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- Electrification of Plasma
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- Electrodynamics of Maxwell
- Anomalies in Thermoelectricity

Discovering Thoughts, Inventing Future

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Realistic Polytropic Models for Neutral Stars with Vanishing Pressure Anisotropy

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Abstract- We find new exact models for the Einstein-Maxwell equations using the poly- tropic equation of state.The models generated satisfy uncharged star with anisotropy present. It is interesting that our anisotropic polytropic models con- tain isotropic case at the vanishing point of anisotropic parameters. In all models, the matter variables and gravitational potentials are well behaved. The radial and tangential pressures are compared at different values of polytropic index η.

Keywords: *einstein's field equations; neutral stars; pressure anisotropy; polytropic equation of state.*

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REALISTICPOLYTROPICMODELSFORNEUTRALSTARSWITHVANISHINGPRESSUREANISOTROPY

Realistic Polytropic Models for Neutral Stars with Vanishing Pressure Anisotropy

Jefta M. Sunzu

Abstract- We find new exact models for the Einstein-Maxwell equations using the polytropic equation of state. The models generated satisfy uncharged star with anisotropy present. It is interesting that our anisotropic polytropic models contain isotropic case at the vanishing point of anisotropic parameters. In all models, the matter variables and gravitational potentials are well behaved. The radial and tangential pressures are compared at different values of polytropic index η.

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I. Introduction

The Einstein-Maxwell equations have been a strong tool to generate models that describe behaviors, properties and structures of relativistic stellar objects such as black holes, neutron stars, gravastars, dark energy stars and hybrid strange quark stars. Different space times geometry are considered when using the Einstein-Maxwell field equations. Using space time that is static and spherically symmetry, several findings on properties of stellar objects have been investigated. Using these field equations Sunzu et al [1, 2] found stellar masses and radii for charged quark matter consistent with several observations. Maharaj et al [3] found new exact solutions that describe Finch and Skea relativistic stars. The solutions to the field equations in static spacetimes obtained by Thirukkanesh and Maharaj [4] describe realistic compact anisotropic models. The astrophysical results obtained by Mafa Takisa and Maharaj [5] are for the anisotropic charged stars with core envelope and Matondo and Maharaj [6] obtained new models with astrophysical significance.

Stellar models with pressure anisotropy are important to be considered even in the absence of electric field. The first anisotropic model was developed by Bowers and Liang [7]. Since then there have been attention drawn by researchers to work in this direction. As indicated in the paper by Dev and Gleiser [8] that pressure anisotropy affects the structures and properties of many relativistic objects. Both the mass and redshift change with pressure anisotropy. According to Dev and Gleiser [9] stability of the stellar spheres do also depend on the pressure anisotropy. Models found by Gleiser and Dev [10] vindicate that the presence of pressure anisotropy may cause several observational effects. They proved that surface redshift for the stellar object may be large and stellar objects at large redshifts may be nearer than they really appear. This is caused by anisotropic distortions. It is shown that stars are more stable if the pressure anisotropy exists near its center. In the work by Sunzu et al [1] it was shown that anisotropic quark stars were less heavier compared to stars with isotropic pressures. Uncharged models for anisotropic bodies described by Kalam et al [11] were found to be compatible with quark strange star of the candidates SAXJ1808.4-3658, Her X-1 and 4U 1820-30. Other neutral anisotropic solutions in spacetime that is spherically symmetry are those obtained by Mak and Harko [12, 13], Harko and Mak [14], Sunzu [15], Maharaj and Chaisi [16, 17], Karmakar et al [18] and quark strange star models determined by Paul et al [19].

Several equation of states have been incorporated together with field equations in order to generate stellar models. We have many charged anisotropic stellar models obtained by considering a linear equation of state: regular compact exact models were formulated by Mafa Takisa and Maharaj [20], exact nonsingular models for quark stars are described by Sunzu et al [1, 2], Sunzu and Danford [21] and Maharaj et al [22], exact models for dark energy stars and strange stars were obtained by Thirukkanesh and Maharaj [4], isothermal anisotropic solutions were generated by Maharaj and Thirukkanesh [23] Sharma and Maharaj [24] obtained models for hybrid stars, and models for conformal invariant matter are indicated by Esculpi and Aloma [25].

Anisotropic models with linear equation of state for quark star in absence of charge are also determined by Sunzu [15]. Analytical models with a linear equation of state for isotropic charged quark stars are found by Komathiraj and Maharaj [26]. Under the same equation of state, isotropic quark star models were obtained by Bombaci [27], Sotani and Harada [28], and Sotani et al [29]. Models for strange stars with anisotropic pressures were found by Rahaman et al [30].

Models with quadratic equation of state include exact stellar models for the charged stars in presence of the pressure anisotropy found by Maharaj and Mafa Takisa [31] and Feroze and Siddiqui [32], models for compact stars obtained by Ngubelanga et al [33]. Other recent treatments in this direction are those performed

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by Sharov [34] and strange quark star model by Malaver [35]. Models generated using Van der Waals equation of state include the charged relativistic models in the paper by Malaver [36, 37], anisotropic compact models generated by Thirukkanesh and Ragel [38] and Sunzu and Mahali [39], and the treatments indicated in Lobo [40].

In the paper by Thirukkanesh and Ragel [41] models for neutral anisotropic compact objects with the polytropic equation of state are obtained. On the other hand Mafa Takisa and Maharaj [42] applied polytropic equation of state to generate anisotropic charged models. In the treatments by Shibata [43] polytropic models are performed by considering the stability of rigidly rotating objects. In the work by Lai and Xu [44] it is shown that huge quantity of gravitational energy is generated during gravitational collapse of polytropes. Most of the polytropic models are isotropic and those that are anisotropic have the anisotropy always present which is not physical. It is important to generate polytropic models with anisotropic pressures which contain isotropic pressures as a special case.

The objective of this paper is to generate uncharged anisotropic models using polytropic equation of state. The models contain isotropic pressures as a special case. In order to achieve this objective this paper is arranged as follows: In the following section, we state fundamental equations, transform the field equations and make choice for the anisotropy and one of the metric function. In Sect. (3) and Sect. (4) we formulate and find exact solutions for two polytropic models. We give discussion on the generated plots in Sect. (5) and the concluding remark is in Sect. (6).

II. Fundamental Equations

We generate models for the stellar object interior whose spacetime geometry is static and spherically symmetric and is represented by the line element

$$ds^2 = -e^{2\nu(r)}dt^2 + e^{2\lambda(r)}dr^2 + r^2(d\theta^2 + \sin^2\theta d\phi^2), \tag{1}$$

in here $\nu(r)$ and $\lambda(r)$ are functions for the gravity. The Schwarzschild exterior spacetime is defined by line element

$$ds^2 = -\left(1 - \frac{2M}{r}\right)dt^2 + \left(1 - \frac{2M}{r}\right)^{-1} dr^2 + r^2(d\theta^2 + \sin^2\theta d\phi^2), \tag{2}$$

where M represents the total mass. The energy momentum tensor for neutral matter with pressure anisotropy is given by

$$T_{ij} = \mathrm{diag}\left(-\rho, p_r, p_t, p_t\right), \tag{3}$$

where ρ is the energy density, p_r is the radial pressure and p_t is the tangential pressure.

These variables are measured relative to a comoving unit timelike fluid four-velocity u^a.

The Einstein-Maxwell equations for anisotropic uncharged matter can be written in the form

$$\frac{1}{r^2}\left(1 - e^{-2\lambda}\right) + \frac{2\lambda'}{r}e^{-2\lambda} = \rho, \tag{4a}$$

$$-\frac{1}{r^2}\left(1 - e^{-2\lambda}\right) + \frac{2\nu'}{r}e^{-2\lambda} = p_r, \tag{4b}$$

$$e^{-2\lambda}\left(\nu'' + \nu'^2 - \nu'\lambda' + \frac{\nu'}{r} - \frac{\lambda'}{r}\right) = p_t, \tag{4c}$$

where primes define derivative with respect to radial distance r. In our model we are applying the units where the coupling constant $\frac{8\pi G}{c^4}$ and the speed of light c are unity.

The mass function for a neutral fluid is defined by

$$m(r) = \frac{1}{2}\int_0^r \omega^2 \rho d\omega. \tag{5}$$

We consider a polytropic equation of state which give the relationship between the radial pressure and the energy density in the form

$$p_r = \alpha\rho^{\left(1+\frac{1}{\eta}\right)}, \tag{6}$$

where η and α are real constants. It is important to note that different equation of states can be obtained by varying the value of polytropic index η.

