outline, then outline with the frozen flow, returning to the previous state, will direct in the conductor emf. This process is equivalent to self-induction.

It is possible to present another form of such an interaction (Fig. 8). For this it is necessary outline with the frozen current to place on the axis, which passes, through its center, and to the axis to fasten the helical spring, which ensures the steady state of outline in the situation, when its conductors are exist equidistantlyed from the conductors of outer ducts. Then with the flow of the current through conductor outline with the frozen current will be turned in that or other side, turning helical spring. In this case in the spring the energy will be accumulated, and the direction of the twisting of spring will depend on direction of flow in the conductor.

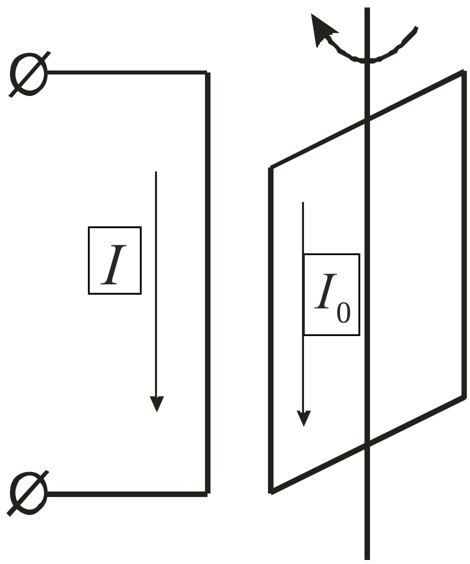


*Fig. 8:* Outline with the frozen current near the conductor, along which flows the current

Until to the ferromagnetic material is superimposed strange external magnetic field, its atoms or the molecules, which represent the microscopic of outline by the szamorozhennym current, they be in the disordered state. This state appears for them it is equilibrium.

Let us take ferrite and will wind winding around it. If we into the winding introduce current, then rod will begin to be magnetized. But external magnetic field as soon as is superimposed on the ferromagnetic material, in it the orientation of magnetic moments along the field begins to occur, on what the energy is expended, since the magnetic moments, located in parallel, are repulsed. But if current in the winding rapidly was turned off, magnetic moments will begin to pass into the initial disordered state and in the winding it will be induced by EMF.

## V. Forced Macroscopic Crystallization Of Magnetic Moments In The Ferrite Rings

As was noted in the division 4, the carried out examination of the processes of self-induction it is approximate, since with this examination were not taken into account the magnetic fields of the scatterings, which be present around the magnetized model (Fig. 9). These fields also possess additional energy and makes a contribution to the general energy of the magnetic field of the magnetized model. Any system is approached the minimization of its free energy and if we roll up the magnetized model into the ring and to magnetize it, then stray fields will be absent. In this case this configuration will correspond to the minimum of free energy. But if we in the magnetized annular model make the clearance, located across the ring, then stray fields there are formed. But since in this case at the opposite ends they are formed the pole of different signs, such of pole will be attracted, attempting to make free energy of the split ring of minimum, attempting to roll up it into the ring.

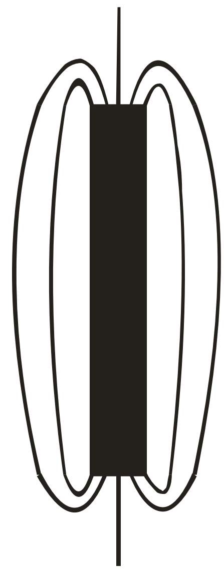

*Fig. 9:* Stray fields of the magnetized model

With this process in the magnetized ferrite ring the magnetic moments will be located in the strictly defined order, and their vector will be directed to one side, as shown in Fig. 10.

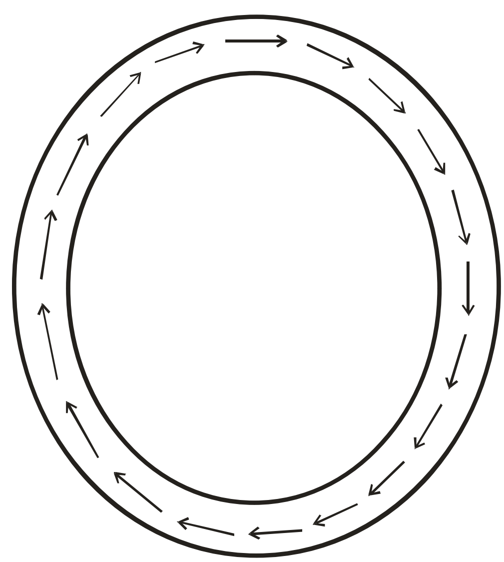

*Fig. 10:* Structure of magnetic moments in the magnetized ferrite ring

In this structure will be absent the stray fields, and structure itself will be steady, since the origin of the previous vector of magnetic moment is attracted the toward the end following vector. This case is very similar to the linear crystallization of atoms in the rod, bent into the ring, with the only difference that atom sites occupy magnetic moments.

If ring was reversed magnetism, then the vector of magnetic moments they change their direction, but their structure will as before remain stable after the removal of magnetizing field.

It is known that in the magnetic crystals also there are microscopic domains, in which the magnetic moments are spontaneously oriented to one side. Domains of exist in ferromagnetic, antiferromagnetic, ferroelectric the crystals and other substances, which possess the spontaneous by the long-range order .

In the ferrite ring the magnetic moments also are located in the determined order; however, this occurs not spontaneously, as it takes place in the magnetic bubbles. The magnetization of ferrite ring bears the goal-directed forced nature, and this process can be named the forced macroscopic crystallization of magnetic moments.

## VI. Conclusion

Ferrite is soft-iron material and therefore it cannot be magnetized. However, the rings, made from ferrite, can be magnetized in the assigned direction. This special feature of the magnetization of such rings did not have, until now, of physical substantiation. In the article are examined the processes of the magnetization of the models of different configuration, including annular. It is shown that the magnetization of ferrite rings can be considered as the forced crystallization of magnetic moments.

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# About Structural Identifiability of Nonlinear Dynamic Systems under Uncertainty

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*Abstract-* Approach to the analysis of nonlinear dynamic systems structural identifiability (SI) under uncertainty is proposed. This approach has a difference from methods applied to SI estimation of dynamic systems in the parametrical space. Structural identifiability is interpreted as of the structural identification possibility a system nonlinear part. We show that the input should synchronize the system for the SI problem solution. The structural identifiability estimation method is based on the analysis of the framework special class. The input parameter effect on the possibility of the SI estimation of the system is studied.

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## I. Introduction

The identification problem of dynamic systems despite the set of obtained results is one of important study directions. Fundamental results are obtained on a system parametrical identification. An approach to the identifiability estimation is based on R. Kallman ideas [1]. Further development of these ideas is given in [2, 3]. R. Li [2] gives the following identifiability definition.

Consider the system

$$\begin{aligned} X_{n+1} &= AX_n, \\ y_n &= C^T X_n, \end{aligned} \quad , \qquad (1)$$

where $X_n \in R^m$ is a state, $A \in R^{m\times m}$, $y_n \in R$ is an exit, $n = J_n = [0, N]$ is the discrete time.

*Task:* Determine by conditions under what the system is identified on the basis of the set

$$\mathrm{I}_o = \left\{ y_n, n = \overline{0, N}, N < \infty \right\}. \qquad (2)$$

Following sufficient and necessary conditions are obtained in [2] when $y_n \in R^m$.

