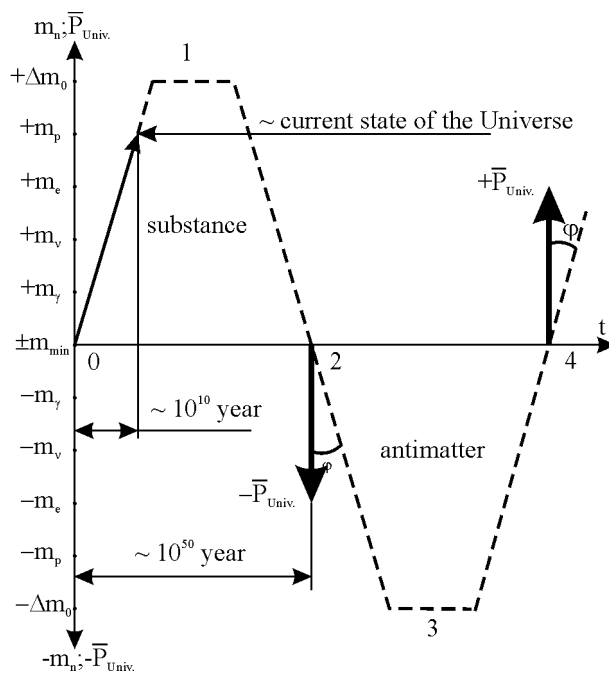


# Spacetime & Substance

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# Spacetime & Substance

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# GRAVY-ELECTROMAGNETISM IN FIVE DIMENSIONS AND MOVING BODIES IN GALAXY AREA

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In Klein geometric model of space the mass is manifestation of the quantized charges oscillations in additional compactified dimension. We analyze model in which common in four-dimensional space-time for mass and electric charge of the particle trajectory is disintegrated in five dimensions on movement of the mass along null geodesic line and trajectory of the charge corresponding to the time-like interval in 5D volume. We find relation between five-velocity vector of electric charge and mass. This scheme is regarded to have concern with many worlds theory. Considered approach is applied to the model of rotating space having four-dimensional spherical symmetry. One proposed appearance additional force in included 4D space-time, which may be explanation of the Pioneer-effect. We analyze also possible part of this force in conservation of the substance in Galaxy area.

Several theories, being studied five-dimensional space-time, are founded on different on physical principles. Generalization of the special theory of relativity for 5D extended space  $G(T; \vec{X}; S)$  with the metric  $(+; -, -, -, -)$  has been proposed and developed in works [1-8]. Built model of extended space (ESM) allows integration of the electromagnetic and gravitational interactions.

The peculiarity of ESM is its studying of the particle trajectory in 5D basing on analogy between the light movement in curved space in general relativity and its movement in medium with refraction coefficient being more than unity [2,3,6]. In ESM mass of the particle is component of the five-vector energy-impulse-mass in space  $G(T; \vec{X}; S)$ . With changes of coordinate frames in this space the electric, gravity and scalar fields are transformed in each other.

As the 5-th additional coordinate in ESM is used quantity, which already exists in the (1+3)-dimensional Minkowski space  $M(T; \vec{X})$ , with time coordinate  $x^0 = ct$ , where  $c$  is light velocity,  $t$  is time, and space coordinates  $x^1, x^2, x^3, x^3$ , namely, interval  $S$ :

$$S^2 = (x^0)^2 - (x^1)^2 - (x^2)^2 - (x^3)^2. \quad (1)$$

This quantity is conserved at common Lorentz transformations in the Minkowski space  $M(T; \vec{X})$  but varies at turns in the extended space  $G(T; \vec{X}; S)$ . Thus, Minkowski space  $M(T; \vec{X})$  is a cone in extended space  $G(T; \vec{X}; S)$ .

In 5D gravity theory, begun by Nordström [9] and Kaluza [10], proposed by Klein [11] approach to the

particle movement analysis examined, for example, in [12-15] requires its trajectory to be null geodesic line in 5D space. One ensures a particle having non-zero rest mass in the 4-D Minkowski space to have it in 5D. The other approach to the kinematics in 5D space is description of the movement of particle, which can be stationary in this space and has non-zero rest mass. At that his trajectory is determined by time-like interval [16-20].

In considered model integrated electromagnetism and gravity we will turn to account following from Klein compactification formalism founded on assumption that electric charge and mass of observed in 4D particle have different world lines in 5D space. At that we suppose any particle having a rest mass in 4D to contain combination of electric charges. The mass movement conforms to null interval, i. e.,

$$0 = \tilde{G}_{ij}(x_m) dx_m^i dx_m^j, \quad (2)$$

where  $x_m^i$  are mass coordinates and  $\tilde{G}_{ij}(x_m)$  is metric tensor of 5D space, which is function of these coordinates. On the contrary, electric charge has trajectory with line element

$$ds_e^2 = \tilde{G}_{ij}(x) dx^i dx^j, \quad (3)$$

where  $x^i$  are electric charge coordinates.

Thus, world line of the particle mass in 5D intersects corresponding world lines of electric charges and, conversely, trajectory of the electric charge is a set of the points appertained to trajectories of corresponding masses. This approach leads us to proposed by Everett

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[21-23] conception of many worlds founded on quantum theory.

Let us touch relation of present scheme to anthropic principle. Our perception of environment arises by means of electro-magnetism and we can not feel gravity direct. This may be considered as account for assumption that to be exact mass, not electric charge moves along null pass in 5D. In this case we can hold that 5D space model with non-zero rest mass of the particle and appropriate time-like interval describes electro-magnetic “trace” of the masses, which appertain consecutively the world line of corresponding electric charges combination. Light velocity in extra dimension in coordinate frame of charge or system of charges being its source is assumed to be null.

Components of mass velocity denoted as  $u_m^i = dx_m^i/ds_e$  form a five-vector. With first four components of the five-velocity vector of charge  $u^i$  corresponding to interval (3) equalities  $u_m^i = u^i$  provide local coincidence of mass and charge coordinates in 4D. Divided Eq. (2) on  $ds_e^2$  we obtain

$$0 = \tilde{G}_{ij}u^i u^j + (\tilde{G}_{i4}u^i + \tilde{G}_{4i}u^i)u_m^4 + \tilde{G}_{44}(u_m^4)^2, \quad i, j \neq 4. \quad (4)$$

At this point the mass velocity along fifth coordinate will be

$$u_m^4 = \frac{-(\tilde{G}_{i4} + \tilde{G}_{4i})u^i}{2\tilde{G}_{44}} + \frac{\epsilon \sqrt{(\tilde{G}_{i4} + \tilde{G}_{4i})^2 u^{i2} - 4\tilde{G}_{44}\tilde{G}_{ij}u^i u^j}}{2\tilde{G}_{44}}, \quad (5)$$

where  $\epsilon = \pm 1$ ,  $i, j \neq 4$ . The opposite values of  $\epsilon$  conform to matter and anti-matter. For extended Minkowski space we have

$$u_m^4 = \epsilon \sqrt{1 + u^{42}}. \quad (6)$$

Let us apply considered conception to analysis of metric example of 5D space with such basis vectors that the fifth of them is not orthogonal to others, which are basis of included 4D space. The cosmological model with movement of the matter along fifth coordinate based oneself on metric conforming to this property has been studied in [20]. We analyze space-time, including four-dimensional spherical space, with coordinates  $x^i = (ct, a, \theta, \varphi, \chi)$  to be rendered to orthogonal frame by transformation

$$\begin{aligned} \eta_0 &= ct, \\ \eta_1 &= a \cdot \sin \chi \cdot \sin \theta \cdot \cos \varphi, \\ \eta_2 &= a \cdot \sin \chi \cdot \sin \theta \cdot \sin \varphi, \quad \eta_3 = a \cdot \sin \chi \cdot \cos \theta, \\ \eta_4 &= a \cdot \cos \chi. \end{aligned} \quad (7)$$

This space is assumed to be rotating and the metric is taken in form

$$ds^2 = c^2[1 - a^2 B(a)^2]dt^2 - da^2 - a^2[2cB(a)dtd\chi + \sin^2 \chi(d\theta^2 + \sin^2 \theta d\varphi^2) + d\chi^2], \quad (8)$$

where  $B(a)$  is dependent on  $a$  coefficient. In accordance with considered approach with  $ds > 0$  conforms to the movement of particle's electro-magnetic trace.

In [20] the geodesic line equations was written in form

$$\frac{d}{ds}(\tilde{G}_{ij}u^j) - \frac{1}{2} \frac{\partial \tilde{G}_{mj}}{\partial x_i} u^m u^j = 0. \quad (9)$$

For metric (8) zeroth, first and fourth components of these equations with comoving coordinates of conventional type ( $u^1 = u^2 = u^3 = 0$ ) yield

$$\frac{d}{ds}[(1 - a^2 B^2)u^0 - a^2 B u^4] = 0, \quad (10)$$

$$aB \left( B + a \frac{\partial B}{\partial a} \right) u^{02} + a \left( 2B + a \frac{\partial B}{\partial a} \right) u^0 u^4 + a u^{42}, \quad (11)$$

$$\frac{d}{ds}[a^2 B u^0 + a^2 u^4] = 0. \quad (12)$$

Solution of this system must be compatible with set by metric (8) condition

$$u^{02} - a^2(u^4 + B u^0)^2 = 1. \quad (13)$$

Such solution will be

$$u^0 = \xi, \quad u^4 = -\xi B(a), \quad (14)$$

where  $\xi$  takes values 1 and  $-1$ . Corresponding fifth component of mass five-velocity (5) is following:

$$u_m^4 = \xi \left( \frac{\epsilon}{a} + B(a) \right). \quad (15)$$

We notice that this equation with other four components of  $u_m^i$  does not put null geodesics of particle mass but it is only velocity of mass in every point of charge geodesics.

Considered coordinate frame is transformed to coordinates  $x^i = (ct, r, \theta, \varphi, y)$  having only 3D symmetry by expressions

$$\begin{aligned} r &= a \cdot \cos \chi, \\ y &= a \cdot \sin \chi. \end{aligned} \quad (16)$$

We find acceleration  $d^2 r/ds^2$  with condition of particle geodesic movement set by Eqs. (14) when the fifth coordinate is  $\chi = 0$ . In this case we obtain  $y = 0$  and

$dr/ds = 0$ . The fifth component of the five-velocity is written as

$$u^4 = \frac{1}{r^2 + y^2} \left( r \frac{dy}{ds} - y \frac{dr}{ds} \right). \quad (17)$$

This equation yields

$$\frac{dy}{ds} = -\xi \cdot r B(r). \quad (18)$$

Equation of the system (9) with  $i = 1$  is rewritten as

$$\frac{d^2 a}{ds^2} = 0. \quad (19)$$

After some transformations we obtain

$$\frac{d^2 r}{ds^2} = -r B(r)^2. \quad (20)$$

Thus, rotation in 5D gives additional force in included 4D space. This force is invariable with

$$B(a) = K a^{-1/2}, \quad (21)$$

where  $K$  is constant. One may be considered as explanation of additional acceleration of the Pioneer 10  $a_p = 8.5 \cdot 10^{-8} \text{cm/s}^2$  towards to the receiving antenna on the Earth [25-27]. Assumed interval to be  $ds = cdt$  we obtain value of the constant which is  $K = 0.97 \cdot 10^{-13} \text{cm}^{-1/2}$ .

This additional acceleration satisfies to the constraint  $a_p R \gtrsim v_{sw}^2$ , where  $R$  is Galaxy radius and  $v_{sw}$  is velocity of the solar wind [28]. It follows from this that if Pioneer-effect spreads on whole Galaxy area, it is conducive to conservation of the matter within the bounds of Galaxy belt.

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# ON THE ORIGIN OF THE NOTION OF GW *ET CETERA*

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The notion of gravitational wave (GW) came forth originally as a by-product of the *linear* approximation of general relativity (GR). Now, it can be proved that this approximation is quite *inadequate* to a proper study of the hypothetic GW's. The significant role of the approximations beyond the linear stage is emphasized.

1. As it is well known, the *linear* approximation of GR (physically, the approximation for *weak* gravitational fields) has Minkowski spacetime as its (*fixed*) substrate [1], [2]. It resembles the e.m. Maxwell theory, and is only Lorentz invariant.

With respect to transformations of *general* co-ordinates, its energy tensor becomes a *false* (pseudo) tensor, which can be reduced to zero through a suitable change of reference system.

A celebrated by-product of the linearized version of GR is the notion of gravitational wave [1], [2]. Now, in 1944 Weyl [3] pointed out that, rigorously speaking, the gravitational field of the linearized version exerts *no* force on matter, i.e. is a “powerless shadow”. Indeed, a basic result of the Einstein-Infeld-Hoffmann method [4] tells us that, as Weyl [3] wrote, “the gravitational force arises only when one continues the approximation beyond the linear stage.” Even in the modern literature this fact is generally overlooked and, quite uncritically, the action on matter of a gravitational wave – e.g. of a plane wave – is formally computed.

In conclusion, the linear approximation of GR – which is the favourite relativistic doctrine of the GW hunters – is completely *inadequate* to an approximate treatment of the question of the GW's.

On the other hand, if we continue the approximation beyond the linear stage (cf. [4] and [5]), we find that the radiation terms of the gravitational field can be *destroyed* by convenient co-ordinate transformations: this proves that the GW's are *only a product of a special choice of the reference frame*, i.e. that they do not possess a *physical* reality [6], [7].

In the recent literature the above crucial role of the co-ordinate system is ignored. E.g., Itoh and Futamase have published a learned study on the third post-Newtonian equation of motion for relativistic compact binaries [7], [8]; *their result is derived under the harmonic co-ordinate condition*. Motivation for this research [7]: “One promising source of gravitatio-

nal waves for those detectors [i.e. GEO600, LIGO, TAMA300] is a relativistic compact binary system in an inspiraling phase. The detectability and quality of measurements of astrophysical information of such gravitational wave sources rely on the accuracy of our theoretical knowledge about the waveforms. A high order, say, third- or fourth-order, post-Newtonian equation of motion for an inspiraling compact binary is one of the necessary ingredients to construct and study such waveforms [...]” Itoh writes (see the abstract of [8]): “Our resulting equation of motion admits a conserved energy (neglecting the 2.5 PN radiation reaction effect), is Lorentz invariant, and is unambiguous [...]”

These authors do not suspect that the radiation terms are *frame dependent*, and can be destroyed by a suitable change of co-ordinate system. Further, they are unaware that – as it is easy to prove – the motions of point masses interacting only gravitationally – as, e.g., the two compact stars of some binaries or the bodies of the solar system – happen along *geodesic* lines [6], and consequently an emission of GW's is obviously impossible.

More radically, it can be proved that *no* “mechanism” exists *in GR* for the generation of GW's [6].

2. Only recently, through a kind letter of Prof. A. Gsponer, I have known the existence of the beautiful memoir by Weyl [3].

Since it seems that the astrophysical community is not aware of Weyl's results, I think very useful to reproduce in an **APPENDIX**, at the end of the present paper, the “Introduction and Summary” and sects. 1, 2 of Weyl's memoir, which are particularly relevant to our theme.

I avail myself of this opportunity for an apology: in 1999 I published a very short Note entitled “Deduction of the law of motion of the charges from Maxwell equations” [9]. Now, my result is contained in Weyl's treatment of Maxwell theory, see sect. 2. of [3]. Weyl wrote that this theorem was “well known”. Yes, but

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only to the Blessed Few!

**Acknowledgment.** I am very grateful to Prof. G. Morpurgo, who has called my attention to the research of Itoh and Futamase [7], [8].

*“Nil sapientiae odiosius acumine nimio”.*

Seneca

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- As it is known, the first theoretical proof of the *physical* non-existence of the GW's was given by T. Levi-Civita in 1917; see his fundamental memoir in *Rend. Lincei*, **26** (1917) 381; an English version in *arXiv:physics/9906004* (June 2nd, 1999).
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## APPENDIX

### HOW FAR CAN ONE GET WITH A LINEAR FIELD THEORY OF GRAVITATION IN FLAT SPACE-TIME?<sup>1</sup>

By HERMANN WEYL

(from: *Amer. J. Math.* **66** (1944) 591)

**Introduction and Summary.** G.D. Birkhoff's attempt to establish a linear field theory of gravitation within the frame of special relativity<sup>2</sup> makes it desirable to probe the potentialities and limitations of such a theory in more general terms. In thus continuing a discussion begun at another place<sup>3</sup> I find that the differential operators at one's disposal form a 5 dimensional linear manifold. But the requirement that the field equations imply the law of conservation of energy and momentum in the simple form  $\partial T_i^k / \partial x_k = 0$  limit these  $\infty^5$  possibilities to  $\infty^2$ , which, however, reduce easily to two cases, a regular one ( $L$ ) and a singular one ( $L'$ ). The regular case ( $L$ ) is nothing but Einstein's theory of weak fields. Resembling very closely Maxwell's theory of the electromagnetic field, it satisfies a principle of gauge invariance involving 4 arbitrary functions, and although its gravitational field exerts no force on matter, it is well suited to illustrate the role of energy and momentum, charge and mass in the interplay between matter and field. It might also help, though this is much more problematic, in pointing the way to a more satisfactory unification of gravitation and electricity than we at present possess. Birkhoff follows the opposite way: by avoiding rather than adopting the  $\infty^2$  special operators mentioned above, his “dualistic” theory ( $B$ ) destroys the bond between mechanical and field equations, which is such a decisive feature in Einstein's theory.

**1. Maxwell's theory of the electromagnetic field and the monistic linear theory of gravitation ( $L$ ). Gauge invariance.** Within the frame of special relativity and its metric ground form

$$ds^2 = \delta_{ik} dx_i dx_k = dx_0^2 - (dx_1^2 + dx_2^2 + dx_3^2) \quad (1)$$

an electromagnetic field is described by a skew tensor

$$f_{ik} = \partial \phi_k / \partial x_i - \partial \phi_i / \partial x_k \quad (2)$$

<sup>1</sup>Received August 9, 1944.

<sup>2</sup>*Proceedings of the National Academy of Sciences*, vol. **29** (1943), p. 231.

<sup>3</sup>*Proceedings of the National Academy of Sciences*, vol. **30** (1944), p. 205.



derived from a vector potential  $\phi_i$  and satisfies Maxwell's equations

$$\partial f^{ki}/\partial x_k = s^i \quad \text{or} \quad D_i \phi = \square \phi_i - \partial \phi'/\partial x_i = s_i, \quad (3)$$

where  $s^i$  is the density-flow of electric charge and

$$\phi' = \partial \phi^i/\partial x_i, \quad \square \phi = \delta^{pq}(\partial^2 \phi/\partial x_p \partial x_q). \quad (4)$$

The equations do not change if one substitutes

$$\phi_i^* = \phi_i - \partial \lambda/\partial x_i \quad \text{for } \phi_i, \quad (5)$$

$\lambda$  being an arbitrary function of the coördinates ("gauge invariance"), and they imply the differential conservation law of electric charge:

$$\partial s^i/\partial x_i = 0. \quad (6)$$

As is easily verified, there are only two ways in which one may form a vector field by linear combination of the second derivatives of a given vector field  $\phi_i$ , namely,

$$\square \phi_i \quad \text{and} \quad \partial \phi'_i/\partial x_i \quad (\phi'_i = \partial \phi^p/\partial x_p). \quad (7)$$

The only linear combination  $D_i \phi$  of these two vector fields which satisfies the identity  $(\partial/\partial x_i)(D^i \phi) = 0$  is the one occurring in (3),

$$D_i \phi = \square \phi_i - \partial \phi'/\partial x_i. \quad (8)$$

Herein lies as sort of mathematical justification for Maxwell's equations.

Taking from Einstein's theory of gravitation the hint that gravitation is represented by a symmetric tensor potential  $h_{ik}$ , but trying to emulate the linear character of Maxwell's theory of the electromagnetic field, one could ask oneself what symmetric tensors  $\bar{D}_{ik}h$  can be constructed by linear combination from the second derivatives of  $h_{ik}$ . The answer is that there are 5 such expressions, namely

$$\begin{aligned} \square h_{ik}, \quad \partial h'_i/\partial x_k + \partial h'_k/\partial x_i, \quad h''\delta_{ik}, \\ \partial^2 h/\partial x_i \partial x_k, \quad \square h \cdot \delta_{ik} \end{aligned} \quad (9)$$

where

$$h = h_p^p, \quad h'_i = \partial h_i^p/\partial x_p, \quad h'' = \partial^2 h^{pq}/\partial x_p \partial x_q. \quad (10)$$

With any linear combination  $\bar{D}_{ik}h$  of these 5 expressions one could set up the field equations of gravitation

$$\bar{D}_{ik}h = T_{ik} \quad (11)$$

the right member of which is the energy-momentum tensor  $T_{ik}$ . In analogy to the situation encountered in Maxwell's theory one may ask further for which linear combinations  $\bar{D}_{ik}$  the identity

$$(\partial/\partial x_k)(\bar{D}_i^k h) = 0 \quad (12)$$

will hold, and one finds that this is the case if, and only if,  $\bar{D}_{ik}h$  is of the form

$$\begin{aligned} \alpha \{ \square h_{ik} - (\partial h'_i/\partial x_k + \partial h'_k/\partial x_i) + h''\delta_{ik} \} + \\ + \beta \{ \partial^2 h/\partial x_i \partial x_k - \square h \cdot \delta_{ik} \}. \end{aligned} \quad (13)$$

$\alpha$  and  $\beta$  being arbitrary constants. In this case the field equations (11) entail the differential conservation law of energy and momentum

$$\partial T_i^k/\partial x_k = 0. \quad (14)$$

With two constants  $a, b$ , ( $a \neq 0, a \neq 4b$ ) we can make the substitution

$$h_{ik} \rightarrow a \cdot h_{ik} - b \cdot h \delta_{ik} \quad (15)$$

and thereby reduce  $\alpha, \beta$  to the values 1, 1, provided  $\alpha \neq 0, \alpha \neq 2\beta$ . Hence, disregarding these singular values, we may assume as our field equations

$$\begin{aligned} D_{ik}h \equiv \{ \square h_{ik} - (\partial h'_i/\partial x_k + \partial h'_k/\partial x_i) + h''\delta_{ik} \} + \\ + \{ \partial^2 h/\partial x_i \partial x_k - \square h \cdot \delta_{ik} \} = T_{ik}. \end{aligned} \quad (16)$$

$D_{ik}h$  remains unchanged if  $h_{ik}$  is replaced by

$$h_{ik}^* = h_{ik} + (\partial \xi_i/\partial x_k + \partial \xi_k/\partial x_i) \quad (17)$$

where  $\xi_i$  is an arbitrary vector field. Hence we have the same type of correlation between gauge invariance and conservation law for the gravitational field as for the electromagnetic field, and it is reasonable to consider as physically equivalent any two tensor fields  $h, h^*$  which are related by (17).