In order to transform the field equations we use new variables given by Durgapal and Banerjee [45] as

$$x = Cr^2, \quad Z(x) = e^{-2\lambda(r)}, \quad A^2y^2(x) = e^{2\nu(r)}, \tag{7}$$

where A and C are arbitrary constants. Using this transformation the field equations become

$$\frac{1-Z}{x} - 2\dot{Z} = \frac{\rho}{C}, \tag{8a}$$

$$4Z\frac{\dot{y}}{y} + \frac{Z-1}{x} = \frac{p_r}{C}, \tag{8b}$$

$$4xZ\frac{\ddot{y}}{y} + \left(4Z + 2x\dot{Z}\right)\frac{\dot{y}}{y} + \dot{Z} = \frac{p_t}{C}, \tag{8c}$$

and the line element (1) becomes

$$ds^2 = -A^2y^2dt^2 + \frac{1}{4xCZ}dx^2 + \frac{x}{C}(d\theta^2 + \sin^2\theta d\phi^2). \quad (9)$$

The transformed mass function (5) becomes

$$M(x) = \frac{1}{4C^{\frac{3}{2}}}\int_0^x \sqrt{\omega}\rho d\omega. \quad (10)$$

The field equations in the system (4) with polytropic equation of state can be written as

$$\rho = \left(\frac{1-Z}{x} - 2\dot{Z}\right)C, \quad (11a)$$

$$p_r = p_r = \alpha\rho^{\left(1+\frac{1}{\eta}\right)}, \quad (11b)$$

$$p_t = p_r + \Delta, \quad (11c)$$

$$\Delta = \left[4xZ\frac{\ddot{y}}{y} + \left(1 + 2x\frac{\dot{y}}{y}\right)\dot{Z} + \frac{1-Z}{x}\right]C. \quad (11d)$$

The variable $\Delta = p_t - p_r$ is the measure of anisotropy. This system consists of six unknown variables namely ($\rho,\ p_r,\ p_t,\ Z,\ y,\ \Delta$) in four equations. The gravitational behavior of the anisotropic polytropic neutral star is governed by the system (11). Mathematically, if we specify any two of these unknown variables the system may be tractable. When $\Delta = 0$ we obtain isotropic model. From a mathematical point of view any two of the six variables can be specified in order to tract the system (11); however the choice should be made on physical grounds so that a model that is well behaved is generated.

Equation (11d) can be re-written as

$$\dot{Z} + \frac{(4x^2\ddot{y} - y)}{x(2x\dot{y} + y)}Z = \frac{\left(\frac{x\Delta}{C} - 1\right)y}{x(2x\dot{y} + y)}, \quad (12)$$

which is highly nonlinear equation in general. If y and Δ are specified then Eq. (12) is linear in the variable Z. In order to find exact solutions to this model we will specify the quantities y and Δ. We specify the metric function

$$y = (a + x^m)^n, \quad (13)$$

where a, m and n are real values. A similar choice was made by Komathiraj and Maharaj [26] and Mak and Harko [46] for a non-polytropic charged model. This choice guarantees that the metric function is regular and finite within the stellar interior. We specify the measure of anisotropy in the form

$$\Delta = A_1x + A_2x^2 + A_3x^3, \quad (14)$$

where A_1, A_2 and A_3 are real arbitrary constants. A similar choice of anisotropy was made in the paper by Maharaj et al [22] and Sunzu *et al* [1, 2] in charged models with linear equation of state. This choice is physically reasonable for it is continuous, finite and regular throughout the stellar interior. It is also possible to regain isotropic models ($\Delta = 0$) when $A_1 = A_2 = A_3 = 0$. It is important to keep this choice of the anisotropy for new polytropic model with vanishing anisotropy to be generated.

Substituting Eq. (13) and (14) in Eq. (12) we obtain the nonlinear differential equation

$$\dot{Z} + \left[\frac{-(a+x^m)^n + 4(B(x) + D(x))}{x\left[2mnx^m(a+x^m)^{n-1} + (a+x^m)^n\right]}\right]Z$$
$$= \frac{(a+x^m)^n\left(\frac{x(A_1x + A_2x^2 + A_3x^3)}{C} - 1\right)}{x\left[2mnx^m(a+x^m)^{n-1} + (a+x^m)^n\right]}, \quad (15)$$

where we have set

$$B(x) = nm^2(n-1)x^{2m}(a+x^m)^{n-2},$$

$$D(x) = mn(m-1)x^m(a+x^m)^{n-1},$$

for convenience. Once Eq. (15) is solved we can find the remaining variables ρ, p_r and p_t from the system (11). The general exact solution for Eq. (15) does not exist, however we can find its solution after specifying values for the constants m and n.

III. Polytropic Model I

We can find an exact solution to Eq. (15) when $m = 1$ and $n = 1$. For this choice the metric function (13) becomes

$$y(x) = (a + x). \quad (16)$$

The differential equation (15) becomes

$$\dot{Z}-\left(\frac{1}{x}-\frac{2}{a+3x}\right)Z=\frac{\left(\frac{(A_1x+A_2x^2+A_3x^3)x}{C}-1\right)(a+x)}{x\,(a+3x)}. \tag{17}$$

Solving Eq. (17) we obtain the solution

$$\begin{aligned} Z &= \frac{1}{C}\left[\left(\frac{2}{5}a+\frac{1}{5}x\right)A_1x+\left(-\frac{3}{40}a^2+\frac{3}{20}ax+\frac{1}{8}x^2\right)A_2x \right.\\ &\left. +\left(\frac{1}{55}a^3-\frac{2}{55}a^2x+\frac{1}{11}ax^2+\frac{1}{11}x^3\right)A_3x+C+\frac{Ckx}{(a+3x)^{\frac{2}{3}}}\right], \end{aligned} \tag{18}$$

where k is a constant of integration.
Therefore the gravitational potentials and the matter variables becomes

$$e^{2\nu} = A^2(a+x)^2, \tag{19a}$$

$$\begin{aligned} e^{2\lambda} &= C\left[\left(\frac{2}{5}a+\frac{1}{5}x\right)A_1x+\left(-\frac{3}{40}a^2+\frac{3}{20}ax+\frac{1}{8}x^2\right)A_2x \right.\\ &\left. +\left(\frac{1}{55}a^3-\frac{2}{55}a^2x+\frac{1}{11}ax^2+\frac{1}{11}x^3\right)A_3x+C+\frac{Ckx}{(a+3x)^{\frac{2}{3}}}\right]^{-1}, \end{aligned} \tag{19b}$$

$$\begin{aligned} \rho &= \frac{1}{(a+3x)}\left[\left(-\frac{6}{5}a^2+\frac{23}{5}ax+3x^2\right)A_1\right.\\ &+\left(\frac{9}{40}a^3-\frac{3}{40}a^2x-\frac{25}{8}ax^2-\frac{21}{8}x^3\right)A_2\\ &-\left(\frac{3}{55}a^4-\frac{1}{55}a^3x+\frac{1}{11}a^2x^2+\frac{30}{11}ax^3+\frac{27}{11}x^4\right)A_3\\ &\left.-\frac{Ck(3a+5x)}{(a+3x)^{\frac{2}{3}}}\right], \end{aligned} \tag{19c}$$

$$\begin{aligned} p_r &= \frac{\alpha}{(a+3x)^{\left(1+\frac{1}{\eta}\right)}}\left[\left(-\frac{6}{5}a^2+\frac{23}{5}ax+3x^2\right)A_1\right.\\ &+\left(\frac{9}{40}a^3-\frac{3}{40}a^2x-\frac{25}{8}ax^2-\frac{21}{8}x^3\right)A_2\\ &-\left(\frac{3}{55}a^4-\frac{1}{55}a^3x+\frac{1}{11}a^2x^2+\frac{30}{11}ax^3+\frac{27}{11}x^4\right)A_3\\ &\left.-\frac{Ck(3a+5x)}{(a+3x)^{\frac{2}{3}}}\right]^{\left(1+\frac{1}{\eta}\right)}, \end{aligned} \tag{19d}$$

$$\begin{aligned} p_t &= A_1x+A_2x^2+A_3x^3\\ &+\frac{\alpha}{(a+3x)^{\left(1+\frac{1}{\eta}\right)}}\left[\left(-\frac{6}{5}a^2+\frac{23}{5}ax+3x^2\right)A_1\right.\\ &+\left.\frac{9}{40}a^3-\frac{3}{40}a^2x-\frac{25}{8}ax^2-\frac{21}{8}x^3\right)A_2 \end{aligned} \tag{19f}$$