*Definition 1:* The system described by the equation (1) is called $n$-identified if the matrix $A$ is possible to determine based on measurement of the variable $X$.

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*Definition 2:* The system described by the equation (1) is called 1-identified if the matrix $A$ is possible to determine on the basis of measurement $y$.

The $n$-identifiability condition consists in that the matrix $\left[ X_0 \mid AX_0 \mid A^2X_0 \mid \dots \mid A^{m-1}X_0 \right]$ was nondegenerate.

*1-identifiability conditions:*

1. The system (1) is $n$-identified.
2. The pair $(A, C)$ is observable.

The identifiability case when the dynamic system order is less $m$ is considered in [2].

The considered result analysis shows that the identifiability estimation of the system (1) consists in the possibility of parameters identification. Call a parametrical identifiability IP-identifiability (IPI). The publication set is devoted to the research IPI. The difference between these studies and the approach stated in [2] consists that identifiability results present in the form accepted in parametrical estimation problems. In [4] the concept of the structural identifiability is introduced.

Let two dynamic systems $S_1(U_1, Y_1, A_1)$, $S_2(U_2, Y_2, A_2)$ are considered with inputs $U_1, U_2$, outputs $Y_1, Y_2$ and parameters $A_1, A_2$. It corresponds to models $\mathcal{M}_1\left(U_1, \hat{Y}_1, \hat{A}_1\right)$ and $\mathcal{M}_2\left(U_2, \hat{Y}_2, \hat{A}_2\right)$.

*Definition 3: [4]* If the condition $\mathcal{M}_1\left(\hat{A}_1\right) \approx \mathcal{M}_2\left(\hat{A}_2\right)$ is satisfied at $U_1 = U_2$, $Y_1 = Y_2$ and $\hat{A}_1 \neq \hat{A}_2$, then models are indistinguishable on observed inputs and outputs.

*Definition 4: [4]* A parameter $\hat{a}_{1,i} \in \hat{A}_1$ is called structurally globally identified if the condition

$$\mathcal{M}_1\left(\hat{A}_1\right) \approx \mathcal{M}_2\left(\hat{A}_2\right) \Rightarrow \hat{a}_{1,i} = \hat{a}_{2,i}$$

is satisfied almost for any $\hat{A}_2 \in \Omega_P$ (except a zero measure subset of parametrical space $\Omega_P$).

*Definition 5 [4]:* Parameter $\hat{a}_{1,i} \in \hat{A}_1$ is called structurally locally identified if such neighbourhood $O_2\left(\hat{A}_2\right)$ exists almost for any $\hat{A}_2 \in \Omega_P$ that

$$\mathcal{M}_1\left(\hat{A}_1\right) \approx \mathcal{M}_2\left(\hat{A}_2\right) \Rightarrow \hat{a}_{1,i} = \hat{a}_{2,i}$$

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follows from the condition $\hat{A}_1 \in O_2\left(\hat{A}_2\right)$.

The local identifiability is a necessary condition for the global identifiability. A parameter is called structurally globally identified if it is structurally locally identified and at the same time it is not structurally globally identified. A parameter which is not structurally locally identified is called structurally locally not identified. Different approaches and methods are applied for structural identifiability verification [5, 6].

In [7] a concept of local parametrical identifiability is introduced and given it's the theoretical justification. Consider the system described by the vector differential equation

$$\dot{X} = F(t, X, P), \quad X\left(t_0\right) = X_0, \qquad (3)$$

where $X_n \in R^m$ is a system state, $P \in R^m$ is a parameter vector, $F(\cdot)$ is a nonlinear vector-function.

*Definition 6:* The system (3) is called locally identified in a point $P_0 \in W$ if such $\varepsilon > 0$ exist that couple $\{P_0, P_1\}$ is distinguishable for any point $P_1$ such that $0 < \|P_1 - P_0\| < \varepsilon$.

*Remark 1:* System structure estimation methods are not considered in most papers. Therefore, the structural identifiability concept does not reflect the essence of the considered problem. As this terminology is actively applied in identifiability estimation problems, in this section we will hold to this concept. Further, we will introduce a concept which is directly related to the structural identifiability of nonlinear systems in the structural space.

Criteria are proposed in [7] for the local identifiability estimation of the linearized system (3). The case is considered when the matrix rank is equal $m$. The local identifiability estimation method based on the Lyapunov exponent analysis is proposed for an inhomogeneous linear system. Parametrical identifiability criteria are introduced in [8], and also generalization and development of results obtained in [7] are given. Full identifiability conditions are proposed in [9, 10] for a linear stationary system on discrete measurements of an output and of state variables.

The IPI-identifiability problem of nonlinear systems was studied by many authors (see e.g., [9-12]). The identifiability research in [10] is based on the sensitivity system analysis on the output system. This approach efficiency is illustrated in the example of the identifiability estimation of system parameter combination. This approach gives a new method the local identifiability problem solution. Local parametrical identifiability conditions are obtained in [9] for different variants of the experimental data measurement. Conditions of a joint observability and the identifiability are obtained for the linear stationary system. The critical analysis of the approaches applied to the biological model identifiability estimation is given in [11]. Models for the nonlinear system identifiability estimation are proposed on the basis of the expansion into Taylor series, tables of identifiability (contains nonzero members of Jacobian coefficients row), the algebra of differentials. Paper [12] is devoted to the practical identifiability study. Practical identifiability estimation is based on the experimental information analysis and the differential algebra application. The basis of the practical identifiability is the least-squares method and the model sensitivity analysis to the obtained parameter estimations. The proposed approach is applied to biology problems.

The identifiability of a static model is considered in [13]. The model is described by a system of the simultaneous equations

$$BY_n + \Gamma X_n = U_n, \qquad (4)$$

where $B \in R^{m \times m}$ is a nonsingular matrix, $X_n \in R^k$ is an exogenous vector (external) variables, $U_n \in R^m$ is a vector of external random disturbances, $Y_n \in R^m$ is a vector of endogenous variables, $\Gamma \in R^{m \times k}$.

The a priori information is about external and internal variables, an accidental character $U_t$, restrictions on coefficients and the variable normalization rule.

Consider the structure $S = \left(B, \Gamma, M_n\right)$ of the model (4) where $M_U$ is a distribution $U_t$. Then $Y_n$ at specified $X_n$ have a distribution $P_n^S$.

*Definition 7:* If $P_n^S = P_n^{\tilde{S}}$, then frameworks $S$, $\tilde{S}$ are observably equivalent.

*Definition 8:* A parameter $\Lambda$ is called identified in the framework $S$ if $\Lambda = \tilde{\Lambda}$ is true for any a framework equivalent $\tilde{S}$.

So, the parameter $\Lambda$ is identified if $\Lambda = \tilde{\Lambda}$ follows from equality $P_n^S = P_n^{\tilde{S}}$ ($n = 1, 2, \ldots, N$).

*Definition 9:* The structure $S$ is called identified if all its parameters are identified.

In [13] various cases of the a priori information accounting about $S$ are considered and identifiability conditions obtained. They are restrictions on the rank of a matrix, depending on variables the system (4) which is previously subject to a normalization. The normalization is the solution of the equation (4) concerning $Y_n$.