The linear theory of gravitation ( $L$ ) in a flat world at which one thus arrives with a certain mathematical necessity is nothing else but *Einstein's theory for weak fields*. Indeed, on replacing Einstein's  $g_{ik}$  by  $\delta_{ik} + 2\kappa \cdot h_{ik}$  and neglecting higher powers of the gravitational constant  $\kappa$ , one obtains (16), and the property of gauge invariance (17) reflects the invariance of Einstein's equations with respect to arbitrary coördinate transformations<sup>4</sup>.

By proper normalization of the arbitrary function  $\lambda$  in (5) one may impose the condition  $\phi' = 0$  upon the  $\phi_i$ , thus giving Maxwell's equations a form often used by H. A. Lorentz:

$$\square \phi_i = s_i, \quad \partial \phi^i/\partial x_i = 0. \quad (18)$$

In the same manner one can choose the  $\xi_i$  in (17) so that  $\gamma_{ik} = h_{ik} - \frac{1}{2}h \cdot \delta_{ik}$  satisfies the equations

$$\partial \gamma_i^k/\partial x_k = 0 \quad \text{and} \quad (19)$$

$$\square \gamma_{ik} = T_{ik}. \quad (20)$$

In one important respect gauge invariance works differently for electromagnetic and gravitational fields: If one splits the tensor of derivatives  $\phi_{k,i} = \partial \phi_k/\partial x_i$  into a skew and a symmetric part,

$$\phi_{k,i} = \frac{1}{2}(\phi_{k,i} - \phi_{i,k}) + \frac{1}{2}(\phi_{k,i} + \phi_{i,k}), \quad (21)$$

<sup>4</sup>Cf. A. Einstein, *Sitzungsber. Preuss. Ak. Wiss.* (1916), p.688 (and 1918, p.154).

the first part is not affected by a gauge transformation whereas the second can locally be transformed into zero. In the gravitational case *all* derivatives  $\partial h_{ik}/\partial x_p$  can locally be transformed into zero. Hence we may construct, according to Faraday and Maxwell, an energy-momentum tensor  $L_{ik}$  of the electromagnetic field,

$$L_i^k = f_{ip} f^{pk} - \frac{1}{2} \delta_i^k (ff), \quad (ff) = \frac{1}{2} f_{pq} f^{qp}, \quad (22)$$

depending quadratically on the gauge invariant field components

$$f_{ik} = \phi_{k,i} - \phi_{i,k}, \quad (23)$$

but no tensor  $G_{ik}$  depending quadratically on the derivatives  $\partial h_{ik}/\partial x_p$  exists, if gauge invariance is required, other than the trivial  $G_{ik} \equiv 0$ .

**2. Particles as centers of force, and the charge vector and energy-momentum tensor of a continuous cloud of substance.** Conceiving a resting particle as a center of force, let us determine the *static centrally symmetric solutions* of our homogeneous field equations (3) and (11) ( $s^i = 0$ ,  $T_{ik} = 0$ ). One easily verifies that *in the sense of equivalence* the most general such solution is given by the equations

$$\phi_0 = e/4\pi r, \quad \phi_i = 0 \quad \text{for } i \neq 0; \quad (24)$$

$$\gamma_{00} = m/4\pi r, \quad \gamma_{ik} = 0 \quad \text{for } (i, k) \neq (0, 0); \quad (25)$$

$r$  being the distance from the center. As was to be hoped, it involves but two constants, *charge*  $e$  and *mass*  $m$ . The center itself appears as a singularity in the field. Indeed  $\phi_0$  and the factor  $\phi$  in  $\phi_{\alpha} [\alpha = 1, 2, 3]$  must be functions of  $r$  alone, and the relations

$$\Delta \phi_0 = 0, \quad \partial \phi_\alpha / \partial x_\alpha = 0 \quad [\alpha = 1, 2, 3] \quad (26)$$

implied in (18) then yield

$$\phi_0 = a/r, \quad \phi = b/r^3, \quad \phi_\alpha = -(\partial/\partial x_\alpha)(b/r). \quad (27)$$

Substitution of  $\phi_\alpha - \partial \lambda / \partial x_\alpha$  for  $\phi_\alpha$  with  $\lambda = -b/r$  changes  $\phi_\alpha$  into zero. In the same manner (25) is obtained from the equations (19 & 20).

A continuous cloud of "charged dust" can be characterized by its velocity field  $u^i$  ( $u_i u^i = 1$ ) and the rest densities  $\mu$ ,  $\rho$  of mass and charge. It is well known that its equations of motion and the differential conservation laws of mass and charge result if one sets  $s^i = \rho u^i$  in Maxwell's equations and lets  $T_i^k$  in (14) consist of the Faraday-Maxwell field part (22) and the kinetic part  $\mu u_i u^k$ :

$$\partial(\rho u^i)/\partial x_i = 0, \quad \partial(\mu u^i)/\partial x_i = 0; \quad \mu du_i/ds = \rho f_{ip} u^p. \quad (28)$$

Since the motion of the individual dust particle is determined by  $dx_i/ds = u^i$  we have written  $d/ds$  for  $u^k \partial/\partial x_k$ . In this manner Faraday explained by his electromagnetic tensions (flow of momentum) the fact that the *active* charge which generates an electric field is at the same time the *passive* charge on which a given field acts. At its present

stage our theory ( $L$ ) accounts for the force which an electromagnetic field exerts upon matter, *but the gravitational field remains a powerless shadow*. From the standpoint of Einstein's theory this is at it should be, because *the gravitational force arises only when one continues the approximation beyond the linear stage*. We pointed out above that no remedy for this defect may be found in a gauge invariant gravitational energy-momentum tensor. However, the theory ( $L$ ) explains why active gravity, represented by the scalar factor  $\mu$  in the kinetic term  $\mu u_i u_k$  as it appears in the right member  $T_{ik}$  of the gravitational equations (11), is at the same time inertial mass: this is simply another expression of the fact that the mechanical equations (14) are a consequence of those field equation.

We have seen that even in empty space the field part of energy and momentum must not be ignored, and thus a particle should be described by the static centrally symmetric solution of the equations

$$D_i \phi = 0, \quad D_{ik} h - L_{ik} = 0 \quad (29)$$

(of which the second set is no longer strictly linear!). Again we find, after proper gauge normalization,

$$\phi_0 = e/4\pi r, \quad \phi_1 = \phi_2 = \phi_3 = 0, \quad (30)$$

and then

$$\begin{cases} \gamma_{00} = m/4\pi r - 1/4(e/4\pi r)^2, & \gamma_{0\alpha} = 0, \\ \gamma_{\alpha\beta} = -(e/4\pi r)^2 \cdot (x_\alpha x_\beta / 4r^2) & [\alpha, \beta = 1, 2, 3]. \end{cases}$$

As before, two characteristic constants  $e$  and  $m$  appear. *At distance much larger than the "radius"  $e^2/4\pi m$  of the particle the gravitational influence of charge becomes negligible compared with that of mass.*

[The remaining sections of the paper by Weyl are entitled: sect. 3. **The singular case**; sect. 4. **Derivation of the mechanical laws without hypothesis about the inner structure of particles**; sect. 5. **Vague suggestions about a future unification of gravitation and electromagnetism**; sect. 6. **A free paraphrase of Birkhoff's recent linear laws of gravitation (B).**]

# HEATING OF SOLAR CORONAL LOOPS BY PHASE-MIXING

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This paper presents an analytical method for the heating of solar coronal loops by phase-mixing. We also discuss herewith the non-linear mode of phase mixing by Alfvén waves. Under typical coronal heating conditions by ohmic dissipation due to phase-mixing can provide magnetic energy on a time scale comparable with the coronal radiative time. For large Lundquist number, it is possible that phase-mixing can attain a hot coronal loop. We introduce two models of loops; i.e., flat symmetric loop model and cylindrical symmetric loop model. The magnetic field is assumed to be static and associated with only inhomogeneities in plasma density. The solution under initial boundary condition and the ohmic dissipation have been discussed.

**Key words:** MHD-Sun: corona, magnetic field.

## 1. Introduction

In a magnetized medium shear Alfvén waves propagate independently on each magnetic field line when the dissipative agents such as resistivity and viscosity are absent (Browning 1991; Davila 1987, Nakariakov et al. 1997). When the medium possesses resistivity and viscosity, the waves propagating on neighbouring field lines get coupled with medium agents. If there is an Alfvén gradient (inhomogeneity in density etc.) the field lines come closer at points where the density is smaller and so the larger Alfvén wave speed. Some structures may not be allowed to propagate up to infinity. Thus the wave propagating on neighbouring field surfaces becomes more and more out of phase as they propagate onwards due to momentum exchange caused by viscosity and energy dissipation due to resistivity. This process is known as phase-mixing in space and it requires several wavelengths to develop. The waves most likely to dissipate by this mechanism are the short period waves  $\sim 10$  sec propagating in magnetic fields  $\sim 10G$  in a medium having number density  $\sim 10^{11} \text{ cm}^{-3}$ . As a result of such dissipation the turbulence in the medium increases and the effective transport coefficients (resistivity and viscosity) get enhanced. This helps in more existing of phase-mixing and the number of wavelengths over which phase-mixing becomes effective depends upon the value of the dissipative coefficients. However, some of the structures do not allow propagation to infinity (or longer extent), such as coronal loops (or open magnetic field lines) with more stratification so that reflection is produced in such cases phase-mixing occurs in time. This phenomenon has been intensively stud-

ied by Tsiklauri et al. 2003, Botha et al. 2000, Ofman and Aschwanden (2002) analytically. The waves may suffer multiple reflection in such a structure. The time of a phase-mixing state in which the rate of dissipation balances exactly the rate at which the waves are excited which depends upon the values of dissipative coefficients (Hood, et al. 1997a, Heyvaerts and Priest 1983, Priest 1993). The concept of non-zero gyro-radius of the ions was introduced by Voitenko and Goossens (2000) with the creation of short transverse length scales in Alfvén waves. The Alfvén waves become essential in the sense that they have long wavelengths and low energy along the magnetic field however short-wavelengths across high energy. In this situation the ion polarization drift in the perpendicular direction creates a charge separation across equilibrium magnetic field  $\mathbf{B}_0$ , while field aligned electron flows tend to cancel this charge separation and thus the motions of the ions and electrons decouple from each other. A shear Alfvén wave propagating in a laterally inhomogeneous structure develops strong velocity gradients due to phase-mixing. The strong gradients are subject to ohmic and viscous dissipation so that phase-mixing may greatly enhance the damping of Alfvén waves and thus provide a viable mechanism for coronal heating (Narain and Ulmschneider 1990, Narain et al. 2001).

## 2. Basic MHD equations

We are expressing the foot-point motion excites linear Alfvén waves in the cavity of coronal loop and we assume to be inhomogeneous only in the x-direction. For the low value of  $\beta (= P_{\text{thermal}}/P_{\text{magnetic}})$  linearized re-

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sistive MHD equations are

$$\rho \frac{\partial \mathbf{v}}{\partial t} = -\nabla P_1 + \frac{1}{\mu} [(\nabla \times \mathbf{B}_1) \times \mathbf{B}_0 + (\nabla \times \mathbf{B}_0) \times \mathbf{B}_1] + \rho \nu \nabla^2 \mathbf{v}; \quad (1)$$

$$\frac{\partial \mathbf{B}_1}{\partial t} = \nabla \times (\mathbf{v} \times \mathbf{B}_0) + \eta \nabla^2 \mathbf{B}_1; \quad (2)$$

$$\frac{\partial \rho_1}{\partial t} + \rho \nabla \cdot \mathbf{v} = 0. \quad (3)$$

Here  $\rho$  and  $\mathbf{B}_0$  are the equilibrium density and magnetic field,  $\rho_1$ ,  $p_1$ ,  $\mathbf{v}$  and  $\mathbf{B}_1$  are the perturbation of the density, pressure, Alfvén wave velocity and corresponding magnetic field respectively. Here the equilibrium velocity is zero. By expressing the wave frequency space dependent in terms of Alfvén velocity and wave number

$$\omega(x) = v_A(x)k, \quad (4)$$

where  $k = \frac{2\pi}{L}$ , and  $L$  is the loop length. For non dissipative plasma the velocity gradient becomes

$$\frac{\partial v}{\partial x} = v.t.\omega'(x). \quad (5)$$

The linear Alfvén wave having its velocity

$$v = \exp[i\omega(x)t - ikz]. \quad (6)$$

The velocity gradient corresponding to x-direction equation (5) which increases with time and it represents that the wave are phase-mixed with respect to time (Hood et al. 1997a). Thus the different frequency on each field line means that initially in phase but when wave motion move becomes out of phase with respect to each other which provide phase-mixing.

Here we consider two symmetries for the coronal loops:

- (i) Flat symmetric loop model.
- (ii) Cylindrically symmetric loop model.

For the flat symmetric loop model, we assume that the density is only a function of the horizontal distance (flat)

$$\rho = \rho(x) \quad (7)$$

and the plasma only moves in the y-direction, the velocity and magnetic field becomes

$$\mathbf{v} = v(x, t) \sin kz \hat{e}_y; \quad (8)$$

$$\mathbf{B}_1 = B(x, t) \cos kz \hat{e}_y. \quad (9)$$

Flat symmetry loop model represent that the line tied disturbances that vanish at the photospheric ends of the coronal loops (Hood et al., 1997a). In the cylindrically symmetric model, we assume that the plasma

is cylindrically symmetric and it only moves in the  $\theta$  direction and we get

$$\mathbf{v} = v(r, t) \sin kz \hat{e}_\theta; \quad (10)$$

$$\mathbf{B}_1 = B(r, t) \cos kz \hat{e}_\theta \quad (11)$$

by considering equilibrium state so that the equilibrium velocity is zero. We adopt the cylindrical coordinates  $r$ ,  $\theta$  and  $z$  and we assume that  $\rho$  and  $\mathbf{B}_0$  depend on  $r$  and  $\mathbf{B}_0$  is in the  $z$ -direction. Thus, the phase-mixing equation can be obtained from equations (1) and (2) in cylindrically symmetric model.

$$\frac{\partial^2 \mathbf{B}}{\partial t^2} = -k^2 v_A^2(r) \mathbf{B} + \eta \nabla^2 \frac{\partial \mathbf{B}}{\partial t}. \quad (12)$$

However, for flat symmetric model the phase mixing equation can be written as

$$\frac{\partial^2 \mathbf{B}}{\partial t^2} = -k^2 v_A^2(x) \mathbf{B} + \eta \frac{\partial^2}{\partial x^2} \frac{\partial \mathbf{B}}{\partial t} \quad (13)$$

from equations (12) and (13) it is clear that the two different geometries can be studied by any one of the above equation (12 or 13) is exactly the same by replacing  $x$  by  $r$  or vice-versa. Both term on right hand side of equation (12) or (13) are responsible for phase-mixing. The second term is of less importance for large horizontal gradient.

### 3. The solution under the initial boundary conditions

Let us consider the equilibrium configurations in the form of a magnetic cylinder with coronal loop of length  $L$ . At the foot points of the loop determined by  $Z = 0$  and  $Z = L$ , the magnetic field line are anchored in the highly dense electrically conducting photospheric plasma. It is assume to be the plasma at rest at  $z = L$ , while it moves in the azimuthal direction at  $Z = 0$ . This leads to the two boundary condition for amplitude function of magnetic field

$$B(x, 0) = 1; \quad (14)$$

$$B(0, t) = 0 \quad \text{and} \quad B(\infty, t) = 1. \quad (15)$$

In equation (13)  $v_A^2$  is the square of Alfvén speed can be expressed in the form of

$$v_A^2(x) = v_0^2 f(x), \quad (16)$$

where  $v_0$  is a typical Alfvén speed in the corona and  $f(x)$  is a dimensionless function in the transverse direction equation (16) can be expressed in terms of single parameter equation under the consideration of dimensionless variables (Hood et al. 1997a)

$$t = \bar{t} \tau_t \quad \text{and} \quad x = \bar{x} a,$$

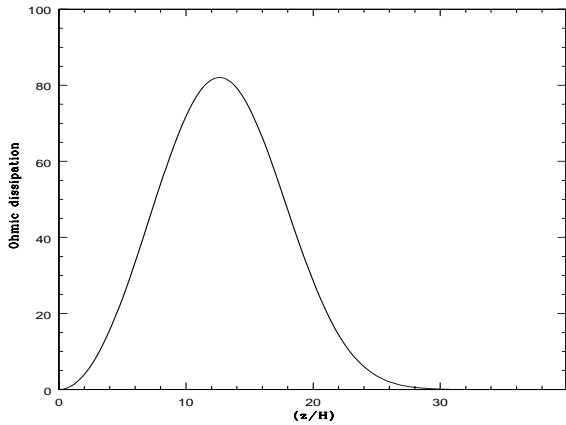


Figure 1: The ohmic dissipation as a function of height

where  $a$  is the typical length-scale for variation of Alfvén speed;  $\tau_t = (kv_0)^{-1}$  is the time for the Alfvén wave to propagate along the loop. For the sake of convenience bars are dropped and we get,

$$\frac{\partial^2 \mathbf{B}}{\partial t^2} = -f(x)\mathbf{B} + \delta \frac{\partial^2}{\partial x^2} \frac{\partial \mathbf{B}}{\partial t} \quad (17)$$

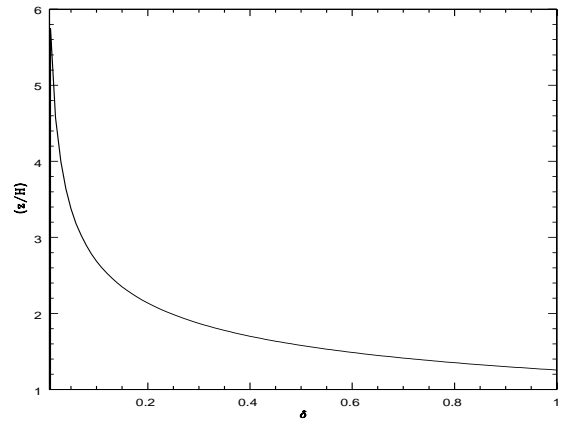
and

$$\delta = \frac{\eta}{a^2} \tau_t = \frac{\tau_t L^2}{\tau_d a^2}, \quad (18)$$

where  $\delta$  is the ratio of the Alfvén travel time ( $\tau_t$ ) to diffusion time ( $\tau_d$ ). We are not taking into the account of viscosity for our further treatment. However, Heyvaerts and Priest (1983) and Ruderman (1999) included a kinematic viscosity of the form  $\rho \nu \nabla^2 v$  since the flow is incompressible for the Alfvén waves. The dissipation coefficient changed from  $\eta$  to  $\eta + \nu$  in equation (12) by the effect of kinematic viscosity. We found that there is no change in the solution of equation (13). Here we also discussed, that the dominant viscosity coefficient is parallel to equilibrium magnetic field. However, for the incompressible Alfvén waves with no velocity component parallel to equilibrium magnetic field does not contribute for the heating of solar corona. Therefore, the remaining terms are small and not taken into the account. Also, viscosity can easily be included by simply changing the dissipation coefficient.

#### 4. Ohmic Dissipation

The presence of resistance in the medium by which the energy of the wave is transferred into heat through ohmic dissipation. The associated current,  $\text{curl } \mathbf{B} = \frac{4\pi}{c} \mathbf{J}$  suffer dissipation through the resistivity of the medium, where  $\mathbf{J}$  is the current density. The reflection of wave propagating along field lines also causes momentum exchange between electrons and ions. The time taken to

Figure 2: The variation of height with respect to  $\delta$  for maximum dissipation

reach a phase-mixed stage, in which the rate of dissipation balances exactly the rate at which the waves are excited depends upon the value of the dissipative coefficients. Under initial condition  $x = 0$ ,  $H = Z/s$  the ohmic dissipation become analytically obtained as by using the formulism (Hood et al. 1997b).

$$\frac{j^2}{\sigma} = \eta \frac{(\frac{a^2}{z^2} + 1)s^2 |\mathbf{B}|}{[1 + \delta^2 s^4]^{1/2}}. \quad (19)$$

By using approximation  $s \gg 1$ , the magnetic field may be estimated then we have

$$\frac{j^2}{\sigma} \approx \eta s^2 e^{-\delta s^3/3}. \quad (20)$$

For maximum ohmic dissipation

$$s_{max} \approx (2/\delta)^{1/3} \quad (21)$$

and

$$(\frac{j^2}{\sigma})_{max} \approx \eta (\frac{2}{\delta e})^{2/3}. \quad (22)$$

Above approximation is must valid for  $\delta s_{max}^2 \ll 1$ . Under usual condition fig(1) represent the ohmic dissipation as a function of height for  $\delta = 10^{-4}$  and  $\eta$  as unity. However Hood et al 1999(b) having similar result for  $\delta = 10^{-8}$ . However, there is also the magnitude of the wave amplitude still to be included. The maximum ohmic dissipation scales  $H_s$  under the consideration of  $\delta = \eta/(a^2 \omega)$  as

$$H_s = \eta^{1/3} \omega^{2/3} a^{4/3}, \quad (23)$$

where  $a$  is the length-scale of the plasma. This equation represents that the amount of coronal heating by phase-mixing are depends on the frequency, phase-mixing length and resistivity. By integrating equation

(20), we get the total amount of ohmic heating under considerable limits

$$\int \frac{j^2}{\sigma} dz \approx \frac{n}{\delta} = a^2 \omega. \quad (24)$$

Thus, under the approximation the total ohmic dissipation is depends on frequency and independent of resistivity. This technique physically represents that the ohmic dissipation. Fig(2) shows that the height of the maximum ohmic heating as a function of  $\delta$ .