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$$-\left(\frac{3}{55}a^4-\frac{1}{55}a^3x+\frac{1}{11}a^2x^2+\frac{30}{11}ax^3+\frac{27}{11}x^4\right)A_3$$

$$\left.-\frac{Ck(3a+5x)}{(a+3x)^{\frac{2}{3}}}\right]^{\left(1+\frac{1}{\eta}\right)}, \tag{19e}$$

$$\Delta = A_1x+A_2x^2+A_3x^3. \tag{19f}$$

The line element corresponding to this model becomes

$$\begin{aligned} ds^2 &= -A^2(a+x)^2dt^2+ \\ & C\left[\left(\frac{2}{5}a+\frac{1}{5}x\right)A_1x+\left(-\frac{3}{40}a^2+\frac{3}{20}ax+\frac{1}{8}x^2\right)A_2x\right. \\ & \left.+\left(\frac{1}{55}a^3-\frac{2}{55}a^2x+\frac{1}{11}ax^2+\frac{1}{11}x^3\right)A_3x+C-\frac{Ckx}{(a+3x)^{\frac{2}{3}}}\right]^{-1}dr^2 \\ & +r^2(d\theta^2+\sin^2\theta d\phi^2), \end{aligned} \tag{20}$$

and mass function becomes

$$\begin{aligned} M(x) &= -\frac{x^{\frac{3}{2}}}{(a+3x)\,C^{\frac{3}{2}}}\left[\left(\frac{1}{5}a^2+\frac{7}{10}ax+\frac{3}{10}x^2\right)A_1\right. \\ & +\left(-\frac{3}{80}a^3-\frac{3}{80}a^2x+\frac{23}{80}ax^2+\frac{3}{16}x^3\right)A_2 \\ & +\left(\frac{1}{110}a^4+\frac{1}{110}a^3x-\frac{1}{110}a^2x^2+\frac{2}{11}ax^3+\frac{3}{22}x^4\right)A_3 \\ & \left.+\frac{1}{2}Ck(a+3x)^{\frac{1}{3}}\right]. \end{aligned} \tag{21}$$

IV. Polytropic Model II

We find second exact solution to Eq. (15) when $m=1$ and $n=2$. For this choice the metric function (13) becomes

$$y(x)=(a+x)^2\,. \tag{22}$$

Then Eq. (15) reduces to

$$\dot{Z}+\left(-\frac{1}{x}+\frac{2}{a+x}+\frac{2}{a+5x}\right)Z=\frac{\left(\frac{(A_1x+A_2x^2+A_3x^3)x}{C}-1\right)(a+x)}{x\,(a+5x)}. \tag{23}$$

Solving Eq. (23) we obtain

$$Z=\frac{1}{(a+x)^2}\left[\left(a^2-\frac{10}{7}ax-\frac{1}{7}x^2\right)+\frac{kx}{(a+5x)^{\frac{2}{5}}}+\frac{F(x)}{C}\right], \tag{24}$$

where

$$F(x) = \left(\frac{38}{119}a^3+\frac{43}{119}a^2x+\frac{4}{17}ax^2+\frac{1}{17}x^3\right)A_1x$$

$$+\left(-\frac{109}{2618}a^4+\frac{109}{1309}a^3x+\frac{39}{187}a^2x^2+\frac{31}{187}ax^3+\frac{1}{22}x^4\right)A_2x$$
$$+\left(\frac{236}{35343}a^5-\frac{472}{35343}a^4x+\frac{236}{5049}a^3x^2+\frac{739}{5049}a^2x^3\right.$$
$$\left.+\frac{38}{297}ax^4+\frac{1}{27}x^5\right)A_3x. \tag{25}$$

Then gravitational potentials and the matter variables becomes

$$e^{2\nu} = A^2\left(a+x\right)^4, \tag{26a}$$
$$e^{2\lambda} = \frac{7\left(a+x\right)^2}{(7a^2-10ax-x^2)+\frac{7kx}{(a+5x)^{\frac{2}{5}}}+\frac{7F(x)}{C}}, \tag{26b}$$
$$\rho = \frac{C\left(\frac{72}{7}a^3+\frac{376}{7}a^2x+\frac{88}{7}ax^2+40x^3\right)+G(x)}{\left(a+x\right)^3\left(a+5x\right)},$$
$$+\frac{C\left(-3ka^2-10akx+9kx^2\right)}{\left(a+x\right)^3\left(a+5x\right)^{\frac{7}{5}}} \tag{26c}$$
$$p_r = \alpha\left[\frac{\left[C\left(\frac{72}{7}a^3+\frac{376}{7}a^2x+\frac{88}{7}ax^2+40x^3\right)+G(x)\right]}{\left(a+x\right)^3\left(a+5x\right)}\right.$$
$$\left.+\frac{C\left(-3ka^2-10akx+9kx^2\right)}{\left(a+x\right)^3\left(a+5x\right)^{\frac{7}{5}}}\right]^{\left(1+\frac{1}{\eta}\right)}, \tag{26d}$$
$$p_t = \alpha\left[\frac{\left[C\left(\frac{72}{7}a^3+\frac{376}{7}a^2x+\frac{88}{7}ax^2+40x^3\right)+G(x)\right]}{\left(a+x\right)^3\left(a+5x\right)}\right.$$
$$\left.+\frac{C\left(-3ka^2-10akx+9kx^2\right)}{\left(a+x\right)^3\left(a+5x\right)^{\frac{7}{5}}}\right]^{\left(1+\frac{1}{\eta}\right)}+A_1x+A_2x^2+A_3x^3, \tag{26e}$$
$$\Delta = A_1x+A_2x^2+A_3x^3, \tag{26f}$$
$$G(x) = -\left(\frac{1148}{119}a^5+\frac{747}{119}a^4x+\frac{1124}{119}a^3x^2+\frac{1342}{119}a^2x^3+\frac{110}{17}ax^4+\frac{25}{17}x^5\right)A_1$$
$$+\left(\frac{327}{2618}a^6+\frac{218}{1309}a^5x-\frac{10035}{2618}a^4x^2-\frac{12872}{1309}a^3x^3\right.$$
$$\left.-\frac{4457}{374}a^2x^4-\frac{1302}{187}ax^5-\frac{35}{22}x^6\right)A_2$$

$$-\left(\frac{236}{11781}a^7+\frac{944}{35343}a^6x-\frac{1888}{35343}a^5x^2+\frac{106973}{35343}a^4x^3\right.$$
$$\left.+\frac{47596}{5049}a^3x^4+\frac{60958}{5049}a^2x^5+\frac{2144}{297}ax^6+\frac{5}{3}x^7\right)A_3. \quad (27)$$

Note that $G(x) = 0$ at the center of the stellar object and this condition is also satisfied for a model with isotropic pressures.

For this model the line element becomes

$$ds^2 = -A^2(a+x)^4dt^2+\frac{7(a+x^2)}{(7a^2-10ax-x^2)+\frac{7kx}{(a+5x)^{\frac{2}{5}}}+\frac{7F(x)}{C}}dr^2$$
$$+r^2(d\theta^2+\sin^2\theta d\phi^2), \quad (28)$$

and mass function is given by

$$M(x) = \frac{-x^{\frac{3}{2}}}{(a+x)^2(a+5x)C^{\frac{3}{2}}}\left[\left(\frac{19}{119}a^4+\frac{233}{238}a^3x+\frac{243}{238}a^2x^2+\frac{21}{34}ax^3+\frac{5}{34}x^4\right)A_1\right.$$
$$+\left(-\frac{109}{5236}a^5-\frac{327}{5236}a^4x+\frac{409}{1309}a^3x^2+\frac{113}{187}a^2x^3+\frac{327}{748}ax^4+\frac{5}{44}x^5\right)A_2$$
$$+\left(\frac{118}{35343}a^6+\frac{118}{11781}a^5x-\frac{118}{11781}a^4x^2+\frac{1919}{10098}a^3x^3\right.$$
$$\left.+\frac{1447}{3366}a^2x^4+\frac{67}{198}ax^5+\frac{5}{54}x^6\right)A_3-C\left(\frac{12}{7}a^2+\frac{64}{7}ax+\frac{20}{7}x^2\right.$$
$$\left.\left.-\frac{1}{2}k(a+5x)^{\frac{3}{5}}\right)\right]. \quad (29)$$