*Remark 2:* In spite of the fact that the system (4) is static, its identifiability is interesting in the problem definition form. Here the concept structure is used also. Therefore, the existing interpretations and problem statements of the SI will be useful to compare.

So, the analysis of publications shows that the model identifiability is the estimation possibility of its parameters. The proposed methods are based on the non-degeneracy estimation of an informational matrix. Similar results are obtained in the parametrical estimation theory, and non-degeneracy condition (rank completeness) of the informational matrix is presented in easily checked the excitation constancy condition of the input and of the output system. As a rule, the model structure is specified a priori and the sense of the structural local identifiability is understandable not always. The structure concept is widely applied in identifiability estimation problems. The nonlinear system identifiability also is transformed into the parametrical identifiability problem on the basis of the different methods linearization model application on parameters. These researches extensive area does not include the structural identifiability problem of nonlinear dynamic systems in the following sense: whether have the problem decision of the structure (a form, dependence) estimation a system nonlinear part under uncertainty. The task not set was in this form.

Identifiability structural aspects of the nonlinear system are considered in such statement in this paper. This is the very complex problem as structure formalization methods of the system are not developed. The concept of the structural identifiability ($h$-identifiability) was introduced in [14] for nonlinear systems. The proposed approach is directed to the structure estimation problem solution of the dynamic system nonlinear part. It is based on the analysis of the framework reflecting the state of the system nonlinear part. Below we give a generalization of results obtained in [14, 15] on the $h$-identifiability. The IPI-identifiability problem is not considered. It's the decision can be obtained, having applied approaches considered above.

The paper has the following structure. The problem statement is given in the second section. The framework design method is stated in section three. The approach is described to the formation of a set for the construction $S_{ey}$-framework. Framework class properties are considered. Estimation need of the nonlinear system $h$-identifiability is substantiated in section four. System examples with a hysteresis are considered and the input parameters effect is analyzed on system nonlinear part properties. We will show that the input has to be constantly excited. But not every input that has excitation constancy property, gives the solution of the structural identifiability problem. Nonlinear system $h$-identifiability (structural identifiability) basis are stated in sections 5, 6. We introduce the concept of a system S-synchronization which the fulfillment allows solving the problem $h$-identifiability. The input which does not have property the S-synchronizability property gives to an "insignificant" $S_{ey}$-framework. Structural identifiability estimation methods are considered. We show that the $h$-identified framework $S_{ey}$ have the specified dimension. Numerical modeling results are presented in section 7.

## II. Problem Statement

Consider dynamic system

$$\dot{X} = AX + B_{\varphi}\varphi(y) + B_u u, \quad y = C^T X, \tag{5}$$

where $u \in R$, $y \in R$ are the input and the output, $A \in R^{q\times q}$; $B_u \in R^q$, $B_{\varphi} \in R^q$ $C \in R^q$ are matrices of corresponding dimensions; $\varphi(y)$ is a scalar nonlinear function. $A$ is the Hurwitz matrix.

Various assumptions are made concerning the function $\chi = \varphi(y)$ structure. They are determined by the a priori information level. Methods based on linearization procedures [16] can be applied under the a priori information. The assumption concerning the function $\chi$ is specified in the absolute stability theory in the form

$$\chi \in \mathcal{F}_{\varphi} = \left\{\varphi(\xi)\xi \ge \xi^2,\ \xi \ne 0,\ \varphi(0) = 0\right\}, \tag{6}$$

where $\xi \in R$ is the input of a nonlinear element.

$\xi$ is the linear combination of vector elements $X$. Further generalization (6) is the sector condition

$$\chi \in \mathcal{F}_{\varphi} = \left\{\gamma_1\xi^2 \le \varphi(\xi)\xi \le \gamma_2\xi^2,\ \xi \ne 0,\ \varphi(0) = 0,\ \gamma_1 \ge 0, \gamma_2 < \infty\right\}. \tag{7}$$

Often the system (5) nonlinear part is described by static (algebraic) equations. Therefore, further, we consider a case when $\varphi(y)$ is described by the algebraic equation. We believe that the function $\varphi(y)$ is smooth.

Let the informational set be known for the system (5)

$$\mathrm{I}_o = \left\{u(t), y(t),\ t \in J = [t_0, t_k]\right\}. \tag{8}$$

*Problem:* Estimate the structural identifiability of the system (5) nonlinear part on the basis of the analysis and processing $\mathrm{I}_o$.

Identification parametrical methods application under uncertainty does not allow obtaining the SI problem solution. Therefore, we apply to the structural identification the approach proposed in [15, 16]. It is based on the transition in a special structural space and design of the framework $S_{ey}$ reflecting properties of the nonlinear part (5). The analysis is associated with the system structural identifiability problem solution. We use the term $h$-identifiability (HI) that to distinguish the proposed approach from IPI-identifiability. Describe the design method $S_{ey}$-framework.

## III. Design Method $S_{ey}$-Framework

Design $S_{ey}$-framework demands the preliminary formation of the set $I_{N,g}$ containing an information on the function $\varphi(y)$. Describe to the obtaining $I_{N,g}$ method following [18].

*a) Set for Formation $S_{ey}$-framework*

Apply the differentiation operation to $y(t)$ and designate the obtained variable as $x_1$. The account $x_1$ expands of the system informational set: $I_{ent}=\{I_o, x_1\}$.

*Remark 3:* If variables $u$, $y$ are measured with an error then apply to $u$, $y$ the filtering procedure.

Allocate a subset $I_g \subset I_{ent}$ corresponding to the system (5) particular solution (steady state). The set does not contain data $I_{tr}$ on the transition process in the system. Apply the mathematical model

$$\hat{x}_1^l(t) = H^T \left[1\ u(t)\ y(t)\right]^T \tag{9}$$

for the selection of the linear component in $x_1$. The variable $x_1$ is defined on an interval $J_g = J \setminus J_{tr}$. $H \in R^3$ is the model parameter vector.
Determine by the vector $H$ as the task solution

$$\min_H Q(e)\Big|_{e=\hat{x}_1^l - x_1} \to H_{opt}.$$

where $Q(e)=0.5e^2$.

Find by the prediction for the variable $x_1$ on the basis of the model (9) and obtain the error $e(t)=\hat{x}_1^l(t)-x_1(t)$. $e(t)$ depends on the nonlinearity $\varphi(y)$ of the system (5). So, the set

$$I_{N,g} = \{y(t),\ e(t)\ \ t \in J_g\}$$

is obtained. Next, we apply the designation $y(t)$ believing that $y(t) \in I_{N,g}$.

*Remark 4:* The structure model (9) choice is the system (5) structural identification stage. Modeling results show that the model (9) is applicable in identification system objects with static nonlinearities. The structure model (9) choice is described in [14] for more complex nonlinearity class.

*b) Frameworks $S_{ey}$*

Application of the phase portrait $S$ described by function $\Gamma:\{y\}\to\{y'\}$ not always the conclusion allows making about system nonlinear properties under uncertainty. Therefore, apply the set $I_{N,g}$ and go in the space $\mathcal{P}_{ye}=(y,e)$ which we will call structural.

Consider the function $\Gamma_{ey}:\{y\}\to\{e\}$ which describes the framework $S_{ey}$ change on the plane $(y,e)$. $I_{N,g}$ contains an information on $\varphi(y)$ therefore, $S_{ey}$ describe the nonlinear function change in a generalized form. The system (5) input has to satisfy certain conditions for the representation obtaining of $\varphi(y)$. It is the excitation constancy property. Such input gives to the closed framework $S_{ey}$.