## 5. Discussion and conclusions

The Lundquist number  $S$  followed by Hood et al. (1997b). In terms of the size of the coronal loop region  $A$

$$S = \frac{A^2 \omega}{\eta}. \quad (25)$$

Numerically by taking the loop length  $L$  ranging from  $10^6$  to  $10^8$  m,  $L/a \approx 10$  and  $v_{A0} \approx 2 \times 10^6$  m/s (Karpen et al. 1994, Ofman et al. 1995) then the time of maximum ohmic dissipation is obtained as

$$t_{max} \approx s^{1/3} \times 10^{-2} \quad (26)$$

in seconds. For high Lundquist number  $S = 10^{12}$ , we get  $10^2$  to  $10^4$  seconds of maximum phase-mixing ohmic dissipation (Woo, 1996 and Malara et al. 2001). Phase-mixing is the main mechanism which is responsible for keeping hot coronal loops, provided that the disturbances (pulses) are repeated severally. According to Narain et al. (2001) a shear Alfvén wave propagating in a laterally inhomogeneous structure develops strong velocity gradients due to phase-mixing. From fig(1) it is clear that the location of ohmic dissipation and their corresponding maximum value can be estimated. However fig(2) represents that the hight of maximum dissipation depends on the value of  $\delta$  and therefore on the value of  $a$ ,  $\eta$  and  $\omega$ . The dissipation height decreases as  $\delta$  increases. A highly appreciable work has been done by Hood et al. in this field. The strong gradients are subjected to ohmic and viscous dissipation so that phase-mixing may greatly enhanced the damping of Alfvén waves and this provide mechanism for coronal heating. It is concluded that the solar coronal heating by Phase-mixing is the dominant process.

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# A COLLAPSING POLYTROPE

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The general results for the gravitational collapse of a polytrope are obtained for whatever polytropic configuration with index  $n \in (0.5)$ . The time-dependence of the solution is analyzed and the collapsing time is determined. This is important for the determination of the time-scale for collapse of polytropes, which will be compared with the stellar free-fall time.

Key words: Astrophysics, stellar evolution, gravitational collapse

## 1. Introduction

The different aspects of this phenomenon encountered in the early stellar evolution as well as final stages was analyzed in many papers. For examples, Goldreich and Weber (1980) were analyzed the gravitational collapse of a polytrope of index  $n = 3$ , the obtained solution been useful for the study of the collapse of a white dwarf that reaches the Chandrasekhar limit or for the understanding of the collapse of a stellar core causing a supernova outburst.

In the following I will find the solution for the problem of the gravitational collapse of a polytropic configuration for every  $n \in (0.5)$  (which is supposed, for instant, to be time dependent) and the polytropic constant  $K$  having a time dependence:  $K = K(t)$ . The case in which  $n$  and  $K$  have not a time dependence was studied by Ureche (1999). The total mass  $M$  and the chemical composition  $\mu$  are known and are keeping constant. We suppose that the star consist of the ideal gas (the pressure will be  $P = P_{gas} = \frac{\mathcal{K}}{\mu} \rho T$ ). The central pressure, the central temperature and the polytropic index at the initial moment  $t = 0$  are:  $P_{c0}, T_{c0}$  respectively  $n_0$  (and they are known). We'll see that in the time of motion the polytropic index is time independent while the polytropic constant is time dependent.

## 2. Basic equations of collapse

The spherical-symmetric collapse will be described by the following equations:

1. The equation of motion of an ideal fluid (equation of Euler):

$$\frac{\partial v_r}{\partial t} + v_r \frac{\partial v_r}{\partial r} + \frac{1}{\rho} \frac{\partial P}{\partial r} + \frac{\partial \Phi}{\partial r} = 0. \quad (1)$$

2. The continuity equation:

$$\frac{1}{\rho} \frac{d\rho}{dt} + \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 v_r) = 0. \quad (2)$$

3. The polytropic equation of state:

$$P = K \rho^{1+\frac{1}{n}}. \quad (3)$$

4. And Poisson's equation:

$$\frac{1}{r^2} \frac{\partial}{\partial r} \left( r^2 \frac{\partial \Phi}{\partial r} \right) = 4\pi G \rho, \quad (4)$$

where the notations are usual (Chandrasekhar, 1939; Cox and Giuli, 1968; Kippenhahn and Weigert, 1991).

We define the dimensionless scale  $z$ :

$$\begin{aligned} r &= a(t) z; \\ v_r &= \dot{a} z, \end{aligned} \quad (5)$$

where  $z$  is time independent and the whole time dependence of  $r$  is contained in  $a(t)$ . We introduce a velocity potential  $\Psi$  by

$$v_r = \frac{\partial \Psi}{\partial r}. \quad (6)$$

Then we can write:

$$\begin{aligned} a v_r &= \dot{a} z = a \frac{\partial \Psi}{\partial r} = \frac{\partial \Psi}{\partial z}; \\ \Psi &= \frac{1}{2} \dot{a} z^2. \end{aligned} \quad (7)$$

The time derivative of  $\Psi$  in the comoving frame is:

$$\frac{d\Psi}{dt} = \frac{\partial \Psi}{\partial t} + v_r \frac{\partial \Psi}{\partial r} = \frac{\partial \Psi}{\partial t} + (\dot{a} z)^2. \quad (8)$$

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We introduce the Emden's variable (with the notation of Kippenhahn and Weigert, 1991)  $w(z)$  by  $\rho = \rho_c w(z)^n$ . There  $\rho_c$  is a time dependent function. We fix  $a = \frac{r}{z}$  by:

$$\frac{1}{a^2} = \frac{4\pi G}{(n+1)K} \rho_c^{1-\frac{1}{n}}. \quad (9)$$

The continuity equation (5) may be written:

$$\frac{1}{\rho} \frac{d\rho}{dt} + \frac{1}{z^2 a^2} \frac{\partial}{\partial z} \left( z^2 \frac{\partial \Psi}{\partial z} \right) = 0 \quad (10)$$

or, using (7):

$$\frac{1}{\rho} \frac{d\rho}{dt} + \frac{3}{a} \frac{da}{dt} = 0. \quad (11)$$

After the integration with respect the time we obtain:

$$\rho = \rho_0 \frac{a_0^3}{a^3}, \quad (12)$$

where  $\rho_0 = \rho(z, 0)$  and  $a_0 = a(0)$ . For the stellar center eq. (12) is writing:

$$\rho_c = \rho_{c0} \frac{a_0^3}{a^3}, \quad (13)$$

where  $\rho_{c0} = \rho_c(0)$ . From (12) and (13) we obtain:

$$\frac{\rho}{\rho_0} = \frac{\rho_c}{\rho_{c0}} = \frac{a_0^3}{a^3}. \quad (14)$$

From the definition of  $w(z)$  we have at  $t$  moment:  $\rho = \rho_c w(z)^n$ , and at  $t = 0$ :  $\rho_0 = \rho_{c0} w(z)^{n_0}$  from which we have (using (14)) that  $n = n_0$  anytime. Therefore, the polytropic index is constant in time of motion and the change is homologous. From (9) we have:

$$\rho_c^{\frac{1}{n}} = \frac{4\pi G}{(n+1)K} a^2 \rho_c \quad (15)$$

and, using (13):

$$\rho_c^{\frac{1}{n}} = \frac{4\pi G}{(n+1)K} \frac{a_0^3}{a} \rho_{c0}. \quad (16)$$

We define:

$$h = \int \frac{dP}{\rho} = (n+1) K \rho^{\frac{1}{n}}, \quad (17)$$

which may be written using (16):

$$h = \frac{4\pi G \rho_{c0} a_0^3}{a} w(z). \quad (18)$$

We try a similar dependence of  $\Phi$  on  $t$  and write:

$$\Phi = \frac{4\pi G \rho_{c0} a_0^3}{a} g(z), \quad (19)$$

which defines the dimensionless function  $g(z)$ .

Using (7) and (17) eq. (4) is writing:

$$\frac{\partial^2 \Psi}{\partial r \partial t} + \frac{1}{2} \frac{\partial}{\partial r} \left( \frac{\partial \Psi}{\partial r} \right)^2 + \frac{\partial \Psi}{\partial r} + \frac{\partial h}{\partial r} = 0, \quad (20)$$

which can be integrated with respect to  $r$ . If we set the integration constant to zero, replace  $\frac{\partial \Psi}{\partial r}$  by  $\dot{a} z$  and using (8) we find that:

$$\frac{d\Psi}{dt} = \frac{1}{2} \dot{a}^2 z^2 - \Phi - h \quad (21)$$

and, using (7), we obtain:

$$\frac{1}{2} a \ddot{a} z^2 = -\Phi - h. \quad (22)$$

If we replace (18), (19) in (22) we obtain:

$$\frac{1}{2} a \ddot{a} z^2 = -\frac{4\pi G \rho_{c0} a_0^3}{a} [g(z) + w(z)] \quad (23)$$

or

$$\frac{1}{8\pi G \rho_{c0} a_0^3} a^2 \ddot{a} = -\frac{g(z) + w(z)}{z^2}. \quad (24)$$

Since the left hand side is a function of  $t$  only the right-hand side is a function of  $z$  only, both sides must be constant:

$$\frac{3}{4\pi G \rho_{c0} a_0^3} a^2 \ddot{a} = -\lambda; \quad (25)$$

$$6 \frac{g(z) + w(z)}{z^2} = \lambda, \quad (26)$$

where  $\lambda = \text{constant}$ . Eq. (25) can be integrated twice:

$$a(t) = a_0 \left( 1 - \frac{3}{2} \sqrt{\frac{8\pi}{3}} G \rho_{c0} \lambda t \right)^{\frac{2}{3}}. \quad (27)$$

The solution  $a(t)$  given by (27) is depending on the polytropic index  $n$  through  $a_0$ . In the following we determine  $w(z)$ . Poisson equation:

$$\frac{1}{z^2} \frac{\partial}{\partial z} \left( z^2 \frac{\partial \Phi}{\partial z} \right) = 4\pi G \rho a^2. \quad (28)$$

If we replace  $\Phi$  by (19),  $g(z)$  by (26) and  $\rho$  by (12) we find:

$$\frac{1}{z^2} \frac{d}{dz} \left( z^2 \frac{dw}{dz} \right) + w(z)^n = \lambda. \quad (29)$$

For  $\lambda = 0$  this is the classical Emden equation. For  $\lambda \neq 0$  the solution deviate from hydrostatic equilibrium. Physically relevant solutions are obtained for  $0 \leq \lambda \leq \lambda_m$ , where  $\lambda = \lambda_m$  corresponds to the strongest deviation from equilibrium.



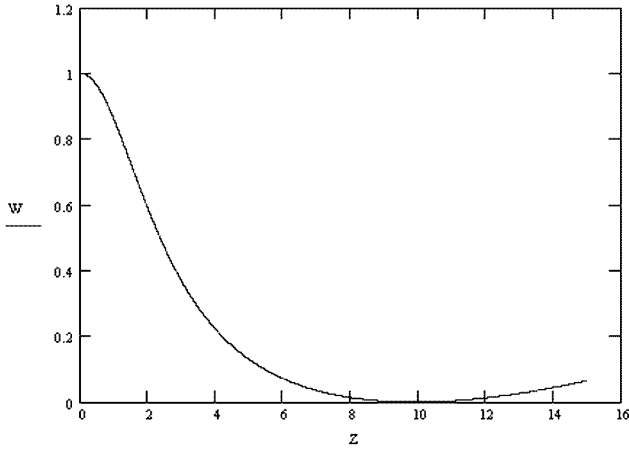


Figure 1: (Case  $n=3$ ) A plot of solution of eq. (29) with  $\lambda_m=0.006545$ . In this case,  $z_m=9.889$  and  $w(z_m)=1.6611 \times 10^{-5}$

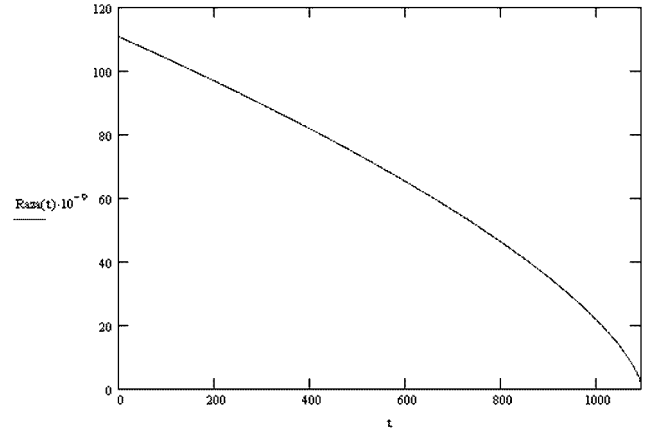


Figure 3: (Case  $n=3$ ) The stellar radius variation when the relativistic effects are not used

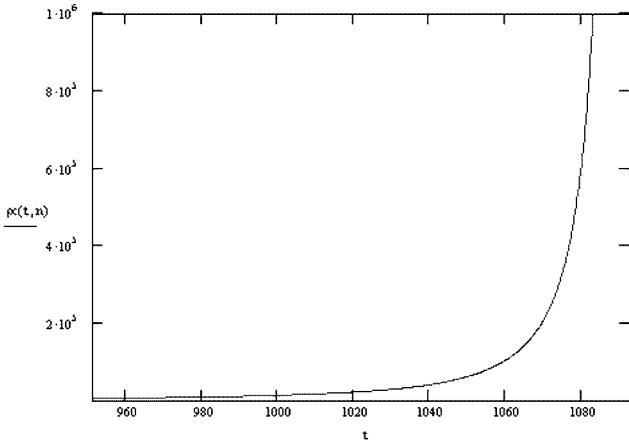


Figure 2: (Case  $n=3$ ) The variation in time of central density when the relativistic effects are not used

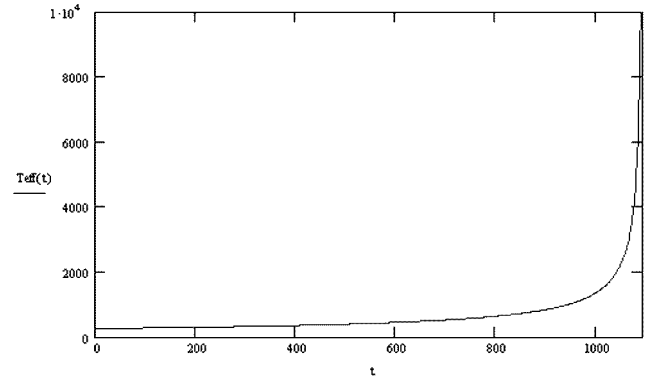


Figure 4: (Case  $n=3$ ) The effective temperature variation when the relativistic effects are not used

### 3. Numerical results

For  $\lambda_m$  we have the following values:  $\lambda_m = 0.40005$  for  $n = 0.5$ ,  $\lambda_m = 0.1785$  for  $n = 1$ ,  $\lambda_m = 0.0826$  for  $n = \frac{3}{2}$  and  $\lambda_m = 0.006545$  for  $n = 3$ . For a polytropic configuration with central pressure and temperature at  $t = 0$  equals with  $2.7 \times 10^{17}$  dyn/cm<sup>2</sup> respectively  $1.6 \times 10^7$  K we obtain for the collapsing time:

$$t_{coll} = \frac{1}{\sqrt{6\pi G \rho_{c0} \lambda_m}} \quad (30)$$

the following values:  $t_{coll} = 139.9445$  sec for  $n = 0.5$ ,  $t_{coll} = 209.504$  sec for  $n = 1$ ,  $t_{coll} = 307.980$  sec for  $n = \frac{3}{2}$  and  $t_{coll} = 1.094 \times 10^3$  sec for  $n = 3$ . The variations in time of central density, radius, effective temperature, polytropic constant and luminosity are plotted in Figs 2, 3, 4, 5 and 6.

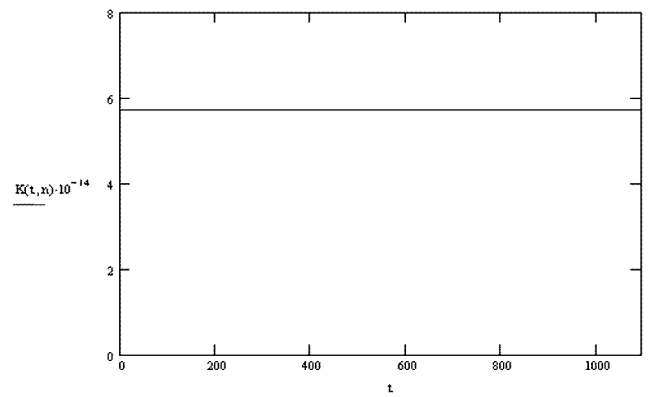


Figure 5: (Case  $n=3$ ) The variation of the polytropic constant K

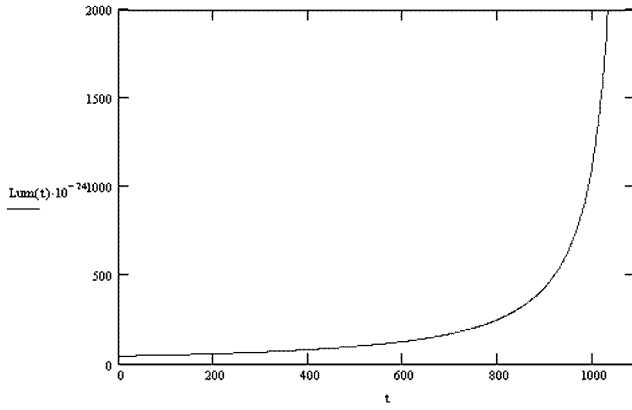


Figure 6: (Case  $n=3$ ) The luminosity variation

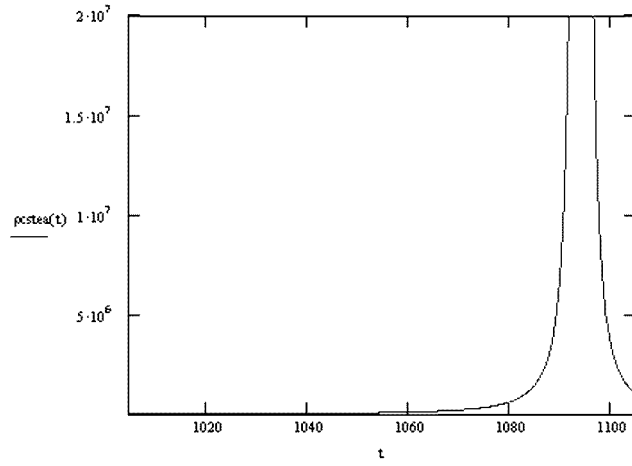


Figure 7: (Case  $n=3$ ) The central density variation when the relativistic effects are used

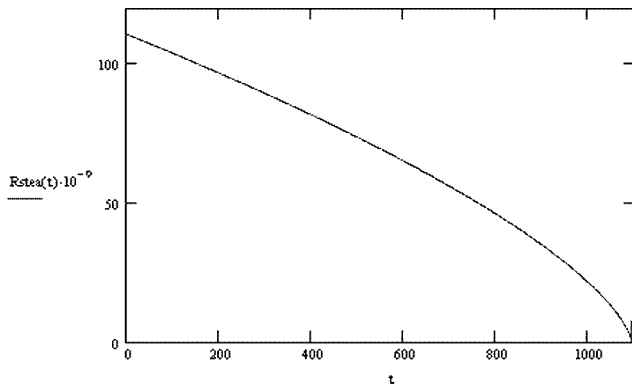


Figure 8: (Case  $n=3$ ) The stellar radius variation when the relativistic effects are used

Until this moment, we doesn't use the relativistic effects in the case in which the density is greater than critic value  $9.74 \times 10^5 \text{ g/cm}^3$ . For example, for  $n = 1.5$  the electronic gas from the stellar center become relativistic after 304.836 sec from the beginning and after 307.977 sec the whole star become relativistic. In this case, the star is a polytrope with  $n = 3$  and polytropic constant  $K = 1.2435 \times 10^{15}$ . The collapsing time is  $t_{coll} = 319.141 \text{ sec}$ . The central density and the stellar radius variation are plotted in Figs 7 and 8.

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# ON NATURAL STRUCTURES: COMPLEMENTARY ISSUES

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In this paper the propositions developed in a previous paper [30] are complemented by the identification of some of the kinds of natural structures which develop from their dependence on NE-connection and from other inherent characteristics pertaining to them. Also it is stated that, although natural structure theory has some resemblance to other theoretical developments, it is clearly differentiated from them. This is complemented by a demonstration of the possibilities for further research and applications that the theory offers, perhaps to improve all this a generalization of the definition of a NE is given and it is noted that NEs have no scale.

## Introduction

After the presentation of the general developments of the theory of NEs in a previous paper it is necessary to list the kinds of NEs that at present are possible of being recognized, therefore this is intended here.

A necessary final step becomes the remark of some points to clarify and emphasize them, also the clarification of the relation between NEs and other, more or less, similar underpinnings and the remarks of the possibilities that the theory has are addressed.