V. Discussion

In this section we indicate that the exact solutions for the field equations in Sect. (3) are well behaved. To do this we generate graphical plots for the gravitational potentials and matter variables. The Python programming language was used to generate graphs for the particular choices $a = 5.2$, $A = 0.16$, $\alpha = 0.33$, $\eta = 2$, $C = 1$, $k = 0$, $A_1 = 0.1$, $A_2 = 0.2$, and $A_3 = -0.2$. The graphical plots generated are for the potential $e^{2\nu}$ (Fig. 1), potential $e^{2\lambda}$ (Fig. 2), energy density ρ (Fig. 3), radial pressure p_r (Fig. 4), tangential pressure p_t (Fig. 5), measure of anisotropy Δ (Fig. 6), and the mass M (Fig. 7). We have also generated graphs for radial pressure and tangential pressure at different values of the polytropic index η as indicated in (Fig. 8 and 9). The plots indicated in (Fig. 10-13) show comparison between radial pressure and tangential pressure at different values of η. All figures are plotted against the radial distance *r*. From (Fig. 1 and 2) we observe the gravitational potentials to be regular and finite which is physical. From Fig. (3 - 5) we see that the energy density, the radial pressure and the tangential pressure are decreasing functions as we approach the boundary from the center. This agrees with the physical behaviour of these variables. The anisotropy is increasing from the center to the region near the surface where it slightly decreases. We observe from Fig. (7) that the mass is monotonically increasing with the radial distance. We have different profiles for the radial and tangential pressures at different values of η. When $\eta = 0.5$ we have the model corresponding to the equation of state $p_r = \alpha\rho^3$. When $\eta = 1.0$ the equation of state becomes $p_r = \alpha\rho^2$ which is quadratic in nature. The equation of state $p_r = \alpha\rho^{\frac{3}{2}}$ when $\eta = 2$. For $\eta = 2.5$ and $\eta = 3.0$ then $p_r = \alpha\rho^{\frac{7}{5}}$ and $p_r = \alpha\rho^{\frac{4}{3}}$ respectively. Therefore the graphs presented in Fig. (8) and Fig. (9) compare the variation of these matter variables at different equation of states. However for each value of η the radial and tangential pressures are decreasing function with maximum value at the center of the stellar object. In general we observe when η is small the index $\left(1+\frac{1}{\eta}\right)$ becomes large as the result the radial pressure and tangential pressure becomes large at the core of the stellar object. It is interesting to note that these values become equal toward the surface of the star regardless of the value of η. We also comment from Fig. (9) that the graphs for tangential pressure at $\eta = 2$ and $\eta = 3$ are merging. This may be due to the presence of polytropic index in both numerator and denominator in the equation for the tangential pressure. From Fig. (10-13) it is clear that these quantities are equal at the center and the region near the center. However at the regions away the center $p_t > p_r$. This is physical and agrees with the properties of stellar objects with astrophysical significance.