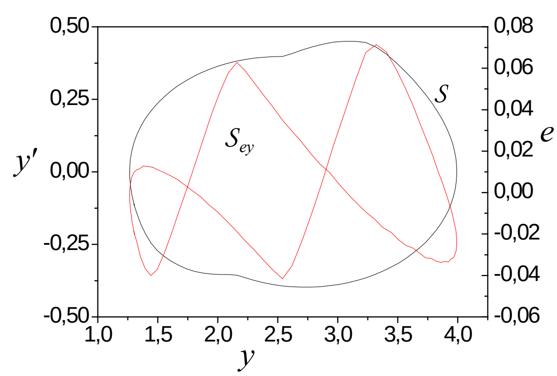
## IV. About Need For Nonlinear System Identifiability Estimation

The paper review on the SI shows that the main attention is given to the IP-identifiability problem. To the urgency of $h$-identifiability problem understands consider arising problems on the example of the second order system (5) with parameters:

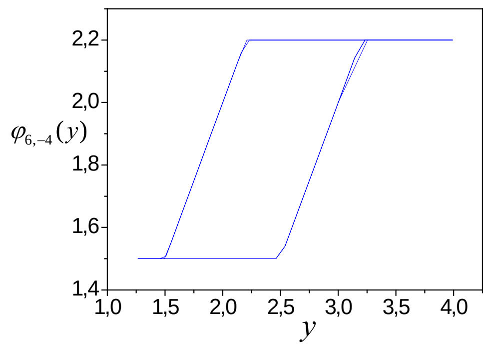
$$A=\begin{bmatrix}0 & 1\\ -3 & -4\end{bmatrix},\ B_u = B_\varphi = \begin{bmatrix}0\\1\end{bmatrix},\ y(0)=3, y'(0)=2,$$

$$\varphi(y)=\begin{cases}2.2 & \text{if } (y-d>2.2)\&(y'>0),\\ y-d & \text{if } (y-d\le 2.2)\&(y'>0),\\ 1.5 & \text{if } (y-d\le 1.5)\&(y'>0),\\ 2.2 & \text{if } (y>2.2)\&(y'<0),\\ y & \text{if } (y\le 2.2)\&(y'<0),\\ 1.5 & \text{if } (y\le 1.5)\&(y'<0),\end{cases} \quad d=1.$$

Results presented below are based on the application of the approach from section 3. They show the input $u(t)$ influence on system (5) nonlinear properties. System properties are estimated on the basis of the framework $S_{ey}$ analysis and the recovered function $\varphi(y)$ corresponding to the input $u(t)$ is presented.



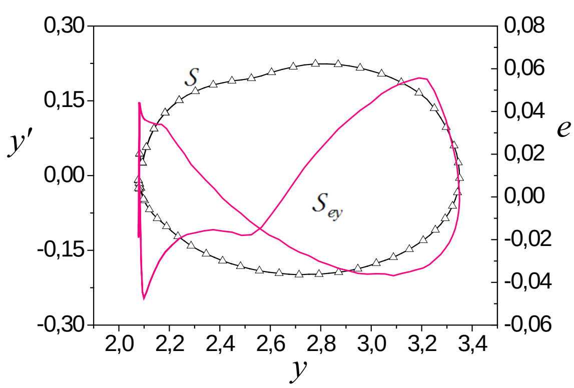

a) frameworks



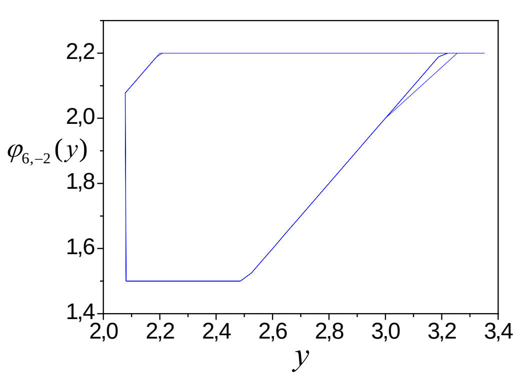

b) nonlinearity

*Fig. 1:* Structure estimation results for $u_{6,-4}(t)$

Fig. 1 represents the phase portrait $S$ and the framework $S_{ey}$ for $u_{6,-4}(t)=6-4\sin(0.1\pi t)$, and also the function $\varphi(y)$ recovered from data $\{y(t),y'(t)\}$. We consider the case of the established motion. Fig. 1 shows that $u_{6,-4}(t)$ give to reference function $\varphi(y)$. The framework $S_{ey}$ is almost symmetric and has features which are also in the framework $S$.




a) frameworks




b) nonlinearity

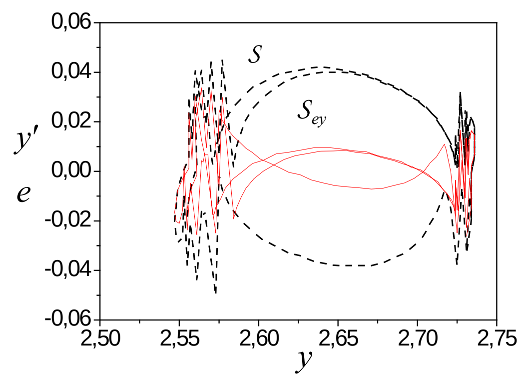
*Fig. 2:* Structure estimation results for $u_{6,-2}(t)$

The further decrease of the sinusoid amplitude gives to the loss of the framework $S_{ey}$ symmetry feature. The restoration impossibility of the form function $\varphi(y)$ is the result of such input property. It shows the case presented in Fig. 2 when $u_{6,-2}(t)=6-2\sin(0.1\pi t)$. We see that the sinusoid amplitude decrease gives to framework definition range compression, and the framework left part have more active changes. It gives function $\varphi_{6,-2}(y)$ saturation area reduction. This area is not recovered by the identification method application. More cardinal changes in $\varphi(y)$ gives the use

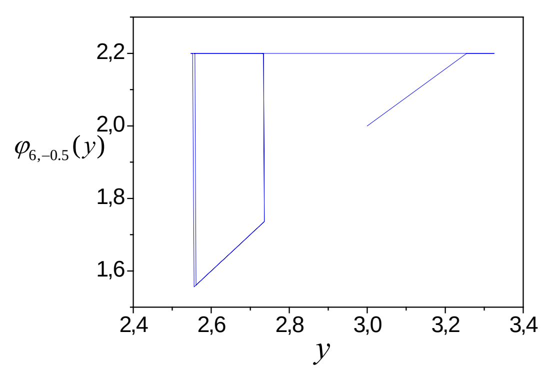
$$u_{6,-0.5}(t)=6-0.5\sin(0.1\pi t).$$

Corresponding results are shown in Fig. 3.