## 1. Remarks and perspectives

### 1.1. Some general remarks

It is necessary to differentiate between NE-connection, relation, and interaction. Since the first has already been defined we shall concentrate on the other two. A relation between two or more entities is the unidirectional, bidirectional or multidirectional exchange of matter, energy or something else between them. It could be possible for a relationship to exist between an entity and itself. Interaction is the influence, in some form, of one or more entities on one or more other entities. It may be unidirectional, bidirectional or multidirectional, or, in the case of the influence of an entity on itself, autodirectional. Interaction embraces relation and NE-connection. It is not necessary for two or more entities to be NE-connected for a relation to exist between them. Also, NE-connected entities may be related or not. What is clear is that any time a NE-connection arises between two or more entities, a NE is formed.

With respect to being, while it might appear that two distinctive characteristics of being are conscious-

ness and the capacity to think, at present them cannot be added to the definition because there are entities which are indisputably beings but it is uncertain whether they are conscious and able to think or not; like a bacterium for instance.

It also could be worth to comment that although it could exist absolute position, in the sense that if there would be only one entity this by necessity would be in some place, the only position possible to be determined is relative position, because to do that it is necessary the existence of more than one entity to make reference to each other.

Two remarks about process. Firstly that it does not necessarily have to be continuous; and secondly that a sequence of only two steps is all that is necessary to make a process.

As has been stated above, in a general sense nature is composed entirely of natural structures. But are fields also NEs or a special kind of NE? Could a fundamental third thing exist, which is a NE or special kind of NE? Would this be related to the vacuum and/or to Einsteinian space-time, and are these also NEs?

Another possibility left open is the existence of macro NEs, in the sense that the universe we know might only be a sub-universe, part of a greater NE (the universe), and NE-connected with other similar NEs (sub-universes) by means of white holes and black holes; the former would be the entry gate for energy (and perhaps matter) and source of the existence of quasars and other cosmological objects, and the latter would be the exit gate for energy (and perhaps matter). For example it is probable that there are black holes at the centre of spiral galaxies, and that these galaxies are on their way out of our sub-universe. It might also be possible that at least some of these holes have a double function, i.e., acting alternately as both entry and exit gates. It is also possible that these are combined with

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wormholes which make effective the NE-connection between them.

It is necessary to refer to one other probable property of NEs, which might appear to be obvious, which is hierarchy. However since the meaning of this term is somewhat blurred it will be analyzed in a specific study.

With respect to finiteness, it appears necessary to clarify that NEs would be finite because, since they exist, they are differentiated from each other (i.e., they are not merged into one another), creating boundaries between them. Otherwise there would be only one entity, which could be infinite. It is also possible that the fact that all the elements of a NE must be NE-connected to it will mean that all NEs have a boundary and are thus finite. There are some propositions which state that our universe or subuniverse is infinite, but since it had a beginning being very tiny and then it is expanding it must be finite at any time. Since the new ekpyrotic-cyclic model of the universe (Khoury, Ovrut, Steinhardt, and Turok, 2001; Steinhardt and Turok, 2002; ) is gaining acceptance it deserves being considered the finiteness or not of the universe under its propositions. This model follows Horava and Witten (1996a, 1996b) and others propositions in which the universe is considered bounded by two branes, if it is the case it is finite. Also it is considered that this two branes approach and collide to separate again which makes it finite. Being cyclic these process the branes cannot separate infinitely because its separation has to come to a halt in order to approach again. In addition, to separate and/or expand to infinity does not mean than something is infinite, it is finite separating or expanding to infinity. Also the fact that it begins to expand means that it is beginning in a finite state. In the model it is supposed that the membranes are infinite, but first the branes in the direction of the movement are not infinite, because if so they will not be membranes they will be totally mixed being only one entity. Second the fact that one or more of the components of an entity (the universe in this case) have a couple of its dimensions infinite does not mean that the whole entity is infinite. But the fact that the branes are infinite is an initial supposed condition which is unnecessary, equally, it might be supposed to be finite without any constrain to the model. Therefore, there is not any compelling argument to assure that they are of infinite extension in any direction. Also it is probably that if the branes are infinite in wide and length this would made them very difficult to move. In addition, it seems that a characteristic of a membrane is to have borders being finite in this way. Also if the branes are almost empty, as is supposed, to be membranes they must have border. All the above does not exclude the possibility of an infinite NE, which in some way (i.e., sense) would embrace all other NEs.

One final point worth to be mentioned is the fact that entities can be penetrated by others because they are composed of sub-entities (i.e., they possess ele-

ments). To penetrate an entity the NE- connection(s) must be broken down in such a way that the NE-connected entities can be put away. This means that if an entity is composed of only one element it is not possible to be penetrated by any other entity. Also the fact that entities can be folded or bent is owing to they are composed of NE-connected sub-entities, being the folding or bending possible to be made in the places where the NE-connections are. Therefore, this case also means that if an entity is formed of only one element it is not possible to be folded or bent.

## 1.2. Some similarities and differences with respect to structuralism, system theory and complexity

Some may consider that NEs is a branch of structuralism and/or system theory and/or complexity, but this is not the case. It may have certain similarities with structuralism, to the extent that both are concerned with the same underlying entity which could be termed structure; but structuralism, which defines structure as a system of transformations or a set of internal relations (Caws, 1988; Piaget 1968; Rickart 1995; Webster 1982; and Webster 1989), deviates from this entity when it takes as fundamental the “actions” (relations, transformations, etc) which may occur among the members (parts, elements, constituents, etc.) which make up a structure, thereby confounding the thing (structure) with what could be some of its resultant characteristics. Another difference is that NEs are, as their name indicates, natural, while structuralism embraces mathematical, logical and linguistic structures. Finally, of the three basic properties attributed by structuralism to structures, only wholeness seems to belong to NEs, while the other two, transformation and self-regulation, are properties only of some specific NEs, and in addition they may well be properties of these NEs to only a partial or limited extent. Moreover, with respect to transformations, there is no clear agreement between the different propositions of structuralism, as shown by Rickart (1995).

NEs has certain similarities with system theory, in that its central object — a NE — is similar in some respects with the definition of a system selected by Klir (1993); however as Klir also makes clear, this is only one of several possible definitions of a system, which is a term that is virtually never explicitly defined by the proponents of system theory. Thus it is not clear what a system is, in contrast to a NE which is defined in detail. Moreover there are small but significant differences between NEs and the definition of a system selected by Klir, with respect to what are referred to in a rather diffuse way as the specifications of a system. This term refers to the set or arrangement of a system, with its internal relations or connections, which however appear to be two different things, and it is not clear

what all these things mean, nor what is meant by the term organic whole, and whether this is distinct from a whole. By contrast, in the case of NEs, everything is clearly defined. Moreover system theory uses “thing” as a term, thereby conferring a degree of generality on a system which makes its meaning more diffuse; this is different from the use of the word “thing” in NEs, where it is used just when some generality is required, but not as a central term as in system theory. But the greatest difference is that a NE, as described above, approximates nature, because NEs exist in the real world (whatever it is), while systems, as correctly noted by Klir (1993) do not exist in the real world (i.e., they are non-real).

In addition, it is worth commenting on the use of the term “common sense” by Klir with reference to the definition of a system which he selects. It seems that to a mathematician, a definition which is not established in mathematical terms is simply “common sense”. In fact there are a lot of definitions established in ordinary language, because this is the way in which they must be established; while a lot of so-called definitions established in mathematical terms are simply formulas. They tell you how to calculate something, but they do not provide a definition; they do not tell you what that something is. The fact that the definition selected by Klir appears in a dictionary and not in a scientific review does not invalidate its scientific nature, nor its vagueness which is also a common feature of many scientific definitions (i.e., the failure to define key terms used in the definition).

NEs might have certain features in common with complexity, in that it sees nature as one and complexity also tends towards a unification of nature in some respects. However, the flavor of complexity is that of a mixture of different sciences, while NEs is a truly different vision that transcends all sciences.

Moreover, it seems that nobody knows what complexity is. As Horgan (1995) shows, several different definitions of complexity exist, and practically anything that a researcher wish may be included under its heading, while in the case of NEs, what a NE is has been exactly defined and from there everything else follows an ordered path.

### 1.3. Possibilities and perspectives

Until now science has been divided and separated into diverse fields, dealing with nature as if it were divided into different compartments. Although this practice has some advantages when it comes to the study of very specific problems, as a result the vision of the whole is lost (we see the trees, not the forest). Some researchers who have become aware of this flaw have tried to correct it by enhancing multidisciplinary work, but the results have not always been adequate. The restating of the oneness of nature, and the vision of it as a unity, has be-

come of paramount importance. NEs is taking up this task by studying nature as one, not by combining different scientific disciplines, but by developing a new vision which transcends the different sciences. In this way, the distinct sciences may make use of the ideas which are developed by NEs and these in turn will, enable them to make new findings. An indication of these possibilities could be that NEs identifies, what might be the basic unity of nature - a NE, thus opening up the possibility of improving the different scientific fields. This possibility appears to be expressed by Feinberg (1987), when he states that contemporary relativistic quantum mechanics is not a complete physical theory because, among other things, a complete theory should have to specify what entities actually exist in the universe. However, as made clear above, a NE is just such a basic entity which might form the starting point for the development of studies in other scientific fields. This point is also understood by Allen and Hoekstra (1992), who point out that “to accommodate change, there must be some defined structure, a thing to change state ... If ecologists are to pull the loose ends of their discipline together, then they must seek natural structure ... This is another way of saying that science should seek that which is robust to transformation and persists when viewed under different criteria.” They also refer to connection (NE-connection in the present theory). “The inside of a natural entity is strongly interconnected ... Connections inside the cycles are strong relative to the connections to the outside world ... Although the strong bonds inside an entity hold it together ... The weak connections between the lower level entities, between the parts, become the strong connections that give integrity to the entity at the upper level, the whole.” As can be seen from this extract, they have an intuition of the close relation between NE-connection, whole, and NE. Margalef (1972) also has the same intuition when he states “It is rather doubtful if we can collect together, as examples of the same category of phenomena, galaxies, stars, Rossby waves in the atmosphere, crustal plates in the lithosphere, eddies in the oceans, crystals in molecules, brains and human groups, but I am seriously tempted to try.”

Which is also remarkable is that NEs may have a close relation and usefulness to the development of constructive dynamical systems which is intended to understand biological organization and self-maintaining organizations in general because there it is called attention to the structural basis of biological order and the interactions among objects are specified internally to them as a function of their structure and this is tied to the construction of more objects (Fontana and Buss, 1994, 1996).

NEs brings new ideas and the possibility of the apparition of new others, because of its focus on the oneness of nature and its use of an objectivity principle. Its way of looking at nature, very different from other ap-

proaches, can and will produce new insights to deepen and improve our knowledge of nature. NEs also opens up the possibility of new mathematical developments to describe this new point of view. At first sight it appears that topology, category theory and maybe lattice theory will do the job, but they may require modifications and perhaps genuinely new developments will be necessary. Within philosophy, too, there is scope for the formulation of new axioms, and perhaps also for a new analysis of old ones. The study of some of these (especially the ones presented here) will be developed in forthcoming papers.

On the basis of these new insights, the possibility of practical application is clearly open, both in the different pure and applied sciences and in the technological field. A case in point might be the G. de Mistral's designed Velcro's hooks and loops (Jacobs, 1996) or Klibanov's (1995) claims with respect to the need to learn much more about the strength and scope of enzyme memory and other related issues, which could only come about as a result of structural research. Something similar is expressed by Trimmer (2001) "Several model-building biologists suspect that what most strongly affects how a cell behaves in response to a drug or disease is not whether any particular gene is turned up or down, and not whether any single protein is blocked, but how all the genes and proteins interact dynamically. Like a connect-the-dots flip book, the story emerges from the links..." Also it could be of some help in proteomics where one of the important points is the fact that proteins are assembled into networks to do their work (Ezzell, 2002). On this respect what is an interesting growing field, network theory, seems to be complementary to NEs, with the possibility of the nodes being the elements of NEs and the links being the NE-Cs. In reality, networks are taking the aspect of relations in general which would mean that not all of them are NEs, but all of them seem more strongly pertaining to a property of NEs: form. Also in some cases the networks may be GNEs (see below). From the different examples that can be picked up it can be chosen the one of the cell in which we have that the cellular components in some cases are related by reactions and in others by NE-Cs. Perhaps, at least some, are also NE-Cs owing to the biochemical reactions. Therefore, NE theory offers an approach to the same entities as network theory but from a something different point of view, in this way both working together may offer new insights and solutions to all the entities that are accomplished by network theory. These possibilities can be seen in Barabasi and Bonabeau (2003), Barabasi (2003), Watts and Stogatz (1998), and Stogatz (2001). Also it is worth of noting that there are some entities that are not scale-free networks like crystal lattices or whose data are inconclusive like food webs or the brain (Barabasi, 2003), while all of them are NEs, therefore the possibility of improving their knowledge by NE the-

ory is clearly open. In addition, there could be applications in social, economic and other fields, such as for instance tensegrity developed by K. Snelson (Snelson, 2001) and being applied to studies of cellular life origin and growth control (D. Ingber, 1998, 2000; S. Huang and D. Ingber, 2000) in which gain importance the way an entire structure distributes and balances mechanical stresses. Perhaps to improve all these developments it is worth to generalize the definition of a NE, thus we have what may be called a general natural structure (GNE) which is any entity defined exactly as a NE but relaxing some requirements, this may be made in three ways; first, elementary particles are not the base elements, in this way the base elements of a GNE can be constituted by any entity that will be the basic, primary unity to the entity in point. This means, that being the same, all the companion ideas of NEs which require elementary particles will abandon that requirement inserting instead what will be the respective base element to the corresponding case. Second, elementary particles are the base elements but the entity is made by a being inside or outside it, remaining all the other aspects pertaining to NEs. Third, its base elements are not elementary particles and the entity is made by a being inside or outside it, in this case what is indicated about the first and second cases will be accomplished. It seems that nice examples of GNEs are the ones accomplished by Turner's idea of the extended organism (Anderson, 2001).

One final point worth to be noted is that NEs have no scale, i.e., all the aspects of it are accomplished at any scale, although one possible objection might be that if elementary particles are the base elements it there could be a lower scale where NEs do not work, but to this, again, we have GNEs where elementary particles are not the base elements opening in this way the accomplishment of all the aspects of NEs to any scale.

## 2. Appendix

Here some kinds of NEs will be listed; however this list not necessarily is exhaustive.

2.1 Rigidly NE-connected means that NE-connected entities cannot change their position with respect to each other. The degree of rigidity will depend on the quantity of effort required to make the NE-connected entities change their position with respect to each other. This may occur as a result of their own action or by the action of any other entity.

Unrigidly NE-connected means that NE-connected entities can change their position with respect to each other without becoming NE-disconnected, whether or not they are able to return to their original position. This change in position can be induced by the action of the entities themselves or by the action of any other entity. The degree of unrigidity will be inversely related to

the degree of rigidity, entities being more unrigidly NE-connected when less effort is required to change their position. The change in position can also be induced by the entity made up by the NE-connected entities, this entity being defined as the possessor; or by any combination of the entities under consideration.

There are NEs which are totally rigidly or unrigidly NE-connected, and partially rigidly NE-connected which are also partially unrigidly NE-connected. NEs are totally rigidly NE-connected when all the elements are rigidly NE-connected, and partially rigidly NE-connected when at least one element is unrigidly NE-connected being the inverse with the unrigidity. There is a complete continuum between rigidly and unrigidly NE-connected, with a maximum of one corresponding to a minimum or zero of the other (i.e., we can talk of a NE which is 100% rigidly NE-connected when it is zero unrigidly NE-connected and vice versa).

The possessor can change its degree of rigidity as a consequence of internal actions, but this does not mean that the NE-connection is rigid or not. Rigidity refers to the response to the action of any entity or entities located outside of the NE-connected entities and the possessor. The NE-connected entities and the possessor can alter the NE-connection by the use of external tools, in this way acting as external entities. An example of rigidly NE-connected entity is a bone, of unrigidly NE-connected entity an arm.

2.2 Strongly NE-connected means that NE-connected entities cannot be separated easily by another entity or entities. The degree of strength will depend on the quantity of effort required to separate the NE-connected entities.

Weakly NE-connected means that the NE-connected entities can be separated easily by another entity or entities, being more weakly NE-connected the lesser is the effort required. As with rigidity there is a complete continuum between strongly and weakly NE-connected entities. For instance it is easier to separate a hair than an arm.

Also in this case, the NE-connected entities, or the possessor, may try to break down the NE-connection. In order to test the strength of the NE connection, this must be done using external tools as indicated above. The possessor may also act internally to change the degree of strength, but this does not mean that the NE-connection is a strong one or not.

Any NE may be NE-connected in any combination according to the four ways listed above (rigidly, unrigidly, strongly and weakly). This will also apply to any other entity, if there are entities other than NEs that are NE-connected at least partially.

2.3 Directly NE-connected means that there is no other element between the two or more that are NE-connected. Indirectly NE-connected means that there are one or more elements between the two or more that are NE-connected.

Totally directly NE-connected means that every element of an entity is directly NE-connected with at least one other element. There could be entities in which all the elements are directly NE-connected. Partially directly NE-connected means that at least one of the elements of an entity is not directly NE-connected with another one.

2.4 Totally NE-connected means that all the elements of an entity are NE-connected with at least one other, this means that every element of an entity is NE-connected to the whole (this must be the case for an entity to be a NE). Partially NE-connected means that there is at least one element that is not NE-connected with any other element of the entity (i.e., that is not NE-connected with at least one other element). The different levels of the entity should be taken into consideration. An entity may be totally NE-connected at the level of its elementary particles, but partially NE-connected at the level of some of its parts composed of molecules. An entity is completely totally or completely partially NE-connected when it is NE-connected in this way at all levels (i.e., from its elementary particles to the level of its largest elements).

2.5 It seems that there is a special kind of NE-connection which is the one that exists between a NE and its elements, it is the fact that the NE is tightly joined to its elements. Since a NE is composed of its elements, this kind of epiploke may be termed composition NE-connection. Since a NE is composed of NEs, each sub-NE will be NE-connected with the other elements of which it is composed by this kind of NE-connection, both to immediately inferior elements and through different layers to any other of the inferior or lower elements (e.g., the connection which exists between an organ and its atoms). It seems that in some cases there is a mutual dependence between a NE and its elements, in the sense that if one disappears the other will too.

2.6 There are two special cases of kinds of NEs that depend on the distances between their elements: these are compact and incompact. Compact is when there is no free space in the interior of an entity, for instance in a body of water like the one posited in a glass. The latter is when there is at least one free cavity in the interior of an entity, for instance a bird which has the interior of its bones just with free cavities. In general, it seems that almost any NE is incompact to some degree. The compactness should be considered as specific and general, the former referring to some determined components of the NE and the latter to all of them. In this sense almost any NE will be general-incompact. A compact entity will be more compact to the extent that the distance between its entities is lesser, the degree of compactness increasing as the distance between its elements is reduced, becoming extremely compact when the distance between the elements is zero. A kind of NE related to a compact NE would be a dense NE, de-

fined by the number of elements per unit, for example unit area or volume. To be denser does not necessarily mean to be more compact, although after a certain point an increase in density will also be an increase in compactness. In some entities this relationship could be reiterative, i.e., after a certain point an increase in density would not be accompanied by an increase in compactness, until another point is reached at which the two properties increase together, and so on.

2.7 Two or more entities may be NE-connected by more than one NE-connection, of the same type, different types or any combination of the two. Perhaps there could be some NEs that are capable of NE-disconnecting with one or more of their elements and then NE-connecting again to it or them or to only some of them; or they could be able to regenerate the element or elements, or continue to exist without it or them.

2.8 NE-connections may also be intermittent or non-intermittent. They are intermittent when they appear and disappear at intervals - either regular or irregular intervals or a combination of the two. Therefore there will also exist intermittent NEs which appear and disappear at intervals. An example might be a shoal of fishes or a flock of birds. These NEs may be termed regularly intermittent, irregularly intermittent or regularly-irregularly intermittent. The interplay between appearance and disappearance may be inherent to the NE or induced by some other entity. NE-connections and NEs being non-intermittent when they appear and disappear only once.

2.9 A NE may be closed if nothing goes out of or into it, and open if there are things which go out of and into it. It is closed-out or open in, if some thing or things only go into it; in which case the thing(s) might increase in amount until they bring about the degeneration of the NE. An NE is closed-in or open-out if some thing or things only go out of it; in which case this may also continue until the loss of this thing or these things brings about the degeneration of the NE. (i.e., in both these cases the gain or loss of some thing or things continues until the functioning of the NE is disrupted. For instance red blood cells in a hypertonic or hypotonic medium). Openness is not necessarily absolute or total; this would in fact be a special case, since the majority of NEs would be partially open, permitting the passage of some things in/out but not others. The cases described above would also be extreme cases, since it is likely that only one thing or a small number of things can only go in or out, with the NE being open in/out to things in general. All the cases above may also be regulated in the sense that the openness or closeness can be directed by the NE becoming it open in or closed in as its convenience.

2.10 A NE is dependent when it requires one or more entities for something; otherwise it is independent. Dependent NEs may be dependent on other entities for,

among other things, existence, function, formation and development. They can also be directly or indirectly, constantly or intermittently, totally or partially, and mono- or multiple-dependent. A NE can be dependent on other entities for the whole of its span of existence or part of it, or alternate between dependence and independence. It can also change its dependence to other entities, either of the same kind as the former ones or not. Some examples of these cases are the different types of symbiosis

2.11 There are evolutionary and non-evolutionary NEs, in the sense that evolution means a process by which an entity gives rise to one or more new and different entities, with the first entity continuing to exist or disappearing either at the time of the appearance of the new entity(ies) or later on. Within the process as a whole, there may be some entities which become extinct without producing any new entity or entities, while others persist during the whole time span of the process without producing any new entity. Equally the new elements may disappear after a time while the old one(s) continues (continue) to exist; in this case the new elements, probably, will continue to appear during the entire time span of the process. It should be understood in all the above cases that entities are able to produce exact copies of themselves. As it is in organic evolution.