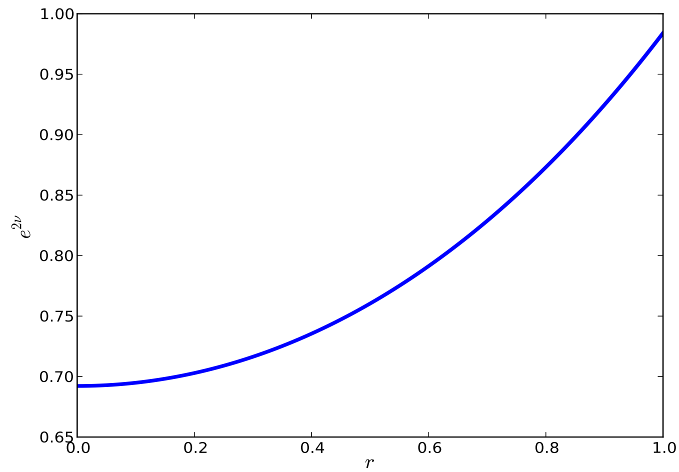

Figure 1: The potential e^{ν} against the radial distance r

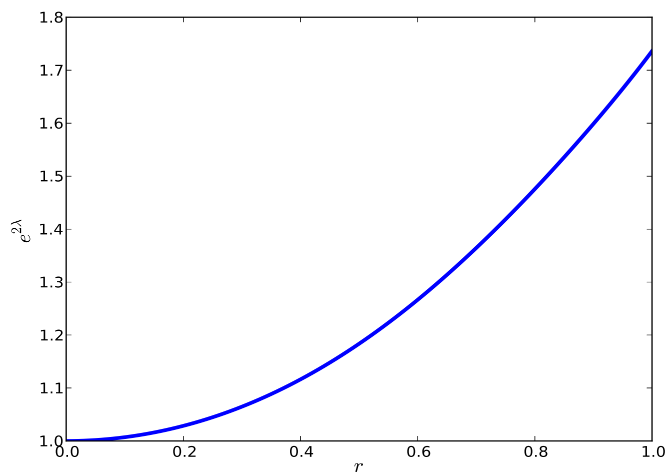

Figure 2: The potential e^{λ} against the radial distance r

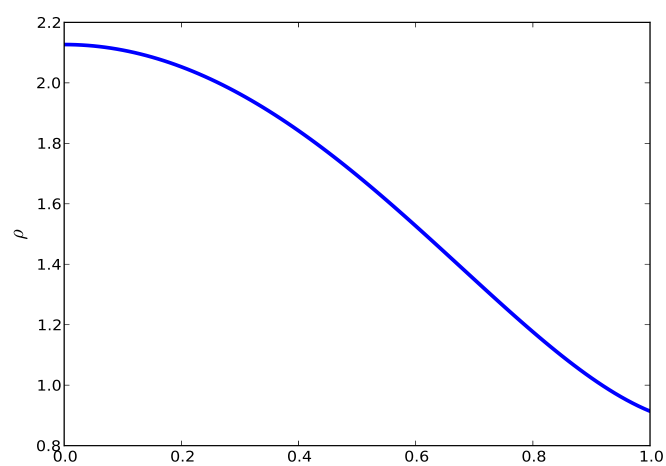

Figure 3: Energy density ρ against the radial distance r

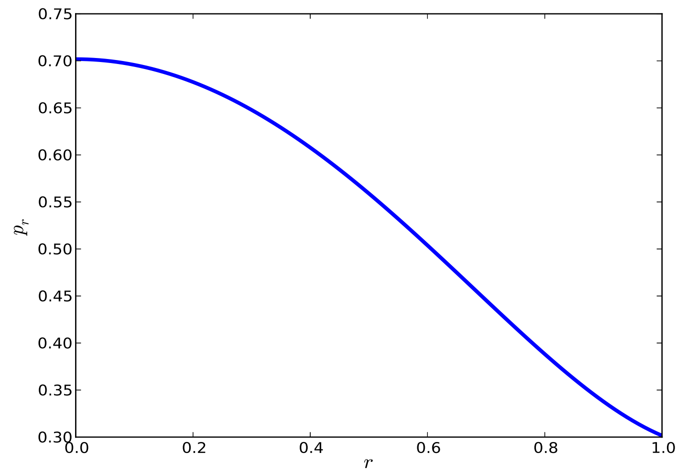

Figure 4: Radial pressure p_r against radial distance r

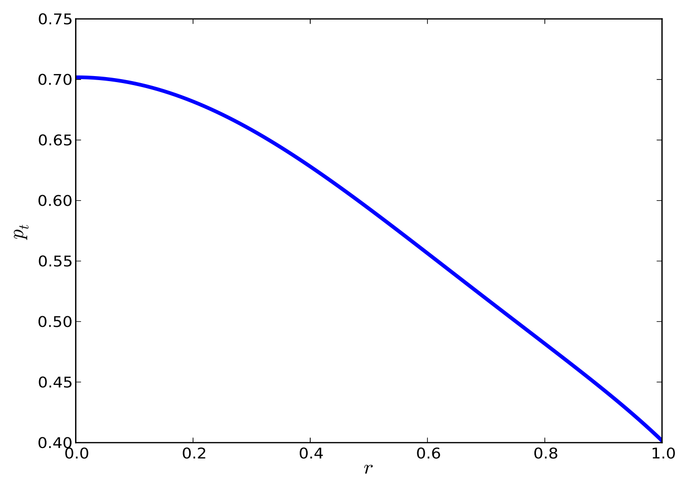

Figure 5: Tangential pressure p_t against radial distance r

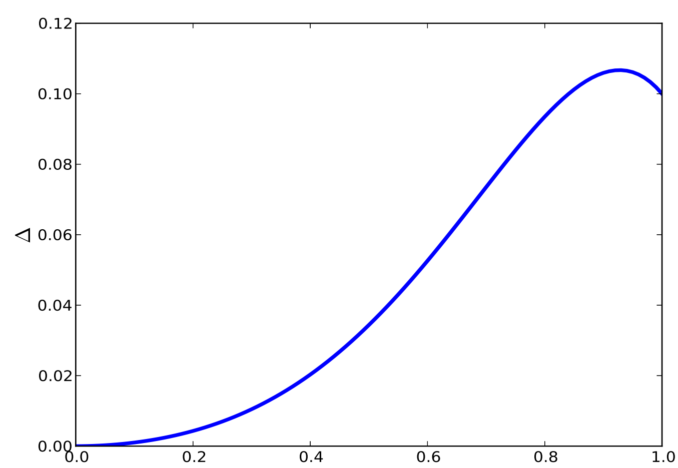

Figure 6: Measure of anisotropy Δ against radial distance r

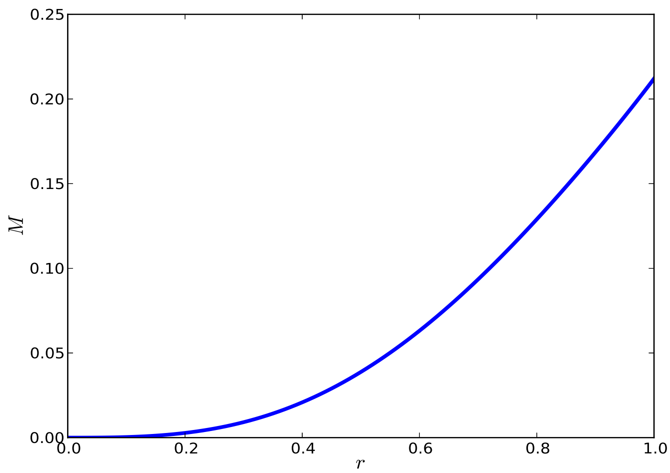

Figure 7: Mass m against radial distance r

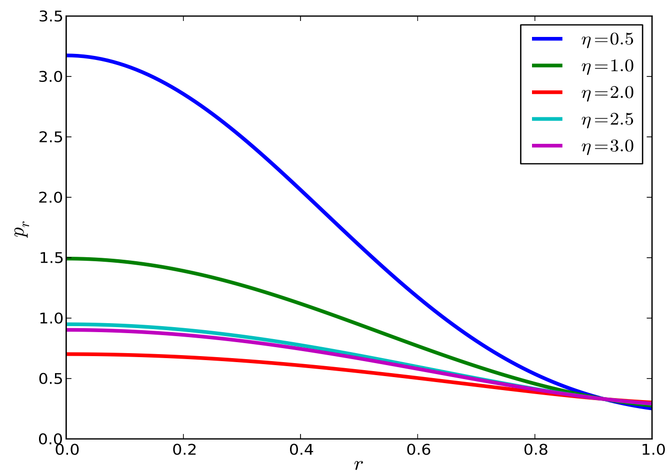

Figure 8: Radial pressures at different values of polytropic indices

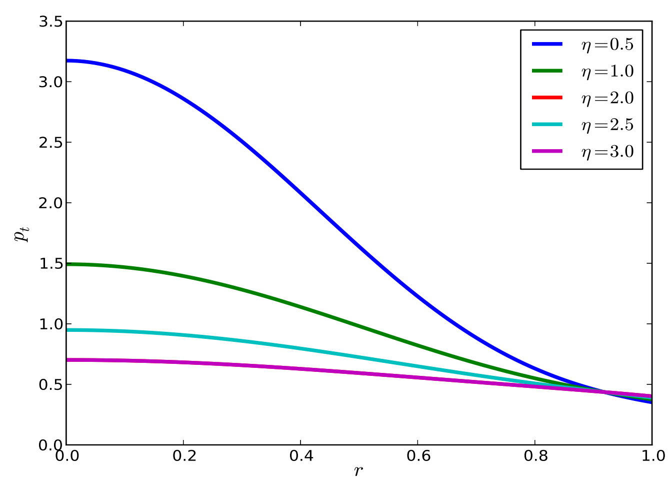

Figure 9: Tangential pressures at different values of polytropic indices

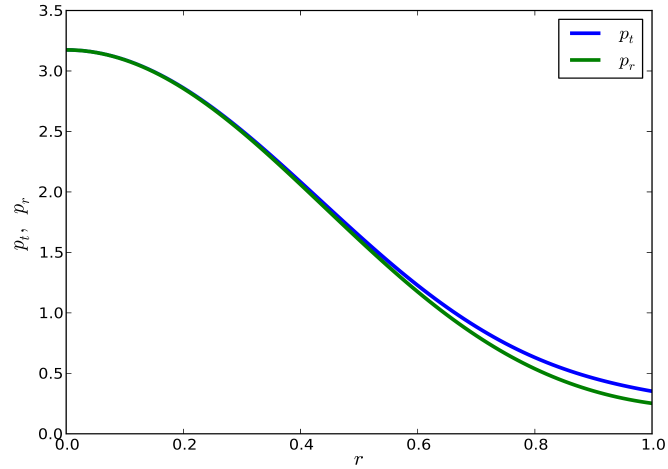

Figure 10: Comparison of the tangential and radial pressure at $\eta = 0.5$

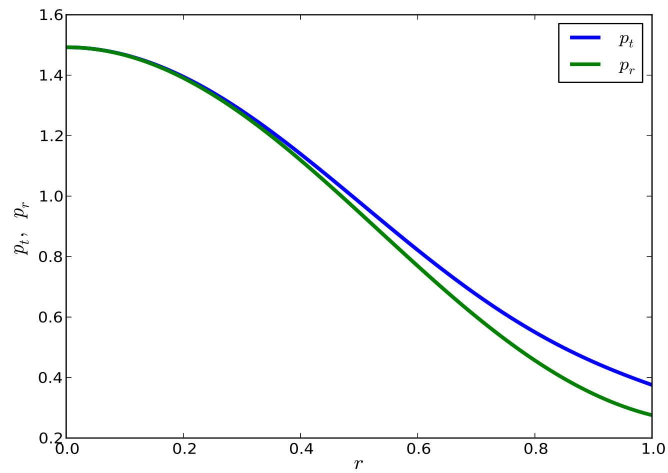

Figure 11: Comparison of the tangential and radial pressure at $\eta = 1.0$

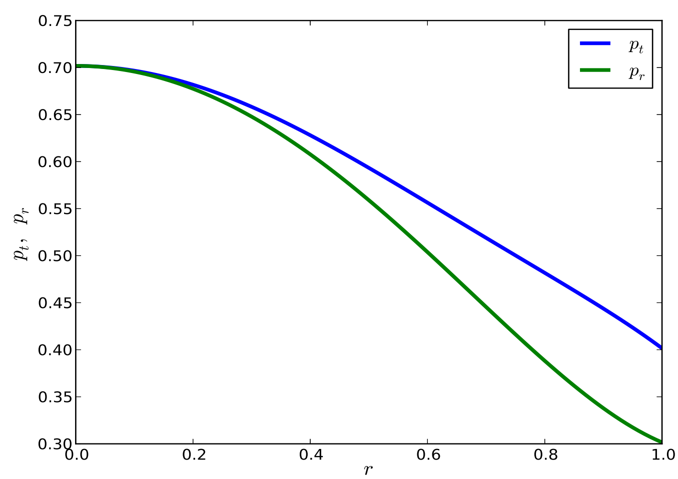

Figure 12: Comparison of the tangential and radial pressure at $\eta = 2.0$

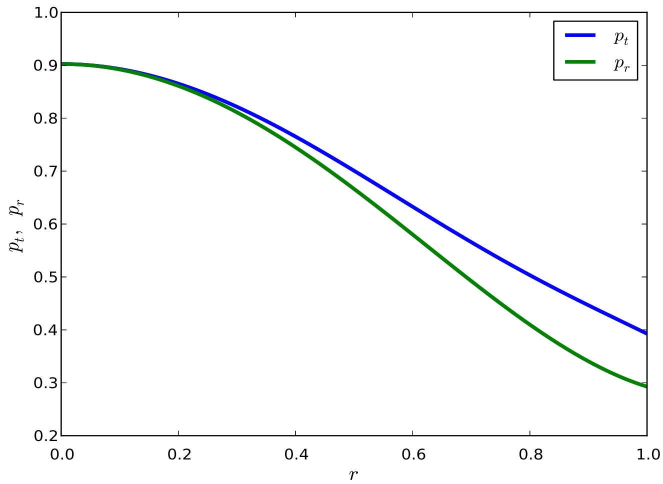

Figure 13: Comparison of the tangential and radial pressure at $\eta = 3{:}0$

VI. Conclusion

In this paper we have indicated that exact solutions for the Einstein Maxwell field equation are possible when the polytropic equations of state is incorporated. The polytropic models formulated describe relativistic stellar objects that admit no electromagnetic field distribution. We have indicated that for different values of polytropic index we obtain different variations for the radial and tangential pressures which is well behaved. We showed that the tangential and radial pressure are all equal at the center and its neighborhood, however the tangential pressure is greater than the radial pressure away the center of the stellar object. The results in this paper highlight new findings for polytropic models and are significant for the study of neutral anisotropic polytropic stellar objects. Other new results are possible when different forms for the equation of state is considered. This could be done by considering quadratic or Van der waal equation of state. Research in this direction is reserved for the future work.