The modeling result analysis shows that there is some parameter set of the input $u(t)$ at which the structural identifiability (structural identification) of the nonlinear system is possible. These results are presented for the system with $\omega=0.1\pi$ in Fig. 4 where following designations are used: $D_y$, $D_e$ are diameters of the variation domain $y$, $e$; $a_u$ is the sine amplitude.




a) frameworks




b) nonlinearity

*Fig. 3:* Structure estimation results for $u_{6,-0.5}(t)$

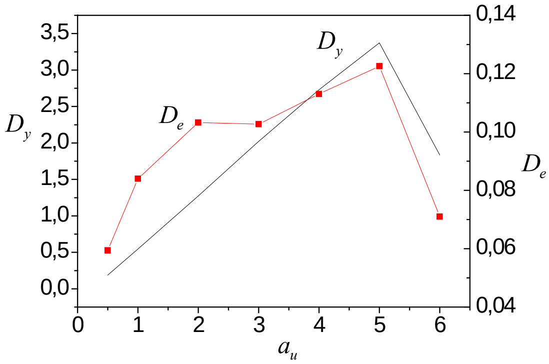
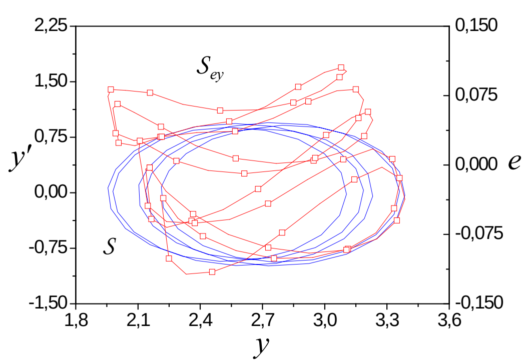



*Fig. 4:* Input amplitude effect on the system (5) identifiability

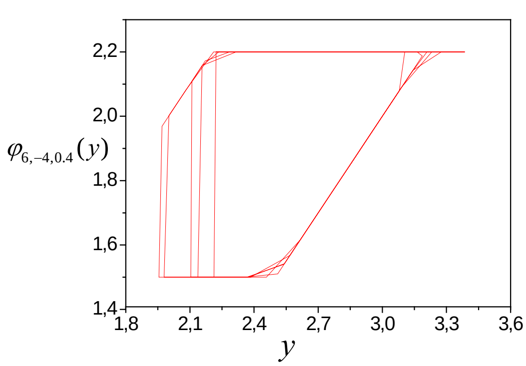
Fig. 4 shows that for the input ($a_u = 5$) which the system SI problem solves exist. The system (5) (see Fig. 1) is identified with the input having the amplitude $a_u = 4$.

We considered the input amplitude effect on system features. Similar the effect gives to the frequency influence (Fig. 5).

*Remark 5:* Modeling results show (Fig. 5) that ensuring the excitation constancy (EC) condition for $u(t)$ can complicate the system $h$-identifiability estimation. Results presented in Figures show that the requirements to the input EC have in structural and parametrical identification problems the essential distinction. It should be taking into consideration in active identification problems.




a) frameworks




b) nonlinearity

*Fig. 5:* Structure estimation results for $u_{6,-4,0.4}(t)$

Modeling results allow giving to $h$-identifiability problem statement as the following task solution: find such an input $u(t)$ for the system (5) which gives the definition range maximum for the output $y(t)$.

## V. $h$-Identifiability

Results obtained in section 4 show that methods applied to the IP-identifiability estimation do not work in the case the $h$-identifiability). Further, we state to the approach to HI estimation proposed in [18].

First, consider properties of the set $\mathrm{I}_{N,g}$ allowing the problem $h$-identifiability to solve. The analysis $\mathrm{I}_{N,g}$ gives to the informational set $\mathrm{I}_o$ important properties determining the further consideration of this problem.

Let following conditions be satisfied.

B1. The set $\mathrm{I}_o$ gives to the parametrical identification problem solution for the model (5). It means that the input $u(t)$ is excitation constancy on an interval $J$.

B2. The input $u(t)$ provides obtaining the informative framework $S_{ey}\left(\mathrm{I}_{N,g}\right)$. It means that the analysis $S_{ey}$ gives the estimates task solution of system (5) nonlinear properties.

*Definition 10:* The input $u(t)$ we will call representative if it satisfies conditions B1, B2.

Let the framework $S_{ey}$ be closed and its area is not zero. Designate a height $S_{ey}$ as $h\left(S_{ey}\right)$ where the height is the distance between two points on opposite sides of the framework $S_{ey}$.

*Statement 1:* [18]. Let: 1) the system (5) linear part is stable and the nonlinearity $\varphi(\cdot)$ satisfies the condition (7); 2) the input $u(t)$ is limited piecewise continuous and constantly excited; 3) such $\delta_S > 0$ exists that $h\left(S_{ey}\right) \geq \delta_S$. Then the framework $S_{ey}$ is identifiable on the set $\mathrm{I}_{N,g}$.

*Definition 11:* Framework $S_{ey}$ having specified properties is $h$-identified.

Let the framework $S_{ey}$ be $h$-identified.

Concept $h$-identifiability features.

1. $h$-identifiability is a concept not parametric, but the structural identification.
2. The demand of the parametric identifiability is the $h$-identifiability basis.
3. $h$-identifiability makes more rigid demands to the system input.

Feature 3 means that "the bad" input can satisfy of the excitation constancy condition. Such input can give so-called an "insignificant" $\mathcal{S}_{ey}$-structure ($\mathcal{NS}_{ey}$-framework). But the $\mathcal{NS}_{ey}$-structure can be $h$-identified. The insignificance property gives the identification of the nonlinearity, atypical for an examined system under uncertainty.

Consider existence conditions of the $\mathcal{NS}_{ey}$-structures. Consider a class of nonlinear functions to which the homotopy operation is applicable. The homotopy [23] is the operation of obtaining one part of a geometrical figure from another part on the basis of it's the rotation and the extension about a certain point on the plane $(y,e)$.

Consider the framework $\mathcal{S}_{ey}$. Let $\mathcal{S}_{ey} = \mathcal{F}^l_{\mathcal{S}_{ey}} \cup \mathcal{F}^r_{\mathcal{S}_{ey}}$, where $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$ are left and right fragments $\mathcal{S}_{ey}$. Determine for $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$ secants

$$\gamma^l_S = a^l y\ ,\ \gamma^r_S = a^r y\ , \qquad (10)$$

where $a^l$, $a^r$ are numbers computed by means of the least-squares method (LSM).

*Theorem 1* [7]. Let: i) the framework $\mathcal{S}_{ey}$ is $h$-identified; ii) the framework $\mathcal{S}_{ey}$ has the form $\mathcal{S}_{ey} = F^l_{\mathcal{S}_{ey}} \cup F^r_{\mathcal{S}_{ey}}$, where $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$ are left and right fragments $\mathcal{S}_{ey}$; ii) secants for $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$ have the form (9). Then $\mathcal{S}_{ey}$ is $\mathcal{NS}_{ey}$-structure, if

$$\left\| a^l \right| - \left| a^r \right\| > \delta_h\ , \qquad (11)$$

where $\delta_h > 0$ is some specified number.

*Remark 6:* The theorem 1 can be proved on the basis of the homotopy of sets [24]. Estimate proximity of sets $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$ in this case. The approach based on the secant method is simpler in the implementation.

*Remark 7:* $\mathcal{NS}_{ey}$-structures are characteristic for systems with multiple-valued nonlinearities. They are the result of the inadequate application of input actions.

Consider the framework $\mathcal{S}_{ey}$. Introduce designations: $\mathcal{D}_y = \mathrm{dom}\left(\mathcal{S}_{ey}\right)$ is definition range $\mathcal{S}_{ey}$,

$$D_y = D_y\left(\mathcal{D}_y\right) = \max_t y(t) - \min_t y(t)$$

is the diameter $\mathcal{D}_y$. Let $u(t) \in \mathrm{U}$, where $\mathrm{U}$ is the admissible input set for the system (5).