There may also be developmental and non-developmental NEs and variational and non-variational NEs, which may be evolutionary or non-evolutionary at the same time. A developmental entity is one that from the beginning of its existence undergoes a process of development which ends at some determined stage, or can continue until the entity disappears. A non-developmental entity is one that does not follow such a process.

A variational entity is one that from the beginning of its existence undergoes a process of variation, which may continue until the disappearance of the entity or end before it. A non-variational entity is one that does not undergo such a process.

There are entities which are developmental-variational, which may be developmental during some span of their existence and then become variational or vice versa, and it seems that some entities may be both developmental and variational at the same time. Organisms in the general are developmental-variational.

Development may be understood as the acquisition of new kinds of elements and/or new kinds of interactions between existing elements, existing elements and new elements, or new elements; which may or may not be accompanied by the loss of existing elements and/or interactions.

Variation can include change in size, volume, weight, number, etc. of the existing elements.

Some entities could undergo development and variation in various combinations.



2.12 NEs may be dynamical or static. Dynamics means to undergo a continuous change (change is defined in 3.6). Static is to remain without change.

2.13 A self-deforming NE is one which undergoes a continuous or discontinuous deformation through its own actions, like an amoeba; the contrary will be a non-self-deforming NE like a stone.

2.14 In accordance with the number of elements it contains, a NE may be denominated El-conformed and, in accordance with the number of components, Co-conformed. It seems that the minimum number of kinds of elements that a NE can have is one; thus a NE may be composed of any number of kinds of elements between 1 and  $n$ , where  $n$  is finite. The same applies to the number of components. The number of members of each kind of element varies from two, if the NE is formed of only one kind of element, or one, if the NE is formed of more than one kind of element, up to any finite number; with the exception of elementary particles which by definition would only have one member of only one kind of element. Therefore NEs can be from 1-El-conformed to  $n$ -El-conformed with the same to Co-conformed.

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# DIONIC THEORY OF MESON

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Dynamical properties of Meson gave way to the experimental Exploration. But a meson's Structure isn't decoded for the present, although a theory predicts that it consists of two Quarks. It is remarkable that Meson's Quarks need not endow with three Colours. Author identified a Quark with only Colour with the Dion. It is a particle that has an electric & magnetic Charge. The offered Theory permits to calculate a mass of the fundamental Quark and to calculate Masses of the well-known Quarks on the Basis of experimental Data for Masses of Mesons. It is showed that a formula for the Hadron's Mass is equivalent to a Condition of the Quantization of Dirac's Monopole.

**KEY WORDS:** particle, quark, dion, monopole, meson, relativity

"Never to speak more exactly than You think."

Niels Bohr

## 1. Introduction

According to author a Meson is a revolving two-quark's Structure. An every Quark lives in the cylindrical world and his speed is equal to  $c$  always. Author identifies a Quark with the Dion. It is a Particle that has an electric & magnetic Charge  $q$  and  $Q$ . A Quark and its Magnetic monopole do not exist in the natural State.

## 2. Positrony in a Field of Meson

Author introduced a Phenomenon [1] of the Species of Helmholtz's coil with a Radius  $R$ , only first Coil is replaced by Meson  $Q\bar{Q}$  and Second Coil — by Positrony  $e\bar{e}$ . All four particles are disposed in the same plane that revolves on its axis  $z$  with the constant angular velocity  $\omega$ . A Magnetic field of Quark is equal

$$\vec{H} = Q\vec{r}/r^3.$$

Diameters  $Q - \bar{Q}$  and  $e - \bar{e}$  are equal and parallel. Therefore Electrons are in a Constant Magnetic field

$$H_z = Q/R^2. \quad (1)$$

A Circular Speed of Larmor's precession is equal to

$$v_\varphi = eRH_z/cm_e. \quad (2)$$

An angular Momentum of Electron is equal to

$$M_\varphi = m_e v_\varphi R \quad (3)$$

or taking into account (1) and (2)

$$M_\varphi = eQ/c.$$

A geometry of Helmholtz's coil only permits to turn out a Momentum  $M_\varphi$  that does not depend from  $R$ . A Condition of the angular Momentum quantization for Electron has a shape

$$eQ/c = n\hbar/2$$

or

$$Q = en/2\alpha_e. \quad (4)$$

P. Dirac [2] obtain this Result first. Any type of the Charge may be noted in a Measurement *gram/sec* [3]. Then  $Q \sim m_{Q\bar{Q}}$ ,  $e \sim m_e$  and a Formula (4) assumes an air

$$m_{Q\bar{Q}} = nm_e/2\alpha_e. \quad (5)$$

Some Particles are given in the Tab. 1. Their Quarks are Dions.

## 3. Quantization of Quark

If a speed of Meson is  $v_z = 0$  then  $v_\varphi = c$  and a Condition of the angular Momentum quantization for Quark assumes an air

$$m_Q cR = \hbar/2 \quad (6)$$

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Table 1: Some Particles

Meson	$n$	$m_{\text{exp}}, \text{MeV}$	$m_{\text{calc}}, \text{MeV}$	$m_{\text{calc}}/m_{\text{exp}}$
$\pi^\pm$	4	139.57	140.05	1.00345
$K^\pm$	14	493.67	490.20	0.99296
$\rho^\pm$	22	769.00	770.31	1.00170
$D^\pm$	53	1869.00	1855.74	0.99291
$D_s^\pm$	56	1969.00	1960.78	0.99583
$B^\pm$	151	5279.00	5287.12	1.00154
Fermions				
$\mu^\pm$	3	105.66	105.04	0.99413
$\Sigma^+$	34	1189.00	1190.00	1.00084
$\Sigma^-$	34	1197.00	1190.00	0.99415

as Quark may exist in the fundamental State  $n = 1$  only. We can prove with the held of the Uncertainty relation

$$\Delta p \Delta R = \hbar/2$$

that the Impulse  $p = m_Q c$  of Quark and the Radius  $R$  cannot change continuously. From the Uncertainty relation

$$(p_{n+1} - p_n)(R_{n+1} - R_n) = \hbar/2$$

we deduce

$$R_{n+1}/R_n = m_n/m_{n+1} = 1/2. \quad (7)$$

But an Additivity of Quark's Energy

$$E_Q = m_Q c^2 = \hbar \omega_Q/2 \quad (8)$$

means side by side with (7) that a Mass of any Quark is equal to

$$m_Q = m_0 n_Q, \quad n_Q = 1, 2, 3, \dots \quad (9)$$

In that way all Quarks may be considered Excited States of the Fundamental Quark  $m_0$ .

#### 4. Quantization of Meson

By Analogy with Coulomb's Interaction an interaction's Energy of Dions  $Q\bar{Q}$  is equal to

$$E_s = \alpha_s \hbar c/2R$$

or taking into account (6)

$$E_s = \alpha_s E_Q. \quad (10)$$

An energy of the Really neutral Meson is equal to

$$E_{Q\bar{Q}} = 2GE_Q, \quad (11)$$

where

$$G = 1 + \alpha_s/2. \quad (12)$$

According to (5)

$$E_{Q\bar{Q}}(n) = nE_e/2\alpha_e. \quad (13)$$

An Energy of the minimal Hadron ( $n = 1$ ) is equal to  $E(1) = 35.01303 \text{ MeV}$ . Now we must find a Relative strength of Strong interaction  $\alpha_s$ . For that we take a theoretical Mass of  $\rho$  - Meson from the Table 1. We consider that a Pure State  $\rho^0 = d\bar{d}$  is realized and a Mass of  $d$  - Quark is equal to 330 MeV. Then on the grounds of (11)  $G = 1.16713$  and  $\alpha_s = 0.33426$ . According to (11) a total Quark's mass of Hadron is equal to 30 MeV. A Mass of the Minimal Meson's & Baryon's Quarks is equal to 15 MeV and 10 MeV respectively. Therefore a Mass of the Minimal Quark is equal to 5 MeV. Further we consider that a Mass of  $u$  - Quark is equal to 335 MeV. Let a Pure State of Meson  $\omega = u\bar{u}$  is realized. Then on the grounds of (11) its Mass is equal to 781.98 MeV. A Calculation of the Rest Quarks consists in a trivial Selection of Numbers  $n_Q$  in Formula (9) in that way that  $E_{Q\bar{Q}}^{\text{calc}} \approx E_{Q\bar{Q}}^{\text{exp}}$ . The Results of the Calculation are given in the Tab. 2.

#### 5. Dynamixs of Quark

If a Meson's Speed  $v_z \neq 0$  then a Speed of Quark's revolution is equal to

$$v_\varphi = c/\gamma, \quad \gamma = (1 - \beta_z^2)^{-1/2}, \quad \beta_z = v_z/c$$

Table 2: The Results of the Calculation

Quark	$n_Q$	$m_Q^{\text{calc}}$ , GeV	Meson	$m_{Q\bar{Q}}^{\text{calc}}$ , GeV	$m_{Q\bar{Q}}^{\text{exp}}$ , GeV	$m_{Q\bar{Q}}^{\text{calc}}/m_{Q\bar{Q}}^{\text{exp}}$
$d$	66	0.330	$\rho^0 = u\bar{u}$	0.770	0.769	0.0017
$u$	67	0.335	$\omega = d\bar{d}$	0.782	0.783	0.9987
$s$	87	0.435	$\phi = s\bar{s}$	1.015	1.019	0.9961
$c$	265	1.325	$J/\psi = c\bar{c}$	3.093	3.097	0.9987
$b$	811	4.055	$\Upsilon = b\bar{b}$	9.465	9.460	1.0005

and taking into account (6)

$$m = \hbar/2Rv_\varphi$$

or

$$m(\gamma) = \gamma m_Q. \quad (14)$$

A Secret of the Corpuscular - wave dualism of Quarks consist in Formulas

$$\lambda_z = v_z T = 2\pi/k_z, \quad T\omega = 2\pi. \quad (15)$$

According to (14)

$$E(\beta_z) = \gamma E_Q = \hbar \omega_Q^2 / \omega(\beta_z). \quad (16)$$

This result differs from the de Broglie's equation

$$E(\beta_z) = \hbar \omega. \quad (17)$$

A longitudinal Impulse of Quark is equal to

$$p_z = m(\beta_z) v_z = \hbar/k_z R^2. \quad (18)$$

This Result also differs from the de Broglie's equation

$$p_z = \hbar k_z. \quad (19)$$

From (16) and (18) this Formula follows

$$E^2(\beta_z) = m_Q^2 c^4 + p_z^2 c^2. \quad (20)$$

It is remarkable that for a Deduction of the given Formula it was not be use the Second Newtonian Law how it has happened as a Rule! Since

$$v_\varphi = 2\pi R/T,$$

then

$$m(\beta_z) = \hbar T/2\pi R^2. \quad (21)$$

Therefore this "Mass" is proportional to a Period of Quark's Revolution  $T$ .

Formulas (6), (8) and (21) determine an essentially different Sense of the Mass's Concept and a Mechanism of the Mass's Creation. According to (8) the mass is a

measure of Quark's Rotation. According to (6) it is possible a Quantum Creation of the Mass by the Quantum Reduction of the Radius  $R$ . It is necessary to expend an Energy for a deceleration of Quark's revolution  $\omega$  that to increase a Speed  $v_z$ . Practically it is necessary to turn a Vector of Quark's Impulse in a Cylindrical world  $R$ . An infinitely Small turn of this Vector apparent's like a Force of Quark's Inertia and so we may call a Quark's mass by the Inert mass. But not in the least it is evident that this mass is a Gravitational Mass since a vexed Question is open. Does a meson generate a Gravitational Field really? Author is not assured that all Elementary Particles generate a Gravity so is conventional to think.

## 6. Conclusion

- A Hypothesis on a Dionic Structure of the Meson permitted to propose a New deduction of the quantization's Condition of the Dirac's Monopole.
- An Analogous Formula for the Hadron's Mass is not contrary to the experimental Data.
- On the Basis of the uncertainty relation the Condition of Quark's quantization is obtained. A Mass of the fundamental Quark was found equal to 5 MeV. It allowed to calculate Masses of the well-known Quarks by the Experimental values of the Meson's Masses.
- A Quark's Dynamics is investigated. It is showed that their wave Nature differs from the de Broglie's waves.
- It is discovered that it may be imply a frequency of the Quark's Rotation as a Quark's Mass.

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# ABOUT THE EXPERIMENTAL CONFIRMATIONS OF SOME PROGNOSSES WHICH FOLLOW FROM THE SOLUTION OF “THE TIME PROBLEM”

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The experimental confirmations of prognoses which were made by the author in 1992: about new, beyond gravitational interaction (“dark energy”) by intensity  $\sim 10^{-52}$  of unities of the strong; about new, a neutrino interaction by intensity  $\sim 10^{-26}$  of unities of the strong; about presence at a neutrino the rest mass  $\sim 10^{-32}$  g; about a substantiation of charging asymmetry of the Universe by a corollary of its masses-oscillations in coordinates “substance”—“antimatter” are given.

## 1. Introduction

I.R.Prigozhin: “Einstein believed that the time orientation and time is illusion — the time orientation arises when we introduce artificially the time in the untimely Universe” [1].

V.L. Ginzburg: “The future theory ..., maybe, will bring something new, but what exactly, I do not know (under suspicion is the concept of time of a quantum mechanics)” [2].

The opportunity to describe the basic units of measurements (physics) in constants  $[h]$  and  $[c]$  is obtained in the works of the author [4], [5] allow to solve “the time problem,” and also to obtain a series of new important corollaries, including such which have already obtained the experimental confirmations.

## 2. About the New Beyond Gravitational Interaction

In the work [3, pp. 38–42] is reported that in 1998 astrophysicists the USA and Australia set necessity of existence unknown new “dark energy, about the physical nature of this energy it is not known”; further in the paper have discussing, that “... with reliability of 99 % it is possible to state, that the Universe should have still any additional energy,” about a problem of the nature of this energy “the intelligible answer until now is not present.”

In 1992, the necessity of existence of the complete lines of series of interactions (known and expected), Fig. 1, is shown in the work of the author [4, pp. 38–49]. Among these series of interaction should be new

expected the beyond gravitational interaction by the intensity  $\sim 10^{-52}$  of unities of the strong with the typical for it a stable fermion with mass  $\sim 10^{-104}$  g (gravitino). Indications of this new interaction took place in observations which are given in work [3].

Repeatedly this prognosis it was informed by the author also in the work [5, pp. 127–128].

## 3. About the New Neutrino Interaction

In the work [6] have informed about the series of experiment with neutrino which have been carried out in 2001, in laboratory of Fermi (Chicago, the USA) on the most powerful accelerator of particles. Experiment have given the unexpected results: diversions of the experimental data from expected were so great, that researchers come to conclusion about necessity of existence of the new, unknown force which act on a neutrino.

In 1992, in work [4, pp. 38–49] the necessity of existence the new neutrino interactions by intensity  $\sim 10^{-26}$  of unities of the strong, the typical for a neutrino, with a predicted rest mass  $\sim 10^{-32}$  g, Fig. 1 also was predicted. Confirmation of necessity of a rest mass at a neutrino has been obtained in 1998, in the work [7, p. 34].

## 4. About the New Overstrong Interaction

The third predicted in 1992, in the work [4] new overstrong interaction by intensity  $\sim 10^{13}$  of unities of the strong, Fig. 1, (it is designated by a dotted line), should

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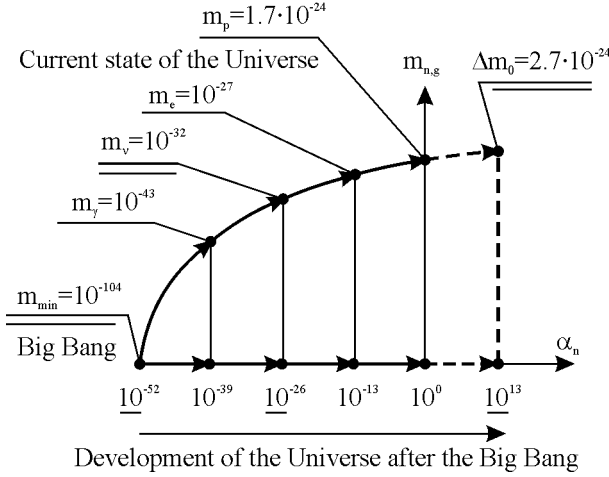


Figure 1:

arise (“switch on”) as a corollary of the further development (expansion) of the Universe in  $\sim 10^{10}$  years, [4, pp. 42–45].

The typical stable fermion for this interaction is the stable fermion  $\Delta m_0 = 2.7 \cdot 10^{-24}$  g also expected through  $\sim 10^{10}$  years, Fig. 1 (it is shown by a dotted line).

Analytical dependence of rest masses of the complete lines of stable fermions (known and expected) and the views of interactions relevant to them (also known and expected) from Fig. 1 will be determined as

$$\alpha_n = |m_n^{y_n}|, \quad (1)$$

where

$$m_n = \underline{m_{min}} < \underline{m_\gamma} < \underline{m_\nu} < m_e < m_p < \underline{\Delta m_0} \quad (2)$$

$$y_n = 0.50; 0.91; 0.81; 0; 0.48.$$

Value of the complete lines of stable fermions  $m_n$  (in gramme):

$$m_n = \underline{10^{-104}} < 10^{-43} < \underline{10^{-32}} < 10^{-27} < 1.7 \cdot 10^{-24} < \underline{2.7 \cdot 10^{-24}} \quad (3)$$

whence the complete series of views of interactions under the formula (1) will be determined as (in terms of the strong):

$$\alpha_n = \underline{10^{-52}} < 10^{-39} < \underline{10^{-26}} < 10^{-13} < 10^0 < \underline{10^{13}}. \quad (4)$$

In the formulas (1), (2), (4) and on Fig. 1 expected stable fermions and the expected views of interactions relevant to them are underlined.

Sequential formation (“switching on”) of the complete lines of views of interactions (4) and the complete

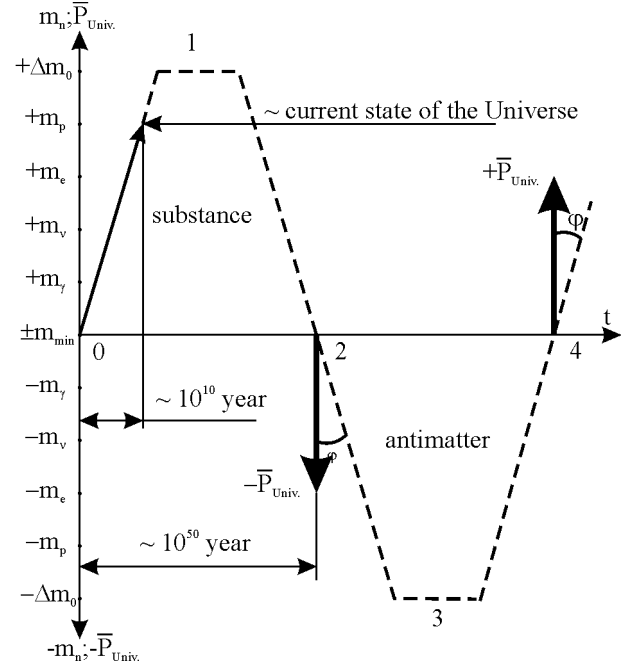


Figure 2:

lines of stable fermions (1), (2) relevant to them, happens when the Universe is dilated, and the furl (“switching off”) happens when the Universe is squeezed, fig. 1, 2. (Electromagnetic interaction is considered as uniform electrofeeble by intensity  $\sim 10^{-13}$  of unities of the strong).

The view (beauty, simplicity) of the function on Fig. 1 can serve by one more argument (besides already obtained experimental confirmations) for the benefit of its reliability.

## 5. About the Solution of the Problem of Charging Asymmetry of the Universe (“Substance” — “Antimatter”)

Really apparent parameters of the Universe are well in accord with its radius of SHvartsschild

$$R_{\text{Shvar.univ.}} = \frac{2\gamma m_{\text{univ.}}}{c^2} \approx 10^{28} \text{ sm} \approx \approx R_{\text{app.univ.}}, \quad (5)$$

where  $m_{\text{univ.}} \approx 10^{57}$  g is the complete mass-energy of the Universe,  $\gamma$  is a stationary value of gravitation.

In this connection, the Universe should be considered as quantum object (“a black hole”) with new effect of masses-oscillations proper in it, Fig. 2, [4, pp. 51–54], [5, pp. 128–129], in coordinates “substance”–“antimatter” with frequency

$$\nu_{m_{\text{univ.}}} \approx 10^{-57} \text{ Hz}, \quad (6)$$

whence the period of one act of masses-oscillations of the Universe (for example, in a phase "substance," Fig. 2) will make

$$\Delta t_{\text{univ.}} = (\nu_{m_{\text{univ.}}})^{-1} \approx 10^{57} \text{ sec} \approx 10^{50} \text{ years.} \quad (7)$$

Hence, for  $\sim 10^{50}$  years the Universe realizes transition from a state "substance" in "antimatter" (and on the contrary), than the problem of charging asymmetry of the Universe is solved: at the given stage of development it is in a phase "substance" (on Fig. 2 it is shown as "a current state of the Universe").

In transition points (singularities) 0, 2, 4 on Fig. 2 impulse of the Universe will make

$$\overline{P}_{\text{univ.}} = \pm \frac{m_{\text{univ.}} (\overline{v}_{\text{univ.}} \rightarrow c) \cos \varphi}{\sqrt{1 - \beta^2}}, \quad (8)$$

where

$$\cos \varphi = \frac{\overline{v}_{\text{univ.}}}{c} \rightarrow 1; \varphi \rightarrow 0 \quad (9)$$

from this follows that in these transition points the Universe with velocity, to the close to light, "fails" in a singularity (points 0,2,4), "by-passing" it in area of the negative (positive) values as the relativistic impulse of the Universe (8) excludes other opportunity of development of events, Fig. 2.