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Electrification of Plasma with its Rapid Heating

By F. F. Mende

Abstract- The concept of scalar-vector potential provides for the dependence of electrical pour on the moving charge from its speed. In this concept the charge is not the invariant of speed. Up to now only indirect experiments, connected with the appearance of electric pulse with the space thermonuclear explosions testified in favor indicated concept. In the proposed article are carried out the straight experiments, which attest to the fact that in the process of the warming-up of plasma it acquires unitary charge. These experiments were carried out by the way of the micro-burst of the thin metallic wires, through which was passed the current from the capacitor bank of great capacity.

Keywords: plasma, scalar-vector potential, faraday's cell, charge, electrization, micro-burst.

GJSFR-A Classification : FOR Code: 020399

Strictly as per the compliance and regulations of :

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Abstract- The concept of scalar-vector potential provides for the dependence of electrical pour on the moving charge from its speed. In this concept the charge is not the invariant of speed. Up to now only indirect experiments, connected with the appearance of electric pulse with the space thermonuclear explosions testified in favor indicated concept. In the proposed article are carried out the straight experiments, which attest to the fact that in the process of the warming-up of plasma it acquires unitary charge. These experiments were carried out by the way of the micro-burst of the thin metallic wires, through which was passed the current from the capacitor bank of great capacity.

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I. Introduction

The concept of scalar- vector potential provides for the dependence of electrical pour on the moving charge from its speed [1-6]. In this concept the charge is not the invariant of speed. Up to now only indirect experiments, connected with the appearance of electric pulse with the space thermonuclear explosions testified in favor indicated concept [7]. In the proposed article are carried out the straight experiments, which attest to the fact that in the process of the warming-up of plasma it acquires unitary charge. These experiments were carried out by the way of the micro-burst of the thin metallic wires, through which was passed the current from the capacitor bank of great capacity.

II. Examination of The Electrization of Plasma with its Rapid Warming-up

In the experiments for the warming-up of plasma the micro-bursts with the discharge of the chemical capacitors of the great capacity through the discharger or with the discharge of such capacitors through the lamp of photoflash were used. In the discharger was used the copper wire, with the connection to which the charged capacitors it was melted and evaporated, being converted into the plasma.

In Faraday's cell, which serves the continuous metal screen (on the figures it is depicted as dotted line) are placed the chemical capacitors of great capacity, the discharger and the key, which makes it possible to connect to the discharger the charged capacitors. The chains of outline, which include capacitor, key and discharger did not have galvanic contact with the screen of Faraday's cell. Faraday's cell surrounds one (Fig. 1) or two (Fig. 2) metallic of screen.

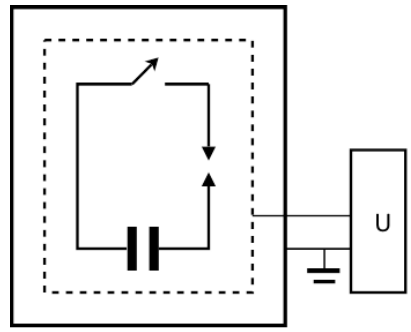

Fig. 1: Diagram of experiment with one external screen.

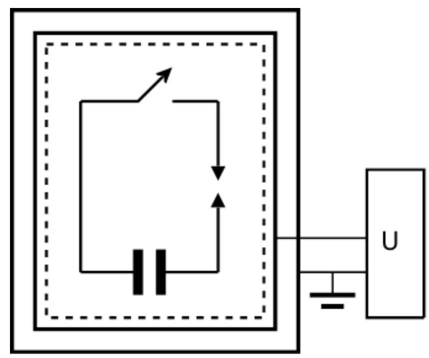

Fig. 2: Diagram of experiment with the intershield.

Characteristic measurement of electric pulse it was achieved with the aid of the digital memory oscillograph SIGLENT SDS 1072CNL.

In the first case (Fig. 1) oscillograph was connected between the screen of the Faraday's cell and the external screen. In the second case (Fig.3) the oscillograph was connected between the external screen and the intershield, located between the screen of the Faraday's cell and the external screen. The schematic of experimental installation is shown in Fig. 3 Composite stock consists of two parts. Brass stock is fastened to the upper textolite bushing with the aid of the pins. Between the lower part of the stock and the brass plate there is a spring, which ensures the electrical contact between the brass part of the stock and the brass plate. To the partition inside the screen of Faraday's cell is fastened the insulating plate with the contact washer to it. The unit of capacitors is connected between the brass plate and the contact washer. To the lower part of the stock are attached thin copper wire, gauge 0.2 mm, its length, which comes out from the stock – 5 mm. During lowering of stock the wire concerns contact washer, and the charged capacitors

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are connected to it: wire is melted and evaporates, being converted into the plasma. The collection of the chemical capacitors with a total capacity 6000 mcF was charged up to the stress 300 v. Fastening bolts and pins are shown by the fatty sections of lines. Are not shown joints for the connection of the oscillograph between the screen of the Faraday's cell and the external screen, between the external and intershield and joints for the charging of capacitors. The charging cable of capacitors from Faraday's cell was disconnected with the measurements.