*Definition 12:* If the definition range $\mathcal{D}_y$ of the framework $\mathcal{S}_{ey}$ have the maximum diameter $D_y$ on the set $\{y(t), t \in J\}$, then the input $u(t) \in \mathrm{U}$ is $\mathrm{S}$-synchronizing for the system (5).

We understand synchronization $u(t) \in \mathrm{U}$ as the choice of such input $u_h(t) \in \mathrm{U}$ which allows reflecting all features $\mathcal{S}_{ey}$ characteristic for $\varphi(y)$. It is true if $u(t)$ ensures $\max_{u_h} D_y$. Here the $u_h(t) \in \mathrm{U}$ and input property choice is directed to the possibility of obtaining the framework $\mathcal{S}_{ey} \neq \mathcal{NS}_{ey}$. The proposed concept of the synchronization by differs from oscillation theory terminology. As the choice $u_h(t) \in \mathrm{U}$ can be interpreted as the synchronization between model and system structures, then $\mathcal{d}_{h,y} = \max_{u_h} D_y$ gives the system $h$-identifiability.

Let the input $u_h(t)$ synchronize the set $\mathcal{D}_y$. We will write $u_h(t) \in \mathrm{S}$ if $u(t)$ is S-synchronizing. Notice that the finite set $\{u_h(t)\} \in \mathrm{S}$ exists for the system (5). The optimum choice $u_h(t)$ depends from $\mathcal{d}_{h,y}$. Ensuring this condition is one of the system (5) structural identifiability prerequisites.

*Definition 13:* If $\mathcal{S}_{ey}$ is $h$-identified and the condition $\left\| a^r \right| - \left| a^r \right\| \leq \delta_h$ is satisfied, then the framework $\mathcal{S}_{ey}$ (the system (5)) is structurally identified or $h_{\delta_h}$-identified.

*Definition 13:* Shows if the system (5) is $h_{\delta_h}$-identified, then the framework $\mathcal{S}_{ey}$ has the area $\mathcal{D}_y$ maximum diameter. Let the framework $\mathcal{S}$ contain $m$ features. We understand function $\varphi(y)$ features as the continuity loss on some interval, and function inflection points or a function extremum. These features are signs of the examined function nonlinearity.

*Definition 14:* If the framework $\mathcal{S}_{ey}$ is $h_{\delta_h}$-identifiable, then the model (9) is $SM$-identifying.

*Theorem 2* [15]. Let: 1) the input $u(t)$ is constantly excited and guarantees the system (5) S-synchronization; 2) the system (5) phase portrait $\mathcal{S}$ have $m$ features; 3) $\mathcal{S}_{ey}$-framework is $h_{\delta_h}$-identifiable and have fragments corresponding to phase portrait $\mathcal{S}$ features. Then the model (9) is $SM$-identifying.

The theorem 2 shows if the model (9) is not $SM$-identifying, then the model (9) structure or an informational set have to be changed.

Consider the framework $\mathcal{S}_{ey}$. Designate the framework $\mathcal{S}_{ey}$ center on the set $J_y = \{y(t)\}$ as $c_S$, and the area $\mathcal{D}_y$ center as $c_{D_y}$.

*Theorem 3.* Let on the set $\mathrm{U}$ of system (5) representative input $u(t)$: (i) such $\varepsilon \geq 0$ exists that $\left| c_S - c_{D_y} \right| \leq \varepsilon$; (ii) the condition $\left\| a^l \right| - \left| a^r \right\| \leq \delta_h$ is satisfied. Then the system (5) is $h_{\delta_h}$-identifiable, and the input $u_h(t) \in \mathrm{S}$.

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*Proof of Theorem 3.* Consider the input $u_h(t) \in \mathrm{U}$. As the condition $\left|a^l - a^r\right| \le \delta_h$ is satisfied the framework $\mathcal{S}_{ey}$ is symmetric concerning the point $c_S$ on the plane $(y,e)$. Therefore, fragment $\mathcal{F}^l_{S_{ey}}, \mathcal{F}^r_{S_{ey}}$ definition range diameters coincide within some size $\varepsilon_{\mathcal{F}} \ge 0$ on the set $\{y(t)\}$, i.e.

$$\left|D_{\mathcal{F}^l_S}\left(\mathcal{D}_{\mathcal{F}^l_S}\right) - D_{\mathcal{F}^r_S}\left(\mathcal{D}_{\mathcal{F}^r_S}\right)\right| \le \varepsilon_{\mathcal{F}}, \qquad (12)$$

where $\mathcal{D}_{\mathcal{F}^l_S}, \mathcal{D}_{\mathcal{F}^r_S}$ are ranges of definition $\mathcal{F}^l_{S_{ey}}, \mathcal{F}^r_{S_{ey}}$.

Then the framework $\mathcal{S}_{ey}$ center is $c_{D_y} = 0.5\left(D_{\mathcal{F}^l_S} + D_{\mathcal{F}^r_S}\right)$. As $D_{\mathcal{F}^l_S} + D_{\mathcal{F}^r_S} = D_y$, such $\varepsilon \ge 0$ exists that $\left|c_S - c_{D_y}\right| \le \varepsilon$. Fulfillment of conditions (i), (ii) guarantees $u(t) = u_h(t)$ and $d_{h,y} = \max_{u_h} D_y$. Therefore, the framework $\mathcal{S}_{ey}$ at $u_h(t)$ will contain all features characteristic of the function $\varphi(y)$. This implies that $u_h(t) \in \mathrm{S}$, and the system (5) is $h_{\delta_h}$-identified. ■

Some subset $\{u_{h,i}(t)\} \subset \mathrm{U}_h \subseteq \mathrm{U}$ $(i \ge 1)$ which elements have the S-synchronizability property can exist. The framework $\mathcal{S}_{ey,i}\left(u_{h,i}\right)$ with the diameter $D_{y,i}$ of definition range $\mathcal{D}_{y,i}$ corresponds to every $u_{h,i}(t)$. As $u_{h,i}(t) \in \mathrm{S}$ the diameter $D_{y,i}$ have the $d_{h,\Sigma}$-optimality property. Let the hypothetical framework $\mathcal{S}_{ey}$ of the system (5) have the diameter $d_{h,\Sigma}$.

*Definition 15:* The framework $\mathcal{S}_{ey,i}$ have $d_{h,\Sigma}$-optimality property on the set $\mathrm{U}_h$, if there is such $\varepsilon_\Sigma > 0$ that $\left|d_{h,\Sigma} - D_{y,i}\right| \le \varepsilon_\Sigma \quad \forall i = \overline{1, \# \mathrm{U}_h}$.

*Definition 16:* Let the input subset $\{u_{h,i}(t)\} = \mathrm{U}_h \subset \mathrm{U}$ $(i \ge 1)$ exist which elements $u_{h,i}(t) \in \mathrm{S}$, and frameworks $\mathcal{S}_{ey,i}\left(u_{h,i}\right)$ corresponding to them have property $d_{h,\Sigma}$-optimality. Then frameworks $\mathcal{S}_{ey,i}\left(u_{h,i}\right)$ are indistinguishable on sets $\{u_{h,i}(t)\}$, $J_y\left(u(t) = u_{h,i}(t)\right) = \{y_{h,i}(t)\}$.