## 6. Conclusions

V.L. Ginzburg: "... already simply it is impossible to find a little informed physics which would not see incompleteness and not closure the fundamental theory, ... new physics unconditionally, it is necessary both in physics and in astronomy" [8].

Backgrounds of embodying of the program formulated above follow from the obtained complete lines of views of interactions (known and expected), providing "completeness and a closure of the fundamental theory," with following from here "new physics both in physics and in astronomy."

Other new results are also obtained [4], [5].

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# STRUCTURE OF PHOTON & LEPTON

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The present author develops a new theory of particles on the basis of fractals and clusters. The theory contains two radical suggestions. 1) Any particle is divisible without end. 2) Any charge is a power of a source. According to Author a Photon consists of Neutrino and Antineutrino. This idea has allowed to calculate a Neutrino Mass spectrum. In Author's opinion the published experimental data 2.2 eV (V.M. Lobashev a.o.) are understated since the Experimenters leave out of account  $\alpha$ —effect. According to Author electron consists of the Preons. The Mass of Preon is equal to 7.3 meV. Preons radiate Photons. A wave-length this Radiation is equal to 0.662 mm. A "Relic" Radiation has the same wave-length. Thus both euristic ideas have an Experimental corroboration.

**KEY WORDS:** photon, lepton, preon,  $\alpha$ —effect, "relic" radiation

"If it dawned upon You then You must seize it  
 by the use of the death grip and not let it  
 what ever happens".

W. Heisenberg

## 1. Introduction

The present work is a continuation of the articles [1, 2]. Author holds that if a Particle has wave properties then it must have a structure. In particular Photon and Electron must have a Structure. Author supposed that Photon consists of Neutrino and Antineutrino. This assumption allows to calculate a Neutrino Mass Spectrum. A coincidence with the Experimental Date is contented. Further author supposes that Electron consists of the Preons. This assumption allows to calculate a Mass of the Preon. A preon has an Electric Charge. It absorbs or radiates Photons. It appeared that a frequency of this Radiation coincides with the frequency of the "Relic" Radiation. On that way both euristic ideas of Author are corroborated experimentally and so they may obtain subsequent Development.

## 2. Global Relativistic Neutrino

That is a particle which moves with a constant speed  $u > c$  along the geodesic of the circular cylinder  $R$ . A neutrino of the Photon is a typical example of the relativistic particle on condition that this neutrino lives in the cylindrical world and if his speed  $u^1$  is equal to  $c$  always. What geometry does a spiral motion of

neutrino raise? First of all it is obvious, that a dimension of the neutrino space is equal two. And two only! What metric does a motion of neutrino generate in this space? Since a geometry of the cylinder is flat then straight lines  $x^0$  are the geodesics on the evolvent of the cylinder. We shall bring right angled co-ordinates in this plane:  $x^1$  — along the generatrix of the cylinder and  $s$  - along the arc of the cylinder circle. We call a plane  $(x^1, s)$  the Newtonian plane. We mark out this plane an elementary triangle

$$(dx^0)^2 = ds^2 + (dx^1)^2.$$

Since

$$ds = R d\varphi, \quad d\varphi = \omega dt, \quad dx^1 = c dt,$$

then

$$(dx^0)^2 = R^2 d\varphi^2 + (c/\omega)^2 d\varphi^2.$$

Let speeds of own neutrino are equal to  $u_1, \omega_1$  and speeds of other neutrino are equal to  $u_2, \omega_2$ . Then

$$\begin{aligned} (dx^0)_1^2 - (c/\omega)_1^2 d\varphi^2 &= \\ &= (dx^0)_2^2 - (c/\omega)_2^2 d\varphi^2 = R^2 d\varphi^2 = inv. \end{aligned}$$

Using a limit of neutrino speed, we turn out

$$d\varphi = \omega dt = \omega_{max} d\tau,$$

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$$dx^0 = u dt, \quad dt/d\tau = \omega_{max}/\omega. \quad (1)$$

We shall call  $\tau$  an absolute Newtonian time and  $t$  — a relative Minkowski time. These times are bind by ratio

$$u^2 dt^2 - (c dt)^2 = c^2 d\tau^2.$$

Hence it follows

$$\begin{aligned} dt &= \gamma d\tau, & \omega &= \omega_{max}/\gamma, \\ \gamma &= (\beta^2 - 1)^{-1/2}, & \beta &= u/c. \end{aligned} \quad (2)$$

We shall consider our space  $dx^1$  real quantity. Then hence it follows that an interval  $ds$  is an imaginary quantity

$$(i ds)^2 = (i dx^0)^2 + (dx^1)^2. \quad (3)$$

We call a plane  $(ix^0, x^1)$  a complex plane of Minkowski. The Lorenz “dual” transformations follow from the condition (3) for any two-component vector

$$\begin{pmatrix} x^0 \\ x^1 \end{pmatrix} = \gamma \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix} \begin{pmatrix} x^0 \\ x^1 \end{pmatrix}'. \quad (4)$$

Neutrino does own revolution  $S = 2\pi R$  in a period  $T$  and by that one goes a distance  $x^1$  that is equal a wave-length  $\lambda$ . In the present case a geometrical Sense of the Interval  $S$  is a circle-length of the cylindrical world in which “lives” the present neutrino. It is evident that

$$u^1 = x^1/t = \lambda/T. \quad (5)$$

Let own neutrino moves with parameters  $\lambda_1, T_1, u_1$  and other neutrino moves with parameters  $\lambda_2, T_2, u_2 < u_1$ . Then on the grounds (4)

$$\begin{pmatrix} u_1 T_1 \\ \lambda_1 \end{pmatrix} = \gamma \begin{pmatrix} 1 & \beta \\ \beta & 1 \end{pmatrix} \begin{pmatrix} u_2 T_2 \\ \lambda_2 \end{pmatrix}, \quad (6)$$

where

$$\beta = (\beta_1 - \beta_2) / (1 - \beta_1 \beta_2).$$

We call a plane  $(x^0, x^1)$  a real plane of Minkowski. According to (3) its metric is the pseudo-Euclidean metric

$$(i ds)^2 = g_{\mu\nu} dx^\mu dx^\nu, \quad g_{\mu\nu} = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}. \quad (7)$$

By analogy with a vector  $(x^0, x^1)$  of the world-point we shall bring a speed-vector  $(v^0, v^1)$ . We call own-component speed  $v^1 = dx^1/d\tau$  a Newtonian speed. We call two-component speed  $u^\mu = dx^\mu/dt$  a Minkowski speed. We shall calculate an invariant  $v^\mu v_\mu$ .

$$v^0 = \gamma u, \quad v^1 = \gamma c, \quad v_\mu = g_{\mu\nu} v^\nu.$$

The speed  $v^0$  is absent in a Newtonian Mechanics!

$$v^\mu v_\mu = -c^2. \quad (8)$$

A physical Sense of this Invariant is that a speed  $u^1$  of the Neutrino is equal  $c$  always under a definition of the constrained Neutrino.

### 3. Charge

A Neutrino model of photon allows to refuse from an electrodynamic units of measure and to come to nothing more then basic units of measure  $m, sec, kg$ . An electrodynamic Energy Density

$$W = (\varepsilon_0/8\pi)(E^2 + H^2) \quad (9)$$

is identified with a Kinetic Energy Density of the rotatory movement of Neutrino and Antineutrino

$$W_\varphi = 0.5 \rho_0 v_\varphi^2. \quad (10)$$

According to (9) and (10)

$$\rho_0 = \varepsilon_0/2\pi \quad (11)$$

and  $[E] = m/s, \quad [\varepsilon_0] = kg/m^3$ .

An electric force is equal to

$$F = qE. \quad (12)$$

From considerations of the unit Measure  $[q] = kg/s$ . In that way a physical sense of the Charge is a Mass of photon which a Source emanates at an unit of time. This conclusion has a fundamental meaning! In the adopted unit of measure  $1 \text{ Coulomb} = 1 kg/s$ . Then  $\varepsilon_0 = 8.854 \cdot 10^{-12} C^2/(N \cdot m^2) = 8.854 \cdot 10^{-15} g/cm^3$ ,  $\rho_0 = 1.409 \cdot 10^{-15} g/cm^3$ . Sources of the Radiation are stationary or changeable. A radioactive Source is changeable. Its mathematical model is a diffusion Equation

$$\frac{\partial \rho}{\partial t} = a^2 \Delta \rho - \chi \rho. \quad (13)$$

A Charge is a property of Stationary Source. Its mathematical model is an Equation

$$-i \frac{\partial \rho}{\partial t} = a^2 \Delta \rho - \chi \rho. \quad (14)$$

Let

$$\rho = f(\vec{r}) T(t).$$

Then

$$T'(t) = -i \Omega T, \quad \frac{\partial \rho}{\partial t} = -i \Omega \rho. \quad (15)$$

If  $V_e$  is a Volume of the Source, for example it is a Volume of Electron, then its Mass is equal to  $m_e = \rho V_e$  and

$$\frac{\partial m_e}{\partial t} = -i \Omega m_e.$$

A Source of the Electromagnetic Field loses a Mass in the State of Photons. Therefore its Charge is equal to

$$Q = \left| \frac{\partial m_e}{\partial t} \right| = \Omega m_e. \quad (16)$$

In that way a Charge of the Source is equal to his mass to within a fundamental constant  $\Omega$ . A Charge of the elementary Particles is equal to unity in an electrodynamic unit of Measure and doesn't depend on their Mass. Therefore an Energy of their interaction is equal to

$$U = e^2(m_1)/r = e^2(m_2)/r. \quad (17)$$

But in the mechanical unit of measure

$$U = Q^2_1/4\pi\epsilon_1 r = Q^2_2/4\pi\epsilon_2 r. \quad (18)$$

Hence it appears taking into account (11) and (16)

$$\epsilon_2/\epsilon_1 = (m_2/m_1)^2. \quad (19)$$

#### 4. Mass of Neutrino

A Condition of the quantization for Photon has a shape

$$m_\gamma c\lambda = h. \quad (20)$$

An Impulse of Photon is equal to

$$p_\gamma^1 = \hbar k, \quad k = 2\pi/\lambda. \quad (21)$$

Taking into account (2) and (5)

$$m_\gamma = h/Tc^2 = \hbar\omega/c^2 = m_\gamma^{max}/m_\gamma.$$

Therefore

$$E_\varphi = \hbar\omega = m_\gamma c^2, \quad p^1 = E_\varphi/c. \quad (22)$$

Let an electromagnetic wave consists of Photons and a distance between Photons is equal to the wave-length  $\lambda$ . Then a fundamental Region  $V = \pi R^2\lambda$  contains one Photon exactly. In that case a mass of Photon is equal to

$$m_\gamma = 2m_1 = \rho_0 V. \quad (23)$$

For the virtual neutrino  $v_\varphi = c$ .

Then

$$V_1 = 2\pi^2 R^3, \quad R = \hbar/m_1 c, \quad m_1 = \pi^2(\hbar/m_1 c)^3 \rho_0.$$

Taking into account (11)

$$m_1 = \sqrt[4]{(\pi\epsilon_0/2)(\hbar/c)^3}. \quad (24)$$

In it  $\epsilon_0$  is a permittivity of electron-positron Vacuum. Taking into account (19) a Formula (24) is generalized to all types of Neutrino

$$m_{\nu_L} = \sqrt[4]{(\pi\epsilon_0/2)(m_L/m_e)^2(\hbar/c)^3}, \quad L = e, \mu, \tau. \quad (25)$$

The Results of the Calculation are given in the Table 1.

Table 1: The Results of the Calculation

Neutrino	$\nu_e$ , eV	$\nu_\mu$ , eV	$\nu_\tau$ , keV
According to (25)	15.635	224.83	0.92387
According to [3]	< 17	< 270	< 35000

A value of The Mass of Electron Neutrino  $m_{\nu_e}^{calc}$  is contained inside the diapason of the experimental data [4]  $14 \leq m_{\nu_e}^{exp} \leq 46 \text{ eV}$ . According to [5]  $m_{\nu_e}^{exp} = -1.5_{-2.3}^{+0.95} \text{ eV}$  or  $m_{\nu_e}^{max} = 2.2 \text{ eV}$ . We consider that V.M. Lobashev interprets results of the Experiment [5] erroneously. He leaves out of account that  $\alpha$  - effect may be takes place in his "new"  $\beta$  - spectrometer.  $\alpha$  - effect [6,7] is an induction of the electromotive force  $\vec{E} = \alpha \vec{B}$  which has a direction of the magnetic Field  $\vec{B}$  for the left Electron and an opposite direction for the right Electron. Electrons obtain an extra Energy  $\Delta E(B)$  at the expense of  $\alpha$  - effect in  $\beta$  - spectrometer [5]. Therefore it was found that a registered Energy of Electron is equal to

$$E_e^{exp}(+B) = E_e + \Delta E.$$

If a Direction of  $B$  will be opposite it will be found that

$$E_e^{exp}(-B) = E_e - \Delta E.$$

In that way true value of the Electron self-energy is equal to

$$E_e^{exp} = 0.5 (E_e^{exp}(+B) + E_e^{exp}(-B)).$$

If  $\alpha$  - effect exists really then an Experiment will give a functional dependence  $m_{\nu_e}^{exp}(B)$ . Author trusts to the Experiment [4] most of all because it doesn't have  $\alpha$  -effect.

#### 5. Electron

According to Author an electron consists of the Preons. A Structure of the electron is the  $n$  - stratum Sphere. It occupies the Volume

$$V_n = (4\pi/3)(nR)^3 \quad (26)$$

A free will of each Preon is limited to the Volume

$$V_1 = (4\pi/3)R^3 \quad (27)$$

Formulas (26) and (27) permit to calculate a Number of Preons  $N_V$  in Volume  $V_n$ , a Number of Preons  $N_s$  in the Surface Layer and the Increase of Preons  $\Delta N_s$  in the external Layer in comparison with the previous Layer. A Dependence of these quantities is given in the Table 2.

Table 2: A Dependence of Quantities

$n$	1	2	3	4	5	6
$N_V$	1	8	27	64	125	216
$N_s$	1	7	19	37	61	91
$\Delta N_s$	+6	+12	+18	+24	+30	

According to (15) all Preons  $N_V$  absorb the Energy  $\Phi_V = N_V f_V$  at first half-period and only Surface Preons  $N_s$  radiate the Energy  $\Phi_s = N_s f_s$  at the Second half-period asf. Since  $\Phi_V = \Phi_s$  then

$$N_s/N_V = f_V/f_s. \quad (28)$$

A charge of one Preon is equal to  $Q_1$ . A Charge of the Electron is equal to  $Q_N = N_V Q_1$ . If we shall locate all Preons in the center of Electron then an Energy of their Interaction with every Preon of the Surface Layer shall be equal to

$$U = N_V Q_1 \cdot Q_1 / 4\pi\epsilon_0 R_n.$$

Since  $\Phi_V = U$  then

$$f_V = Q_1^2 / 4\pi\epsilon_0 R_n. \quad (29)$$

Any Preon absorbs or radiates one Photon only. A Surface Preon radiates Photon with the Energy  $f_s = \hbar\omega$

$$f_s = \hbar\omega. \quad (30)$$

Therefore

$$N_s/N_V = Q_1^2 / (4\pi\epsilon_0 R_n \hbar\omega). \quad (31)$$

Ratio  $N_s/N_V$  is a fundamental constant of the Electron. It means that a Quantity  $\omega R_n$  is a Fundamental constant too. We suppose that a Speed of Preons revolution in the Surface Layer is Highest possible i.e.  $V_\varphi = \omega R_n = c$ . Then

$$N_s/N_V = Q_1^2 / (4\pi\epsilon_0 \hbar c).$$

In electrodynamic units of measure

$$N_s/N_V = e^2 / \hbar c = \alpha. \quad (32)$$

A Formula (32) permits to calculate a Number of preons in the Electron.

$$\begin{aligned} N_s &= (n+1)^3 - n^3, \quad N_V = n^3, \\ N_s/N_V &= (1+n^{-1})^3 - 1 = \alpha. \\ n &= [1/(\sqrt[3]{1+\alpha^{exp}} - 1)]. \end{aligned} \quad (33)$$

According to (33)  $n = 412$ ,  $N_V = 69.934528 \cdot 10^6$ . A mass of Preon is equal to

$$\begin{aligned} m_{pr} &= m_e / N_V, \\ m_{pr} &= 511 \text{ keV} / 69.93428 \cdot 10^6 = 7.30 \text{ meV}. \end{aligned} \quad (34)$$

## 6. Background Radiation

According to the offered Theory all charged Particles are pulsating Sources. On the ground of (16) a frequency of Pulsations is identical for all Sources and it is a fundamental Constant  $\Omega$ . It is possible an Existence of the Constrained Structures of Microparticles and a Thermodynamic Equilibrium of Universe on condition that a reradiation of Sources is eternal only. A wave-length of the background Radiation  $\lambda_{pr}$  may be calculate on the ground of the following Considerations. According to (25)

$$m_{\nu_e} / m_{\nu_{pr}} = \sqrt{N_V}. \quad (35)$$

Since  $m_{\nu_e} / m_{\nu_{pr}} = \omega_{\gamma_e} / \omega_{\gamma_{pr}} = \lambda_{\gamma_{pr}} / \lambda_{\gamma_e}$ , then

$$\lambda_{\gamma_{pr}} = \lambda_{\gamma_e} \sqrt{N_V}. \quad (36)$$

For a virtual Neutrino  $v_\varphi = c$ . Therefore

$$\lambda_{\gamma_e} = 2\pi R_{\nu_e}, \quad R_{\nu_e} = \hbar / m_{\nu_e} c. \quad (37)$$

$$m_{\nu_e} = 15.635 \text{ eV} / 5.61 \cdot 10^{32} \text{ eV/g} = 2.787 \cdot 10^{-32} \text{ g},$$

$$R_{\nu_e} = 0.3515 \cdot 10^{-37} \text{ g} \cdot \text{cm} / 2.787 \cdot 10^{-32} \text{ g} =$$

$$= 1.26 \cdot 10^{-6} \text{ cm},$$

$$\lambda_{\gamma_e} = 7.917 \cdot 10^{-6} \text{ cm},$$

$$\lambda_{\gamma_{pr}} = 7.917 \cdot 10^{-6} \text{ cm} \cdot 8.363 \cdot 10^3 = 0.0662 \text{ cm}.$$

Given value  $\lambda_{\gamma_{pr}}$  is contained inside the experimental diapason of the wave-length of the "Relic" Radiation  $0.25 - 0.059 \text{ cm}$ . Since a background Radiation is eternal then it isn't logical at all to explain a origin of the Background radiation by means of the Big Bang theory.

## 7. Conclusion

◦ An assumption about the Neutrino Structure of the Photon allowed to calculate a Spectrum of the Masses of Neutrino. Experimental data [4]  $m_{\nu_e}^{exp}$  confirm a theoretical value  $m_{\nu_e}^{calc}$ . In my opinion Experimental data [5] are understated since V.M. Lobashev leaves out of account an increase of the Electron Energy in  $\beta$ -spectrometer at the expense of the  $\alpha$ -effect.

◦ An Electrical Charge is identified with a Current of virtual Photons and the Charge has the Unit measure  $\text{kg/s}$ .

◦ An Assumption about a Preonic Structure of the Electron allowed to calculate a Mass of Preon and a frequency which a Radiated Background Photons have. This frequency is contained inside the experimental frequencies of the "Relic" Radiation.

## Acknowledgements

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# MASS OF THE NEUTRINO AND ITS CHARGE

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Both electron and its neutrino possess not only the anomalous magnetic moment but each of existing types of the electric charges and their dipole moments. Any of them can interact with field of emission leading to the elastic scattering on a spinless nucleus. We list some implications implied from the analysis of these phenomena in the case of one - photon exchange. The processes cross sections give the possibility to establish the individual as well as the united equation between the Dirac and the Pauli form factors of light leptons. They define the electronic neutrino electric charge as a consequence of the availability of a kind of mass.

In many works a question about the neutrino with a non - zero rest mass was investigated. Analysis of existing experiments assumed [1] that a massive Dirac neutrino must have not only the magnetic moment [2] but also the electric charge. Such a conclusion one can make by following the behavior of the neutrino in the nucleus field. From this point of view, the spin phenomena [3] may become highly useful.

In a given work the elastic scattering of electrons and their neutrinos on a spinless nucleus have been considered at the account of fermions charge and magnetic moment interactions with field of emission of virtual photons. Starting from the processes cross sections equality for longitudinal polarized and unpolarized particles, it is shown that if the neutrino corresponds to the electron ( $\nu = \nu_e$ ), between the Dirac and the Pauli form factors of the neutrino and electron there exists the individual as well as the united dependence. They state that the four - component neutrino possesses both normal and anomalous electric charges. Herewith its full electric charge has the size

$$e_\nu = -\frac{3eG_F m_\nu^2}{4\pi^2 \sqrt{2}}, \quad e = |e|. \quad (1)$$

Such a regularity, however, meets with many problems which give the possibility to make the most diverse predictions. The treatment of any of them would bring us too far and all they therefore will require the more detailed description. But here we can add the following.

Using (1) for the neutrino [4] with mass  $m_\nu = 10$  eV and taking into account [5] that  $G_F = 1.16637 \cdot 10^{-5}$  GeV<sup>-2</sup>, we find

$$e_\nu = 6.267 \cdot 10^{-25} \left( \frac{m_\nu}{1 \text{ eV}} \right)^2 e = 6.27 \cdot 10^{-23} e. \quad (2)$$

Earlier laboratory facts and conservation of charge in neutron decay define the upper limit [6] equal to

$e_\nu < 4 \cdot 10^{-17} e$ . Refinement of each of the electric charges of the neutron, proton and electron allows to conclude [1] that  $e_\nu < 10^{-21} e$ . Analysis of elastic  $\bar{\nu}_e e$  scattering experiment [7] assumed [8] that  $e_\nu < 2.7 \cdot 10^{-10} e$ . Cosmological considerations for the neutrino charge lead to the estimate [9] of  $e_\nu < 10^{-17} e$ .