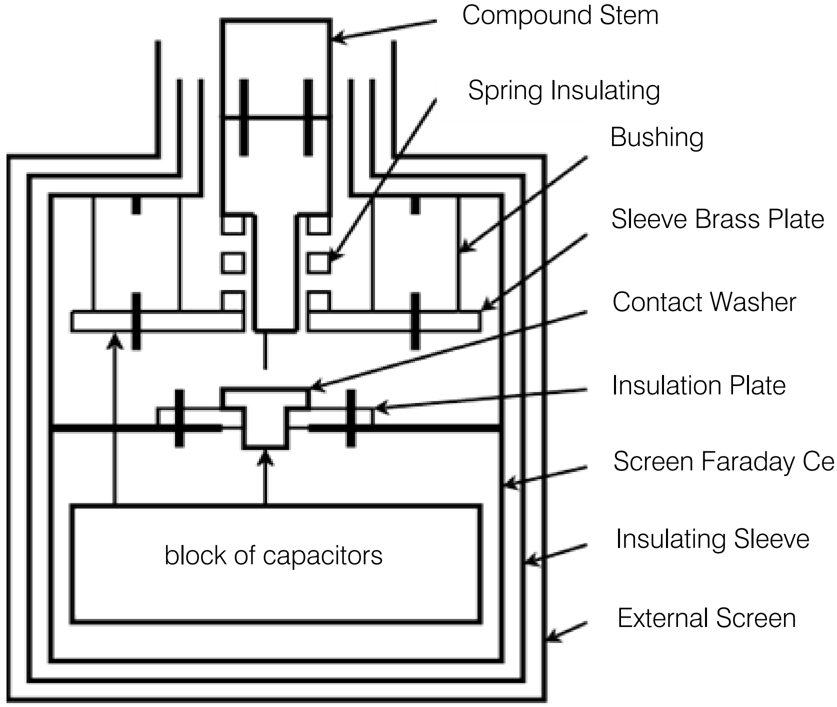

Fig. 3: The schematic of experimental installation is

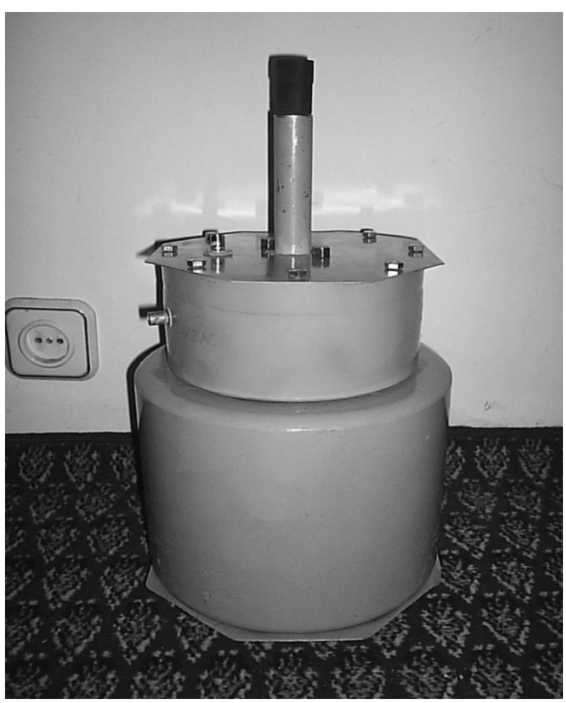

Fig. 4: Photograph of the cell Faraday in the collection

Fig. 5: Photograph of the experimental installation in the dismantled form

The photograph of the screen of Faraday's cell it is shown in Fig. 4. Diameter of the upper and lower part of the screen of the Faraday's cell 180 mm and 220 mm respectively.Height of the upper part 80 mm, and lower – 220 mm. The upper part of the screen is capped, to which is attached the tube, into which is put composite stock. The screen of Faraday's cell is covered with three layers of acrylic auto-enamel. Above can stick copper foil – intershieldin Fig. 5 the separate parts of installation are depicted. The lower part of the photograph presents external screen. Its diameter 300 mm, and a height 600 mm. On top on the external screen, closed with cover, stands Faraday's cell. In the installation in the assembled form Faraday's cell is located inside the external screen on the insulating table.

In the process of experiments it was established that the surge voltage appears with the capacitor discharge through the discharger between the screen of the Faraday's celland the external screen. In order to be certified in the fact that with the warming-up of plasma in Faraday's cell actually is formed the unitary charge, was carried out the following experiment. After rubbing by the fur of model from the amber (in this case on it it is formed negative charge), it through the tube in the upper lid was rapidly introduced into Faraday's cell. On the oscillograph, connected between the screen of Faraday's cell and the external, is registered the pulse (Fig. 6). Shape of pulse with the rapid withdrawal of the model of the charged amber from Faraday's cellis shown in Fig. 7. If we the charged model from the amber rapidly introduce into the cell and to immediately just as rapidly tzyat it from there, then is observed pulse shown in Fig. 8. Between the negative and positive parts of pulse there is a region of the reduction of the derived amplitude of pulse on the time, since. with introduction and withdrawal of the model of amber from Faraday's cell it is not possible to instantly change the speed of stock, at which is fixed the model, to the reverse.

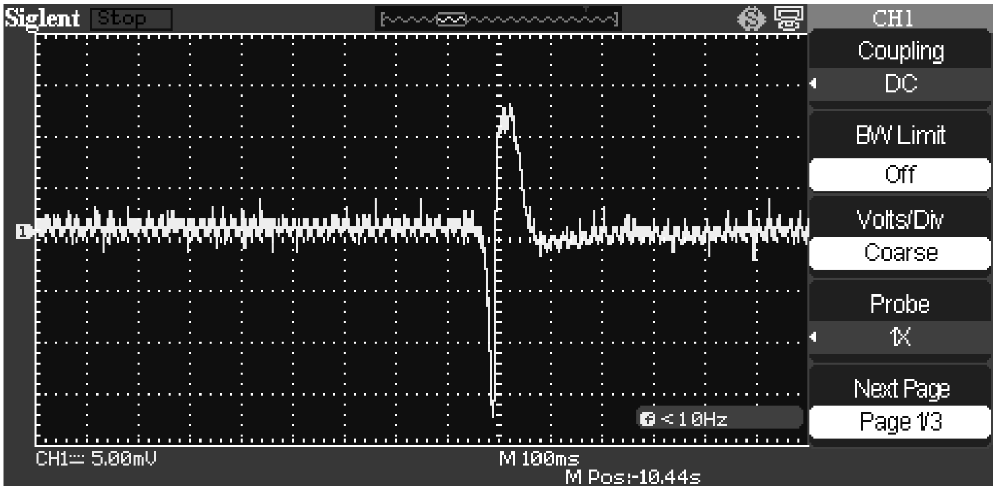

Fig. 6: Shape of pulse with the rapid withdrawal of the model of the charged amber from Faraday's cell

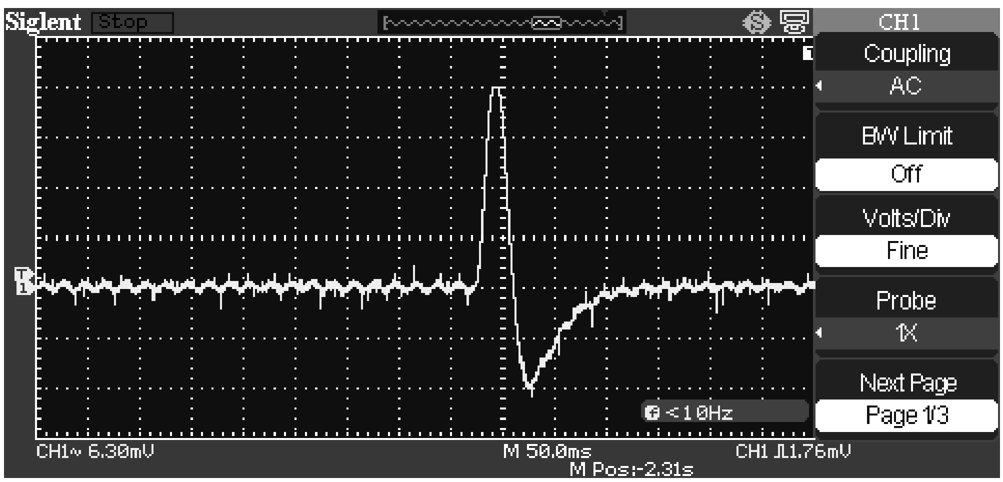

Fig. 7: Shape of pulse with the rapid withdrawal of the model of the amber

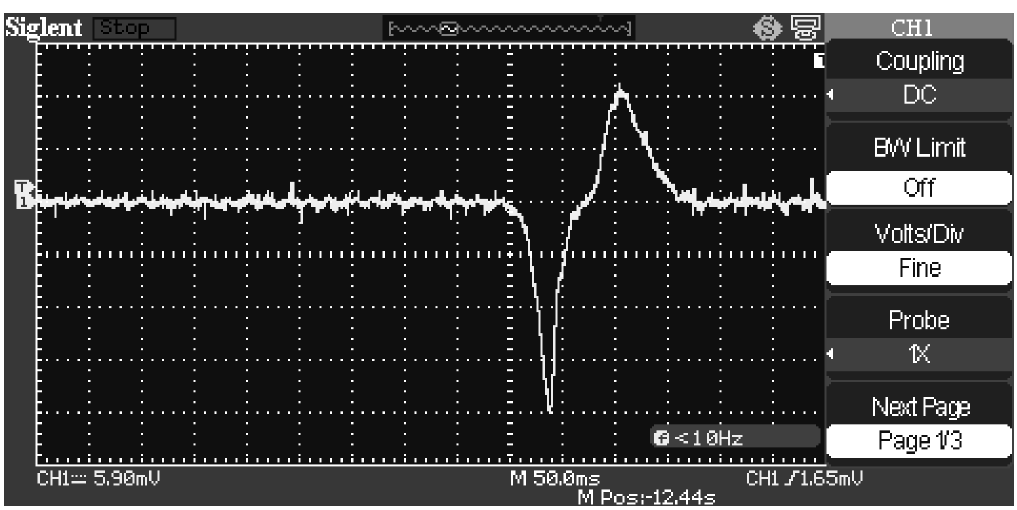

Fig. 8: Voltage pulse, obtained with the rapid introduction and the subsequent withdrawal from the Faraday's cell of the charged model of amber

In Fig. 9 the oscillogram of transient process with the capacitor discharge through the discharger is represented. In discharge time approximately one 600 s voltage across capacitors falls s 300 v to 50 v, and the energy of capacitors – on 162 J; therefore the average power of micro-burst 270 kW. The form of the voltage pulse between the external screen and the screen of Faraday's cell, obtained with the discharge through the discharger of the capacitors with a capacity 6000 of F, charged to the stress 300 v, it is shown in Fig. 10 (scale value according to axis X 2.5 ms) and Fig. 11 (scale value 1ms). Formation of the negative part of the pulse (Fig. 11) approximately it coincides with the capacitor discharge time (Fig. 9). This is the time of the greatest warming-up of plasma, since. with the high current the warming-up is connected not only with its effective resistance, but also with the pinch effect. Shapes of pulses in Fig. 6 and Fig. 10 it is very similar. The difference only in the fact that with the mechanical introduction and the withdrawal of amber from the cell it is not possible to ensure this pulse time and the steepness of its fronts as with the electrical discharge.in Fig. 10 the stages of warming-up and cooling of plasma are well visible, evident also that its heating occurs much faster than cooling.