From definitions 15, 16 we obtain if the set $\mathrm{U}_h$ exists then the $h_{\delta_h}$-identifiability estimation can be determined on any input $u(t) \subset \mathrm{U}_h$.

*Remark 8:* Here, the case of symmetric nonlinearities is considered. Therefore, remarks made above about the $\mathcal{NS}_{ey}$-framework existence remain are fair. If a nonlinear function does not have the symmetry property, then the research of this problem to be continued needs. Explain it with nonlinearity features. The accounting of these features is possible only under the a priori information on the system or in the further analysis of the framework $\mathcal{S}_{ey}$.

Go to estimation methods $h_{\delta_h}$-identifiability of the system (5) now.

## VI. Approach to $h_{\delta_h}$-Identifiability Estimation

Consider the definition problem of an integral indicator which allows making the decision about the system (5) $h_{\delta_h}$-identifiability. It is based on the analysis of framework $\mathcal{S}_{ey}$ properties.

In the nonlinear dynamics and the fractal theory, approaches based on the principle of the covering [21] are applied for the dimension estimation of a framework. Different types of the dimension are proposed. Topological dimension is one of simplest indicators. It estimates the framework geometry and is it always reflects its internal features. Attractors and fractals often are heterogeneous. The heterogeneity reflects an irregularity of point distribution on the framework. Heterogeneity estimations of frameworks obtain on the basis of parameters reflecting of system properties. It is estimated on the basis of the probability analysis of the filling with certain objects of fractal geometrically identical elements. The heterogeneity characterizes discrepancy between probabilities of the fractal filling with the specified bodies and geometrical sizes of the respective areas. Such heterogeneous fractal objects call multifractals [21]. $\mathcal{S}_{ey}$-frame works of dynamic systems with many-valued nonlinearities is the example of heterogeneous frameworks. Section 4 contains examples of heterogeneous frameworks.

Various indicators of the covering (correlation dimension, informational dimension, etc.) are approximate and labor-consuming [21]. They give an assessment of framework fragment geometrical distinction not always. Therefore, we introduce the integral characteristic of the framework which is the distribution function of the variable $e$ on the set $\{y(t)\}$ [15]. Such approach eliminates various a priori assumptions concerning the framework covering local objects. We state to the proposed approach.

Let the framework $\mathcal{S}_{ey}$ be obtained for the system (5). Perform the fragmentation $\mathcal{S}_{ey} = \mathcal{F}^l_{S_{ey}} \cup \mathcal{F}^r_{S_{ey}}$ where $\mathcal{F}^l_{S_{ey}}$, $\mathcal{F}^r_{S_{ey}}$ are left and right parts of the framework $\mathcal{S}_{ey}$. Fragments $\mathcal{F}^l_{S_{ey}}$, $\mathcal{F}^r_{S_{ey}}$ are described by functions $e^l(y), e^r(y)$ where $\{e^l\} \subseteq \{e\}, \{e^r\} \subseteq \{e\}$.

Construct frequency distribution functions (histograms) $\mathcal{H}^l, \mathcal{H}^r$ for $\mathcal{F}^l_{S_{ey}}, \mathcal{F}^r_{S_{ey}}$. Obtain cumulative

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frequency functions $I\mathcal{H}^l, I\mathcal{H}^r$ on the basis $\mathcal{H}^l, \mathcal{H}^r$. Let $\mathrm{I}_{\mathcal{H}} = \left\{ i\Delta e, i = \overline{1,k} \right\}$ is the definition range of functions. Present the value range of functions $\mathcal{H}^l, \mathcal{H}^r$ in the form of vectors

$$L\left(I\mathcal{H}^l\right) = \left[I\mathcal{H}_1^l, I\mathcal{H}_2^l, \ldots, I\mathcal{H}_k^l\right]^T,$$

$$R\left(I\mathcal{H}^r\right) = \left[I\mathcal{H}_1^r, I\mathcal{H}_2^r, \ldots, I\mathcal{H}_k^r\right]^T.$$

Here, $k$ is the quantity of pockets set on $\mathrm{I}_{\mathcal{H}}$, $\Delta e$ is the pocket size on $e$.
Apply the model

$$\hat{R} = a_H L\left(I\mathcal{H}^l\right) \tag{13}$$

and determined the parameter $a_H$ having applied the least-squares method.

The model is adequate if the parameter $a_H \in O(1)$ where $O(1)$ is the neighbourhood 1. If the condition $a_H \in O(1)$ is fair, then the system (5) is $h_{\delta_h}$-identifiable and $\mathcal{S}_{ey} \neq \mathcal{NS}_{ey}$. Otherwise, the framework $\mathcal{S}_{ey}$ is insignificant.
So, the following statement is fair.

*Statement 2:* Let for the system (5): 1) the framework $\mathcal{S}_{ey} = \mathcal{F}^l_{\mathcal{S}_{ey}} \cup \mathcal{F}^r_{\mathcal{S}_{ey}}$ is defined on the set $\{y(t)\}$ where $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$ is framework $\mathcal{S}_{ey}$ fragments; 2) frequency $\mathcal{H}^l, \mathcal{H}^r$ and cumulative $I\mathcal{H}^l, I\mathcal{H}^r$ are distribution functions are known for $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$. Then the system (5) is $h_{\delta_h}$-identified if $a_H \in O(1)$.

*Definition 17:* If the system (5) is $h_{\delta_h}$-identifiable, then the framework $\mathcal{S}_{ey}$ have the dimension $DH_h = a_H$.

Definition 17 shows if $u(t) \in \mathrm{S}$, then dimension for the structurally identified system is approximate to 1. Such value $DH_h$ shows that the framework $\mathcal{S}_{ey}$ does not have complex areas and fragments $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$ are structurally identical or homothetic. If $DH_h \notin O(1)$, then it is a sign $\mathcal{NS}_{ey}$-framework or a system with more complicated nonlinearity form. You can supplement results obtained on the basis of statement 2 with the histogram analysis for the framework $\mathcal{S}_{ey}$. Obtain $\mathcal{H}^l, \mathcal{H}^r$ and $I\mathcal{H}^l, I\mathcal{H}^r$ functions and analyze their correlations considering features $\mathcal{S}_{ey}$. Some approaches are proposed in [14, 15].

## VII. Examples

Consider the system from section 4 with the input $u_{\mathcal{N}}(t) = 6 - 4\sin\left(0.5\pi t\right) + 0.4\sin\left(0.1\pi t\right)$. Frame works $\mathcal{S}$, $\mathcal{S}_{ey}$ are showed in Fig. 5 for system steady state. We see that theorem 3 conditions are not satisfied. The sector which has to belong the function $f_e = e(y)$ does not exist for $\mathcal{S}_{ey}$. Therefore, the system is not S-synchronized and $\mathcal{S}_{ey} = \mathcal{NS}_{ey}$. So, the system is not $h$-identified.