We recognize that (2) violates the charge conservation law. There are many uncertainties both in the nature and in the size of the neutrino mass. Another reason of inconsistency is the absence of quality picture of  $\beta$  - decay processes. Nevertheless, if we suppose [1] that  $e_\nu < 10^{-21} e$  then taking (1), it is not difficult to establish the theoretical bound on the neutrino mass:  $m_\nu < 40$  eV. It is compatible with that following from the experiment [10]:  $14 \text{ eV} < m_\nu < 46 \text{ eV}$ .

Basing on the analysis of evolution of the Universe, it was found [11] that  $m_\nu < 0.3$  eV. Insertion of this value in (1) gives  $e_\nu < 5.64 \cdot 10^{-26} e$ .

Having the formula (1) and by following the fact that the force of the Newton attraction between the two neutrinos is less than the force of their Coulomb repulsion, we get the following estimates of

$$m_\nu > \frac{4\pi^2 \sqrt{2}}{3G_F} \left( \frac{G_N}{\alpha} \right)^{1/2} = 1.53 \cdot 10^{-3} \text{ eV}, \quad (3)$$

$$e_\nu > \frac{4\pi^2 \sqrt{2}}{3G_F} \left( \frac{G_N}{\alpha} \right) e = 1.46 \cdot 10^{-30} e, \quad (4)$$

where  $G_N$  is the constant of gravitational emission.

Of course, such a definition of values of (3) and (4) is not very standard. At the same time the existing laboratory bounds may serve as further confirmations of our earlier findings. Insofar as the discrepancy is concerned, it reflects just many properties of a certain latent regularity of general picture of massive neutrinos.

In the framework of the loop phenomena, the neutrino must be electrically neutral [12] at the condition of gauge invariance. It appears that here on the basis of

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(1) one can will decide a question about the equality of the neutrino physical mass to zero. But we can say that a non - zero interaction of Pauli arises at the expense of usual Dirac interaction. Thus, the neutrality of the neutrino in the loop approximation one must interpret as an indication to the new structure of electromagnetic gauge invariance.

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# THE CONTINUUM IS STRUCTURED

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Multiplicities of masses, time (frequencies), the dimensional parameters were considered in the previous paper “Multiplicities of fundamental physical constants. Cosmological model”. The deduction is obtained that a continuum – space – time – field – substance are structured. Correlation of a series of multiplicities has enabled to interpret, the obtained results, as cosmological model. It has been put forward a series of theses. One of theses treated a compendency of parameters of space, time and a multiplicity of masses, as structurization of space – time – substances (empty space – fields – substances). It is a corollary of existence of a uniform, quantized continuum at all levels which has blanket laws of the organization, and as a whole, with the mechanism of regulation of processes forms a blanket Universum.

## 1. The frequency relations

In the previous work the multiplicities of frequencies (time)  $10^{20}$  in a range from Planck frequency up to Hubble constant and a probable life time of a proton  $10^{37}$  were considered:

$$T(s) \ 10^{38} 10^{18} 10^{-2} 10^{-22} 10^{-42}$$

$$\text{or } 10^{37} 10^{17} 10^{-3} 10^{-23} 10^{-43}.$$

Hubble constant is really defined quantity from astronomical observations, and the frequency  $10^3$  Hz is measured, but with this frequency known physical effects, except for frequency of a sound range are not bound or not interpreted.

About the Compton frequency  $f_p$  relevant to a wave length of de Broijl for a proton, it is possible to speak in correlation with existing experimental data on definition of radius of a proton

$$r = 10^{-15} m.$$

Planck frequency and a proton lifetime  $t_p$  are theoretical quantities:  $t_p$  is not confirmed experimentally. Planck frequency corresponds to a hypothesis of the Big Bang. For this hypothesis the models and with other parameters [1] designed. In stationary models [2] it misses. Thus, Hubble constant, frequency  $10^3$  Hz which is not having physical interpretation, and Compton frequency of a proton  $f_p$  concern to really apparent physical quantities (Fig. 1).

For frequencies the relations will be fulfilled:

$$f = (f_1 \cdot f_2)^{\frac{1}{2}} = (10^{43} \cdot 10^{-37})^{\frac{1}{2}} =$$

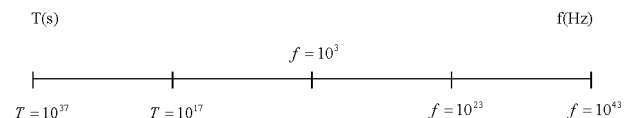


Figure 1: A scale of time – frequencies.

$$= (10^{23} \cdot 10^{-17})^{\frac{1}{2}} = \dots$$

## 2. Multiplicities of velocities

Let's consider a series of values of velocities which are the multiple to the velocity of light in vacuum  $10^8$ :

$$c \left( \frac{m}{c} \right) : 10^{-32} \ 10^{-12} \ 10^8 \ 10^{28} \ 10^{48}. \quad (1)$$

Values  $10^{-32}$  and  $10^{-12}$  have physical interpretation; values  $10^{28}$  and  $10^{48}$  have explicitly debatable character. Nevertheless, there are effects which can be treated with viewing velocities, reduced orders; moreover, the models of some effects have physical sense only in limits of such values. We shall consider these quantities (1). If to correlate values of velocities (1) with the multiple values of the relevant radiuses:  $r(R)$  (m):  $10^{-35} \ 10^{-15} \ 10^5 \ 10^{25} \ 10^{45}$ , we shall receive the following relations:

$$\begin{aligned} f &= \frac{10^{-32}}{10^{-35}} = \frac{10^{-12}}{10^{-15}} = \frac{10^8}{10^5} = \\ &= \frac{10^{28}}{10^{25}} = \frac{10^{48}}{10^{45}} = 10^3, \end{aligned} \quad (2)$$

or the frequency relations:

$$f = (f_1 \cdot f_2)^{\frac{1}{2}} = (10^{43} \cdot 10^{-37})^{\frac{1}{2}} =$$

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$$= (10^{23} \cdot 10^{-17})^{\frac{1}{2}} = \dots$$

These relations take place both in cosmological model and at a microlevel.

A series of multiplicities of gravitational potentials corresponds with a series of multiplicities of velocities (1):

$$G \frac{m}{r} = c^2$$

for a proton and model of formation of mass. At a microlevel these quantities are small but nuclear forces, electromagnetic, feeble and gravitational interactions are linked and have the frequency relations of such order. The given models also will be surveyed at the analysis of existing confirming effects.

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# MAGNETIC-GRAVITATIONAL EXPERIMENTS

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The preliminary qualitative experimental results of the influence investigation upon the weight of the laboratory container of thermal magnetic chemical process, made in the container, are presented in the paper.

## 1. Introduction

In 90<sup>th</sup> years of XX century the research divisions of RPA called after Lavochkin (Chimky, Moscow region) and the A.N. Podgorny Institute for Mechanical Engineering Problems of SA in Ukraine (Kharkiv) have carried out experimental checkout of S.M. Polyakov's idea about the interrelation of magnetic and gravitational interactions on the basis of a governmental decision about the research carrying out as to the search of new physical principles of flying apparatus travel.

S.M. Polyakov carried out the experiment as for a thermal destruction of magnetic rings from the cast alloy UNDK confirming the stated imaginations, in which he observed shock affect upon superstrong ceramics at the magnetization destruction in a ring structure. He identified this affect as gravitational impulse.

S.M. Polyakov used microwave-radiation placing magnets to the resonator inside for prompt magnets heating above the Curie point. Despite of the arguable deductions by the experiment results, but taking into account S.M. Polyakov's theoretical imaginations logic, it was decided to check his hypothesis in a bit different experiment accomplishment.

We have developed the experiment scheme as to direct recording of possible power effects at the thermal destruction of cast magnets and ferrite magnetization to fulfill this task.

## 2. The idea of experiment

The idea of experiment consisted in prompt magnet heating in the close antimagnetic cylinder placed in an-

timagnetic vessel, hanged through a tensor-measuring force measuring device to a fixed bar set in a laboratory wall. However unlike S.M. Polyakov's experiments, we used non-gaseous ferrite-magnetic termite for the magnet heating. According to our imaginations such experiment accomplishment represents independent interest, as the heating process is carried out by low-temperature plasma in a magnetic field. Such heating process can be accompanied by the vortex phenomena in plasma medium. Therefore, as it is known, vortex phenomena show a series of abnormal properties, the experiment accomplishment, offered by us, can be considered as qualitative development of Polyakov's experiments. By virtue of the process peculiarities, proceeding in our device, we used such concept as thermal magnetic chemical reaction later on.

It should be noted that the experiment accomplishment with the vortex phenomena execution, including electromagnetic ones, corresponded to the subjects of our department in the Institute of mechanical engineering problems including the investigation of abnormal energy demonstration, for example, such as a ball lightning. We created the relevant experimental basis for carrying out such a work, the considerable experimental experience was gained, the valuable experimental facts still requiring all-round study and description were obtained.

That's why we placed the special emphasis to the experiments with possible occurrence of the vortex phenomena.

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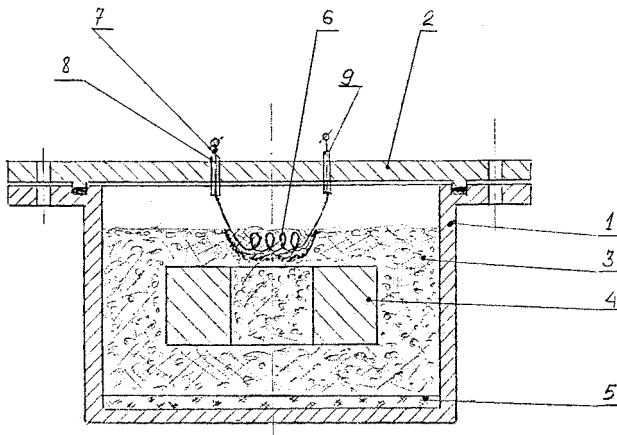


Figure 1: The cross section of the container with a magnet

### 3. The description of the experimental device

The cross section of the container with a magnet is given in Fig. 1.

The container represented the cylinder from steel 1X18H10T with the wall thickness of  $5 \cdot 10^{-3}$  m and total capacity  $0.5 \text{ dm}^3$ , which was closed by the lid 2 of the same steel mark. The holes are made in the lid including the ceramic tubes 8 and 9 for input of a nickel-chrome burn spiral 6 and 7, disposed in an intermediate burning charge. Magnet 4 is in the dense filling of the termite charge 3. Non-gaseous ferrite-magnetic termite was used as the termite charge. The ceramic tile 5 was stacked on the container bottom.

The container capacity is filled with grinded well-dried powder of the termite mixture in three-quarters.

At layer-by-layer termite filling the magnet was put approximately half of the filling capacity. After filling and leading-out wires of a burning spiral outside through the third hole in a lid (not specified in the drawing) the chrome-aluminum thermoelectric couple in glass-fiber isolation was introduced inside the capacity. The lid was fixed by bolts on a container flange, then the container was interposed into other cylinder of greater capacity made of aluminum alloy.

The key diagram of the whole experimental stand is given in Fig. 2.

The cylinder 8 with the container 10 was hanged on a bar connected to a tensor-measuring ring 2 according to the scheme. The bar is closed hardly up into the laboratory wall. The cylinder 8 was hanged to a tensor-measuring ring with a steel cable of the diameter  $3 \cdot 10^{-3}$  and length 2 m.

The interior capacity of the container 8 was filled with asbestos fibril, and its outer surface was wound with asbestos cloth as a heat insulation and protection of measuring sensors around the container.

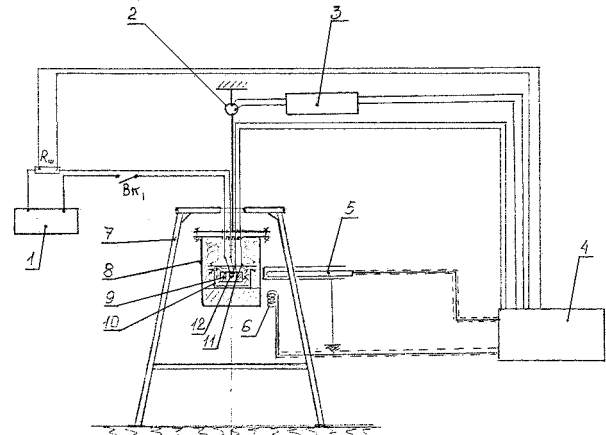


Figure 2: The key diagram of the whole experimental stand

The inductance coil 6, the Hall's sensor 5, the tensor scales 2 with the tensor amplifier 3 have been used as measuring sensors. The current recording in a burning spiral 12 was carried out according to power drop out on the shunt R, included consistently into a burn chain. The rectifier BK-102 has been used as a direct current source.

The recording of signal value changes from sensors was carried out on the tail oscillograph H-117 (point 4 in the Fig. 2).

Tensor scales represented a steel ring with the tensor sensors glued on an interior ring surface. Tensor scales were made by the experts of RPA called after Lavochnik, they were calibrated by him as well allowed to execute the force measuring of the value up to 100n with an error not worse 0.1n. The scales provided the precision and dynamics stable, warranted by the developer, as the further investigations have shown. The order of the experiment accomplishment was the following.

Before each experiment and after it, 10 experiments were carried out, the calibration of scales and preliminary checkout of the serviceability of used measuring means was executed. After that the oscillograph 4 was included into zero lines broach, and only having executed this operation, they included the burning current of termite mixture.

The magnetic rings of the alloy UNDK2A (2 pieces) with external diameter  $6.5 \cdot 10^{-2}$  m, internal diameter  $3 \cdot 10^{-2}$  m and thickness  $2.5 \cdot 10^{-2}$  m, and also ferrite magnets from loudspeakers with the diameter on the outer surface  $90 \cdot 10^{-2}$  m, the interior surface  $4.0 \cdot 10^{-2}$  m were used during the experiments. Maximal value of a magnetic induction: on the magnet surface UNDK is 250 mTl that corresponds to a magnetic energy  $E_M \approx 4.56 \text{ J}$ ; on the surface of ferrite rings  $B \approx 117 \text{ mTl}$ , and  $E_M \approx 1.469 \text{ J}$ . The Curie point for UNDK2A is  $T_K = 1490^\circ \text{C}$ , for ferrite is  $T_K = 445^\circ \text{C}$ . There is no

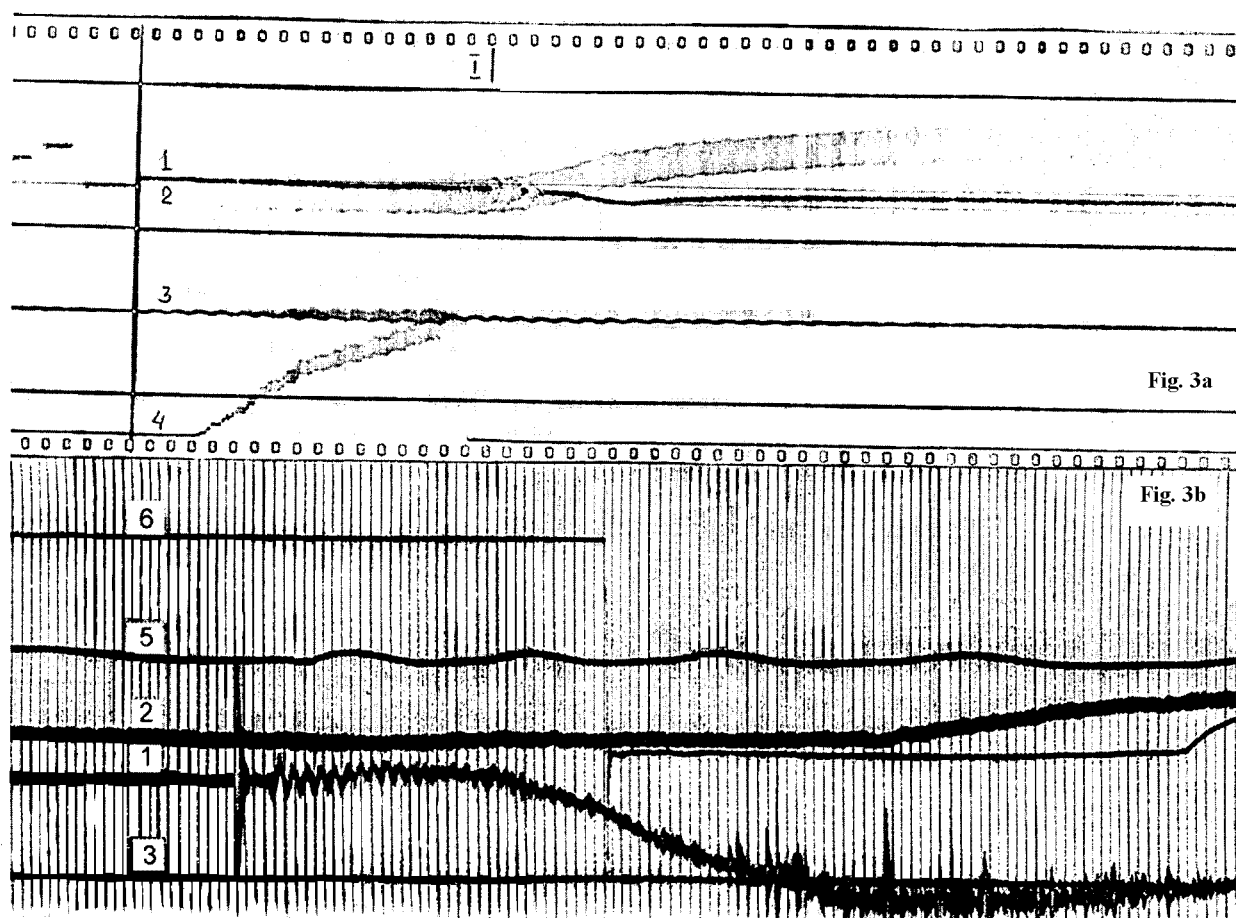


Figure 3: The oscillograms were obtained during main experiments

magnetic induction after burning.

In the first experiments we confronted with the difficulty of the magnetized termite mixture burning, though our former experience with similar mixture excluded the presupposing of complications occurrence at the burning initiation. We had to increase voltage and current accordingly for burning. The termite mixture burning did not cause difficulties in the tests (without a magnet).

It should be noted, that the container filling with 8 asbestos fibril above the container with a magnet, was the necessary stage, as the powerful vertical effluxion of some incandescent products through one of the reserve holes in the container lid with a magnet was observed at the termite mixture burning. The length of an effusing jet was restricted by the laboratory ceiling height (2 m above the laboratory table). The filling of the asbestos fibril was applied to exclude the reactive force of red-hot products. As a result the appearing burning products came out of the outer container diffusely and in small quantity.

The material means lack has not allowed carrying out the investigation of the similar effluxion of the burn-

ing products in open atmosphere, though the interesting practical results could be obtained in this case.

#### 4. Results of experiments

The oscillograms were obtained during main experiments, two of which are given in the Fig. 3a and Fig. 3b.

The signals of the following data units are marked with numerals in oscillograms:

- 1 — tensor scales;
- 2 — Hall's sensor;
- 3 — inductance;
- 4 — signal from the resistor R;
- 5 — signal from the photodiode;
- 6 — signal from the thermoelectric couple.

Despite of the magnetic rings use with various magnetic induction the reduction of the container weight and magnetic induction registered by the Hall's sensor and inductance coil is registered distinctly in both oscillograms.

The line I in the Fig. 3a marks the beginning moment of the thermal magnetization destruction, when

the temperature warming up has exceeded the Curie point value of the alloy.

More sensitive galvanometer was included into the channel registering the tensor bridge misbalance and it is well seen both in an oscillograph and in Fig. 3b, that all systems begin to change as oscillations with the frequency 5 Hz, transferring in more high-frequency ones with the considerable component constant.

The signal from the photodiode seems interesting, it should react to hot gases exhausts from the container 8. Visually no exhausts were observed, however photodiode before mixture burning gave signal pulsations with the period  $\sim 10$  sec, and changed in a sequence: 3.8; 4.0; 4.8; ... sec after the burning period of these oscillations; and up to the initial value. In other words, there were some energy processes in the ambient around the container, this space area was in an excited state and came to an equilibrium state during 70–90 sec.

## 5. Conclusion

Unfortunately, due to the lack of sufficient magnets quantity of various magnetic materials and according to various magnetic properties, lack of high-temperature thermoelectric couples, which could be disposed immediately on magnet bodies, limited nature of registering instrumentation, the considerable share of the useful information was not obtained.

Because of strong suspension and considerable containers mass (up to 5 kg) it was not possible to observe the expected container rotation around an axial line of the magnetic ring at its destruction (we mean physical interrelation of the mechanical and magnetic moments).

We consider the obtained results as preliminary and qualitative, but, nevertheless, it is possible to make the following conclusions:

1. The power interaction in the experimental system is observed at the stage of thermal magnetic chemical charge burning and crystalline magnet structure destruction.
2. The power interaction effect is more expressed in magnetic materials with major specific energy.
3. The affect upon p-n transitions in a semi-conductor diode is observed in the zone around the container.
4. The investigations in this direction should be prolonged.

## Acknowledgements

In conclusion we express our gratitude to our former colleagues M.F. Slobodenuk, I.V. Bershova, M.K. Boyan for the help in preparation and carrying out of these laborious experiments, as well we express our gratitude to RPA employees called after Lavochkin both for the help and research support, and discussion of the obtained results.

# PENETRATING RADIATION OF CAVITATION CAVITIES

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The schemes and descriptions of experimental devices as well as the experiment results of radiation recording transiting through metal screens and having not even precisely obscure nature are given in the article.

## 1. Introduction

The presupposition of additional radiation type in nature available termed as polarization one and having considerable penetrating ability was stated by the author in the paper [1]. However the methods of radiation generation and recording of similar type remained unknown, and it was possible only to guess, that there are a lot of similar radiants both in space as well as on the Earth. This vagueness led only to the opportunity of a casual find of a laboratory radiation source and the method of its recording.