Let $u(t) = 6 - 2\sin\left(0.1\pi t\right)$. The system has frameworks showed in Fig. 2. Construct segments $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$ for the framework $\mathcal{S}_{ey}$. It can be made on the basis of Fig. 2. Secants for $\mathcal{F}^l_{\mathcal{S}_{ey}}, \mathcal{F}^r_{\mathcal{S}_{ey}}$ have the form

$$\gamma^l_S = -0.0359y + 0.0792, \ \gamma^r_S = 0.0211y - 0.0649. \tag{14}$$

The APPLICATION of theorem 1 will show that $\mathcal{S}_{ey} = \mathcal{NS}_{ey}$ i.e. the system is not $h$-identifiable. This conclusion is confirmed with diameters $D_{\mathcal{F}^l_S} = 0.478$, $D_{\mathcal{F}^r_S} = 0.792$. $h$-identifiability estimation results of the system are show in Fig. 6 on the application basis of statement 2. The model (13) has the form

$$\hat{R} = 26 + 0.656L\left(I\mathcal{H}^l\right). \tag{15}$$

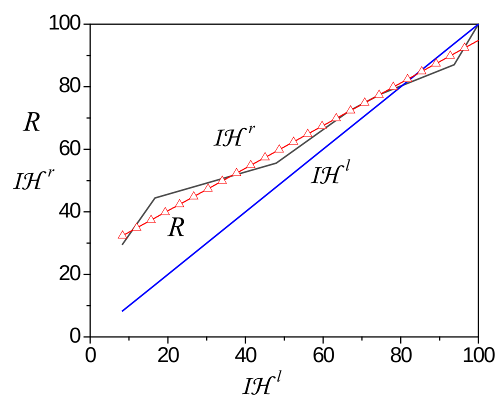


*Fig. 6:* Estimation $h$-identifiability of system on basis fragment cumulative distribution function

The model (15) adequacy is 97%. The framework $\mathcal{S}_{ey}$ dimension is 0.65. Analysis results show that the system (5) is structurally non-identifiable on input $u(t) = u_{6,-4}(t)$.

Consider the system from section 4 with

$$u(t) = u_{6,-4}(t) = 6 - 4\sin\left(0.1\pi t\right).$$

Corresponding frameworks are shown in Fig. 1. We see the framework have some asymmetry that explains with characteristics of the nonlinear function (Fig. 1b).

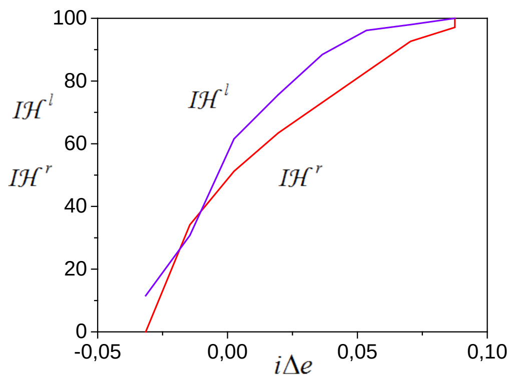


*Fig. 7:* Functions $\mathcal{IH}^l, \mathcal{IH}^r$

Following parameters of the secants (10) are obtained for fragments $\mathcal{F}_{S_{ey}}^l, \mathcal{F}_{S_{ey}}^r$: $a^l = -0.025$, $a^r = -0.027$. Let $\delta_h = 0.003$. The condition (11) not be satisfied and $S_{ey} \neq \mathcal{NS}_{ey}$. To confirm this inference, determine by functions $\mathcal{IH}^l, \mathcal{IH}^r$. They are shown in Fig. 7, and results of $S_{ey}$-framework dimension estimation are presented in Fig. 8.

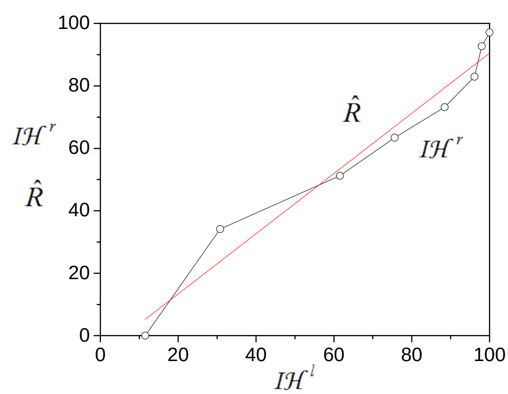


*Fig. 8.* $h$-identifiability system estimation on basis cumulative frequency function of fragment with $u_{6,-4}(t)$

The model (13) has the form

$$\hat{R} = -5.845 + 0.96L\left(\mathcal{IH}^l\right),$$

and the coefficient of determination is 96%. Statement 2 conditions are satisfied and the system is $h_{\delta_h}$-identifiable. Framework $S_{ey}$ dimension $DH_h$ is 0.96. Framework fragment diameters are equal $D_{\mathcal{F}_S^l} = 1.16$, $D_{\mathcal{F}_S^r} = 1.43$. The diameter $S_{ey}$ is equal to 2.59. This value coincides with $D_{\mathcal{F}_S^l} + D_{\mathcal{F}_S^r}$. If to choose $\varepsilon_{\mathcal{F}} = 0.4$, then the condition (12) will be satisfied. The distinction between fragment $\mathcal{F}_{S_{ey}}^l, \mathcal{F}_{S_{ey}}^r$ definition ranges depends on properties $S_{ey}$. The condition 2) theorem 3 is satisfied with $\varepsilon = 0$. Therefore, the system is the SI or $h_{\delta_h}$-identifiable with $u_{6,-4}(t)$, and $u_{6,-4}(t) \in \mathrm{S}$.

## VIII. Conclusion

The approach to structural identifiability analysis of nonlinear dynamic systems is proposed under uncertainty. This approach has a difference from methods applied to the structural identifiability estimation of dynamic systems in the parametrical space. We interpret the SI as structural identification possibility of the system nonlinear part. The input has to satisfy excitation the constancy condition in SI problems. This condition differs from requirements to inputs in adaptive systems. We show that the input has to have the synchronization property (S-synchronizability) for SI problem solution. The SI estimation is based on special class framework $S_{ey}$ analysis. Therefore, the S-synchronization has to give to the maximum value of the framework definition range. Non-synchronized input gives to an insignificant framework which does not allow solving the structural identification problem. Therefore, the system is not structurally identifiable. We obtained conditions under which it is possible to estimate the system structural identifiability. An input subset is allocated has the S-synchronizability property, and frameworks $S_{ey}$ not indistinguishable.

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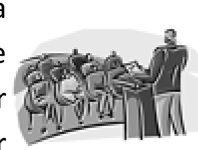

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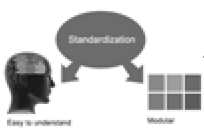

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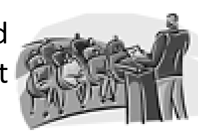

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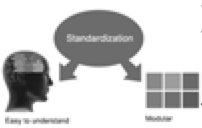


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Global Journals is in partnership with various universities, laboratories, and other institutions worldwide in the research domain. Authors are requested to disclose their source of funding during every stage of their research, such as making analysis, performing laboratory operations, computing data, and using institutional resources, from writing an article to its submission. This will also help authors to get reimbursements by requesting an open access publication letter from Global Journals and submitting to the respective funding source.

## Preparing your Manuscript

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:**

  - Single section and succinct.
  - An outline of the job done is always written in past tense.
  - Concentrate on shortening results—limit background information to a verdict or two.
  - 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<br><br>Above 200 words | No specific data with ambiguous information<br><br>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 |

# Index

save our planet

# Global Journal of Science Frontier Research

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or email us at helpdesk@globaljournals.org

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