Such situation also has predetermined this method usage applied by N.A.Kozyrev for radiation recording of star systems [2] as the recording one.

## 2. The Experimental Device Construction

The hydrodynamic contour with a cavity nozzle used for checkout of thermal physical effects of cavitation hydrodynamic systems was chosen almost casually as a laboratory radiant source.

The key diagram of hydrodynamic contour with the cavitation nozzle is given in the Fig. 1.

According to the experimental device construction, it consists of the tray (1), electric engine (2) with the centrifugal pump (3), mouth (4), cavitation mesh (5), thermal couple outlets (6), pipeline of reverse liquid supply to the pump (7), feed tube of hydraulic medium (8), bibb (9), hose of air release from filled pipeline system (10), screw clamp (11), replaceable magnet (12), deflector of the engine ventilation (13).

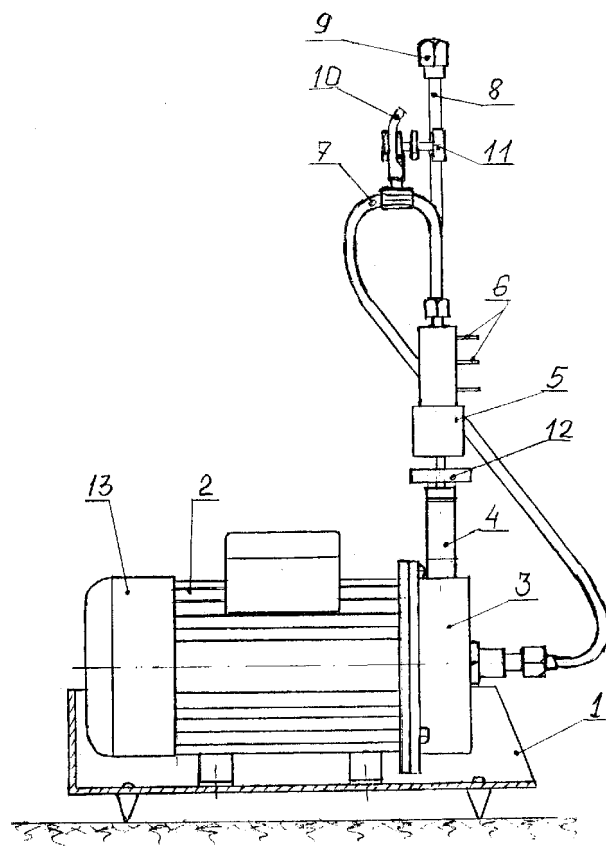


Figure 1: A key diagram of a hydrodynamic contour with a cavitation mesh

The flow diagram of the experimental device including: the irradiated resistor (1), reflector of waves (2), generator of waves (3), steel and dielectric screens (4,5), microvoltmeter of a direct current (V), thermal cou-

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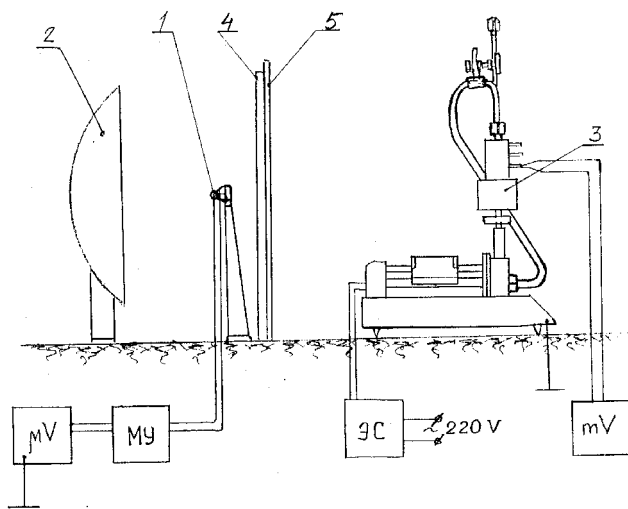


Figure 2: The flow diagram of the experimental device

ple miliampervoltmeter (mV), counter of electric energy (EE) and Winston's bridge (WB) is given in the Fig. 2.

The glass parabolic mirror with aluminum coat of the diameter 0.5m has been used as a reflector.

The resistor of the mark MLT-0.125 with the resistance  $R_1 = 4.7 \text{ k}\Omega$  was applied as the recording resistor. The resistor was placed into the reflector focus.

Other resistors with an opportunity of their adjustment for Winston's bridge balancing were placed inside a foam box and outlets of offtake wires to the resistor  $R_1$  as well as intake wires to the power supply (the batteries of 9V) were connected to the massive metal plates fixed on a dielectric. This connection allowed hoping for the lack of heat inflows through wires to the resistors inside a box.

The microvoltmeter of a direct current TR-1452 (produced by the firm TESLA) was used as a recording instrument.

For excluding of any luminous fluxes penetrating onto the recording resistor, the mirror (reflector), the recording resistor and screens were covered with a black thick cloth. The recording reflector and resistor were removed from a hydrodynamic contour in the distance of 3 m.

### 3. Results of Experimental Investigations

The experimental investigations were conducted as follows.

The conditions of cavitation occurrence in a hydrodynamic contour were fulfilled at the first stage, that was determined by well iterated water heating in a cav-

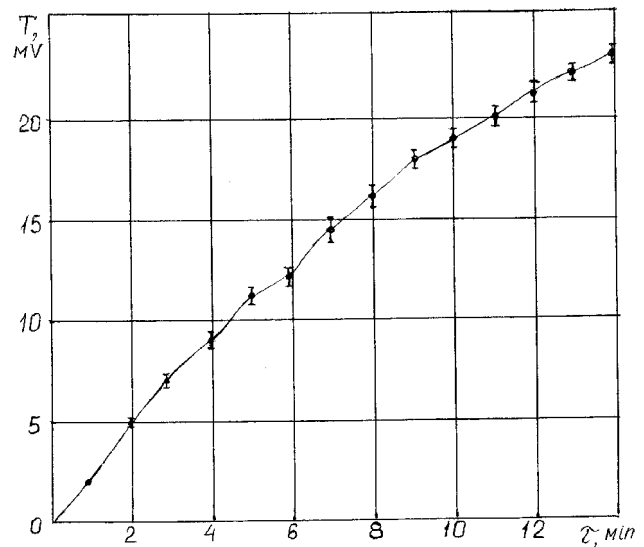


Figure 3: The time course of water temperature change in the contour

itation mesh registered by "chromel - kopelev" thermo-electric couples of the diameter  $0.310 \cdot 10^{-3} \text{ m}$ . Distilled water was used as hydraulic medium (the contour volume was 0.65 liters).

The results of temperature rise during contour running are given in the Fig. 3. The time course of the contour temperature change is well iterated in the same fluid and differs essentially while various water solutions of salts using, at the heavy water additive and aqueous stream magnetization going to a cavitation nozzle.

The water pressure in a contour at the work beginning is  $0.15 \cdot 10^5 \text{ Pa}$ , through 600 sec is  $(0.45-0.5) \cdot 10^5 \text{ Pa}$ . To understand, what occurs in a hydrodynamic contour and what the cavitation section means, a direct copper tube was included into the system instead of cavitation section, equal to removed section as for length, with the diameter and interior section equal to the diameter and the socket interior section at the cavitation section inlet. An apparent deficiency of such replacement is smaller connecting metal mass, that should result to more prompt heating of a pipeline system, if the heat release reason was in other radiant, rather than physicochemical processes in the cavitation fluid.

The water temperature rise in a contour was not observed in the experiments with a direct tube (even without magnetic field affect), and the temperature value in a contour has considerably lower value, in comparison with a cavitation mesh available.

We succeeded to increase the water temperature in a contour up to values 70C and more during a lot of experiments, but we restricted to this temperature limit taking into account the pump electric engine heating without wishing its preliminary failure. The execut-

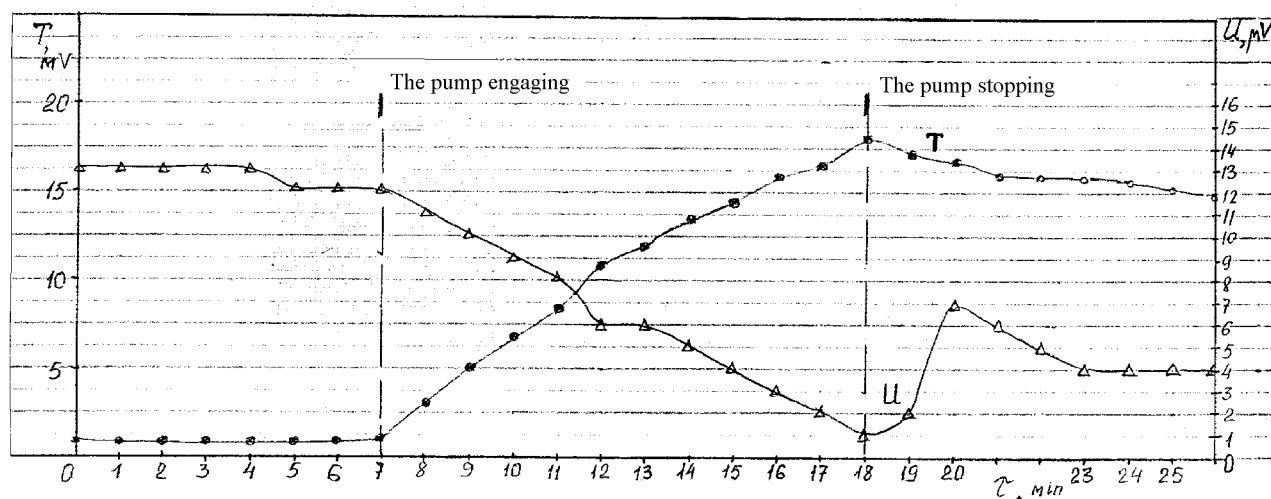


Figure 4: The time course of water temperature dependence and signal value from Winston's bridge

ed estimations of the transformation efficiency of the supplied electrical energy into thermal one, have given the transformation coefficient value of more than 1.1 (i.e. more than 110 %), that became the Potapov's observation confirmation about high efficiency of energy cavitation transformation [3, 4].

The linear temperature increase from the system operating time is recorded practically in all experiments.

The multiple radiation measurements from a hydrodynamic contour have enough clear repeatability and exclude doubts in their casualty and other nature, rather than from the processes occurring in a hydrodynamic contour.

The time course of water temperature in a contour and signal value from the Winston's bridge resistor is given in the Fig. 4.

It is necessary to note, that the given course of the signal change from the resistor ( $U$ ) is stipulated not by its decrease, and that the value  $U=16$  V with the subsequent signal deviation to the zero mark was accepted as the reading balanced indication before measuring on the microvoltmeter scale.

As it can be seen from the diagram, the legible correlation of radiation signal occurrence and change registered from the hydrodynamic contour operation is observed.

However the signal value course after the pump stopping in the hydrodynamic contour is inexplicable. There is an impression that the contour remains as the generating structure for some time.

The executed improvement of the recording scheme of radiation signal changes by the signal recording on a recorder has allowed to find out new features in the explored radiation character.

In particular, the signal value and character undergo evident changes even at rather small (less than 5 %)

additives to water, circulating in a the hydrodynamic contour, alkalis or salts.

The time course of the signal value change from the Winston's bridge resistor for water solutions of ytterbium bromide ( $\text{YbBr}_3$ ), ammonium hydroxide ( $\text{NH}_4\text{OH}$ ), potassium chloride ( $\text{KCl}$ ) and pure distilled water ( $\text{H}_2\text{O}$ ) is given in the Fig. 5.

And if the sufficient equal course of signal change dependencies for solutions  $\text{KCl}$  and  $\text{NH}_4\text{OH}$  does not contain the information, enough for use in the subsequent radiation generators, so the signal from water solution of ytterbium bromide enables to think a lot about the radiation generation features.

The numerous peaks on a signal curve allow speaking about interesting radiation generation features in a cavitation cavity as the solution temperature rise. Since the recorder did not allow registering peak values at the used sensitivity limit, the issue remains open, exactly the same as in the investigations with water solutions of other rare-land compounds.

Of course, it is difficult to notice the amplitude swings (by virtue of inertial properties of the pointer device) at visual recording of signal value changes on the microvoltmeter, the recorder enabled observing failures in the signal generation in an upper curve for pure water signal even in water.

The attempts to understand what role the reflector executes in radiation concentration on the resistor left some indeterminacy in the problem of radiation interaction with the reflector materials, as the hydrodynamic contour location behind the reflector gave the value diminution of the registered signal that missed expectations of its essential diminution.

The recording attempt of -background possible change was made at the device running during investigations. The used dosimeter "Jupiter- SIM-0.5" did not register

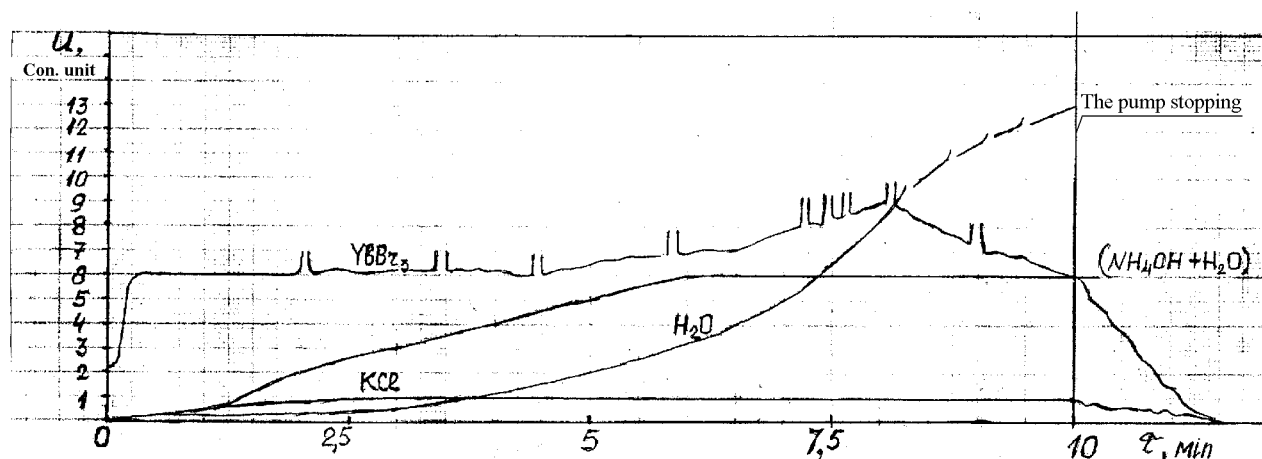


Figure 5: The time course of the signal value change from the Winston's bridge for various operating bodies in a hydrodynamic contour

the radioactive background increase, but it, however, does not exclude the fact that the use of more sensitive recording instrumentation will give other results.

#### 4. Conclusion

The executed investigations, unfortunately, due to various reasons have not allowed to receive the single meaning answer about the registered radiation nature and put more questions than received answers. The authors have some variants of theoretical explanations, however, they will refrain from polemic as for theoretical problems in the article in order of the greatest trust making to experimental data.

One thing is doubtless - the detection of new radiation types open new technological opportunities, and presuppose the careful biomedical investigation of this radiation influence upon alive organisms taking into account the unfavorable influence of registered radiation upon some investigators.

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# BRAKING FORCE AND ENERGETICS IN HOMOPOLAR GENERATORS

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We analyze, for the first time, energy conservation as applied to homopolar electromagnetic devices. Our findings, advanced in this journal ([www.spacetime.narod.ru](http://www.spacetime.narod.ru), **3**, 3 (13), 2002), disprove wrong statements recently appeared in the literature (A.L. Kholmetskii, *Am. J. Phys.*, **71**, 6, 2003).

## 1. General Force and Torque Considerations

Free energy believers sustain the possibility of energy extraction from the space with the aid of homopolar generators. The above unphysical expectation was suggested by N. Tesla himself (1) and advocated by B. De Palma, P. Tewari and others (2–6). The correct physics of homopolar induction (7 and references therein) allow us disprove such naive expectations.

Figure 1 sketches the essential components of the ancient Faraday (Maxwell) homopolar generator (motor):

- 1) A magnet creating an uniform  $B$ -field.
- 2) A conducting radial bar able to rotate about magnet's symmetry axle. The ends of the bar are terminated as contacts able to slide, respectively, on the axle and on a (radius  $R$ ) metallic ring.
- 3) A *closing-circuit* wire, the closing wire from herein, also terminated as sliding contacts touching both the axle and the outer ring.

When the bar is spun on the magnet, the **bar itself** becomes an emf source able to drive a DC across the entire closed circuit (bar plus closing wire). Torque (due to the magnet) acting on the  $dr$  bar segment located at  $r$  is worth  $d\tau = (IB \cdot dr) r$  which, integrated along the entire bar gives  $\tau_{M,B} = I \langle B^* \rangle R^2 / 2$  for a constant field. Here  $B^*$  means the component of  $B$  which is normal to the bar and  $\langle \rangle$  means average value. Moreover, an **equal but opposite** torque  $\tau_{M,CW} = -\tau_{M,B}$  (due to the magnet) acts on the closing wire. The two (equal but opposite) **reaction** torques acting on the magnet,  $\tau_{B,M}$  and  $\tau_{CW,M}$  precludes its own rotation. From all the above torque relations we select the following one,

$$\tau_{M,B} = \tau_{CW,M} \quad (1)$$

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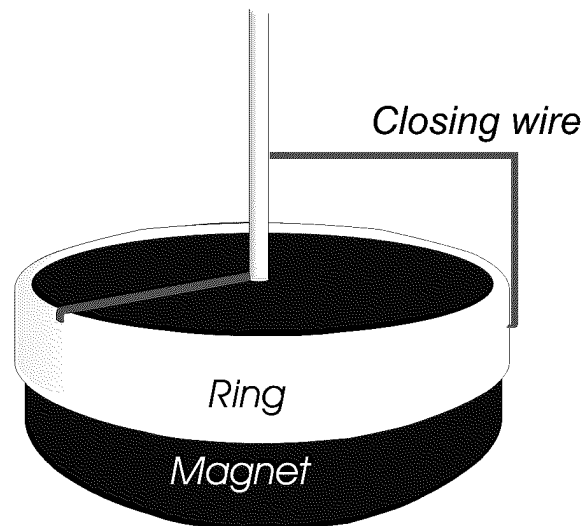


Figure 1: Faraday-Maxwell's Setup Magnet Bar and Closing Wire

in order to clarify further energetics considerations.

When the bar is attached to the magnet and both co-rotate, the bar no more works as an emf source. The **closing wire** (at relative motion with the magnet) becomes now the emf source. Being the bar attached to the magnet, and due to the action-reaction cancellation, the torques  $\tau_{M,B}$  and  $\tau_{B,M}$  are unable to produce rotation. The torque  $\tau_{CW,M}$  acting on the magnet **due to the closing wire**, is the responsible for magnet's rotation (8).

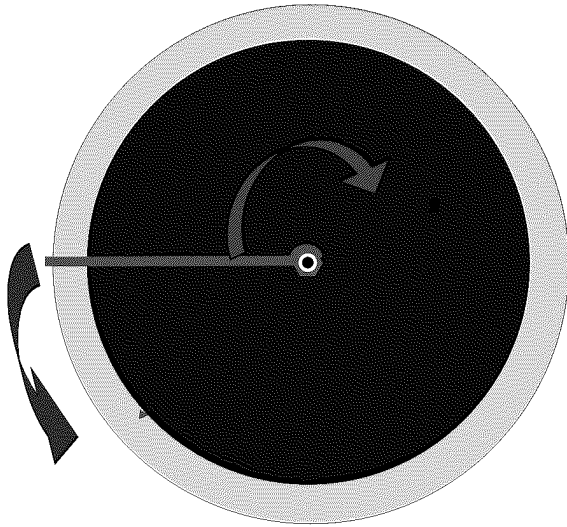


Figure 2: The bar rotates in the CCW sense (red arrow). Braking force on the bar (blue arrow) diminishes its kinetic energy

## 2. Energetics

1) Bar free to rotate in the CCW sense on the north pole of the magnet at rest in the lab (figure 2) generates a centrifugal DC. Also the closing wire remains at rest in the lab. The bar is acted on by the CW sense braking force  $F = \int_0^R IB \cdot dr$ , which diminishes its kinetic energy

This force produces the torque  $\tau_{M,B}$  described above. In order to keep the rotational angular velocity  $\omega$  (radians per second) constant, the external source of mechanical energy must deliver power (watts) at the rate  $P = \tau_{M,B}\omega$ . Here  $\tau$  is measured in newtons times meter. **Energy transference** takes place between the **spinning bar** and the **magnet** (both at relative motion).

2) Bar attached to the magnet, both spinning in the CCW sense; the closing wire at rest in the lab. Now **energy transference** takes place between the **spinning magnet** and the **closing wire**. Being the bar at relative rest with the magnet, it only plays a passive role (to provide a current-path). Customary physics don't prescribe how the forces produced by the closing wire on the magnet are distributed on its bulk, which make impossible the direct calculation of the relevant torque  $\tau_{CW,M}$  generated by the closing wire, acting on the magnet. Nevertheless, our former analysis, equation 1, ensures that  $\tau_{CW,M} = \tau_{M,B}$  and, consequently, the mechanical power supply required in order to keep rotational kinetic energy constant must be the same as in the case described in paragraph 1.

## 3. Conclusion

As well as in ordinary flux-varying engines, energy conservation works at all in homopolar devices. Overunity outputs claimed by some authors (9) lack of physical grounds. All customary misconceptions about the issue disappear when one is able to recognize that an uniform rotating magnet induces a Lorentz-like radial electric field in its vicinity (10).

## Acknowledgements

To C.N. Gagliardo and O. Cabrera for helpful assistance.

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