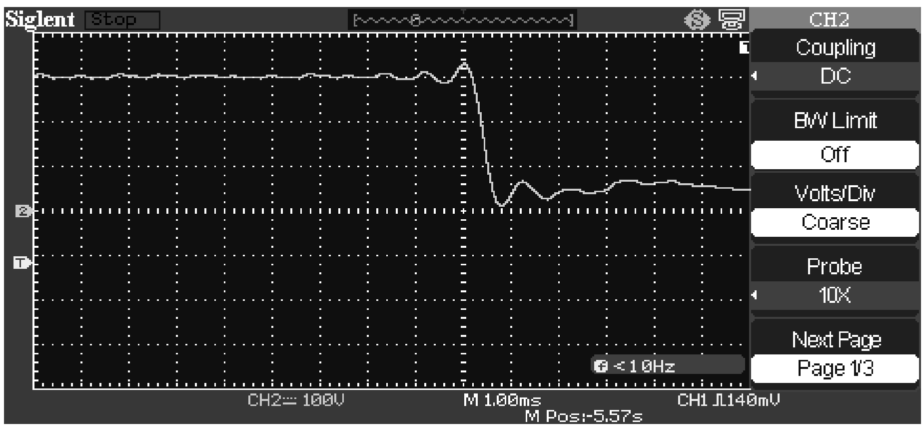

Fig. 9: Oscillogram of the transient process

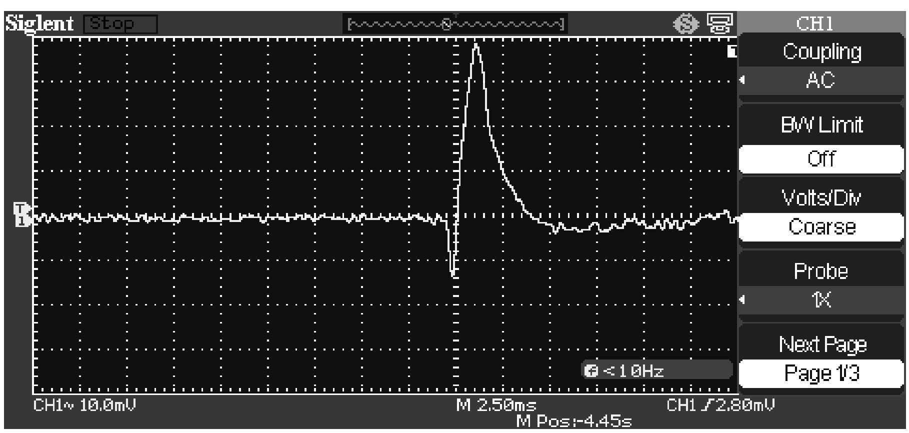

Fig. 10: Form of the voltage pulse

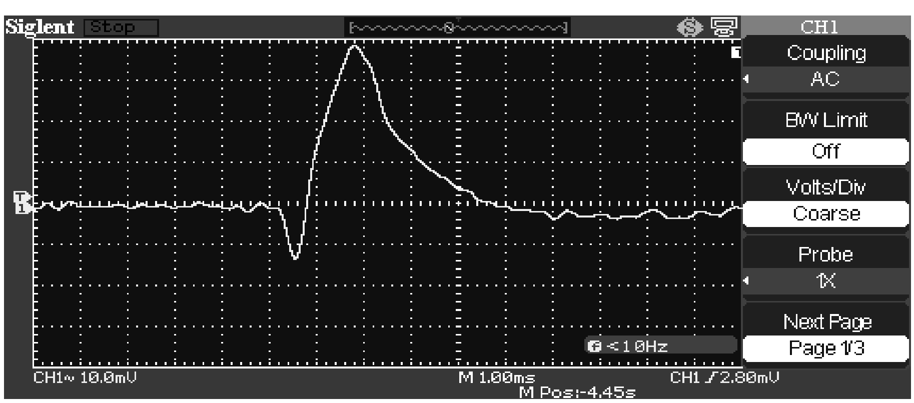

Fig. 11: Form of the voltage pulse

The total capacitance of the input circuit of oscillograph and capacity between the screen of the Faraday's cell and the external screen is 204 pF, and the resistance of the input circuit of oscillograph equally by 1Mom, therefore, the input circuit of oscillograph is differentiating.

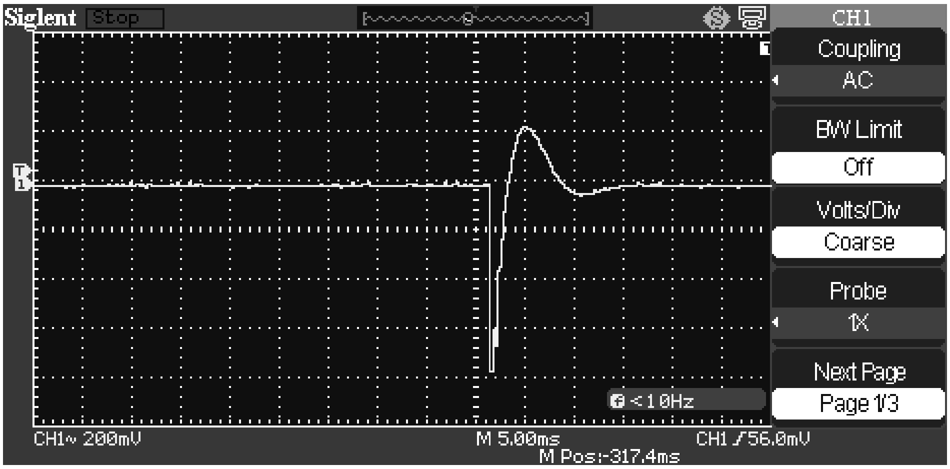

Fig. 12: Derivative of the current, which flows through the plasma

Therefore oscillogram in Fig. 10 and Fig. 12 they present the derivative of the voltage pulse, which appears between the screen of the Faraday's cell and the external screen. Naturally to assume that the temperature of plasma, since it has effective resistance, it is proportional to the current, which flows through it. Derivative of the current

The derivative of the current, which flows through the plasma was removed with the aid of the chain, inductively connected with the conductors of the outline, along which flows the current of discharge. Pulses in Fig. 10 and Fig. 12 they are identical. This means that in the case in question we deal concerning the generation and the disappearance in the Faraday's cell of the unitary charge, connected with the electron motion. In the formed plasma the number of electrons and positive ions is equal, but electrons have high speed, than ions.

Given experimental data are the proof of the fact that in the process of the warming-up of plasma with an equal quantity in it of electrons and ions in the plasma is formed the not compensated by positive ions unitary negative charge, but this means that the charge is not the invariant of speed. Experiment directly confirms that the fact that the invariant of speed is only the polarity of the moving electric charge, and its absolute value depends on speed.

III. Conclusion

Experiments on the rapid warming-up of plasma by the way of the transmission of the high currents through the thin copper wire, that leads to its micro-burst, they showed the presence of unitary charge in the composition of the plasma, obtained thus. These results testify in favor the concept of scalar- vector potential, from which follows this behavior of plasma with its warming-up.

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Abstract- Considering gravitation as magnetic binding of (e-p) pairs, galactic systems are described in a fundamental theory based on a QED like Lagrangian with fermions coupled to boson fields. In this formalism severe boundary conditions have to be fulfilled, related to geometry, momentum and energy-momentum conservation. In this way all needed parameters are determined; thus giving rise to a description based on first principles.

The primary process is magnetic binding of (e-p) pairs, leading to a very small binding energy of about 3 10 −38 GeV and a first-order equivalent coupling constant, which is in agreement with Newton's gravitational constant ttN.

Systems of magnetic binding of 10~100 (e-p) pairs (or hydrogen atoms) are related to galaxies. However, creation of stable galactic systems has been possible only under extreme conditions: a strongly reduced attractive force and heating, both arising from the annihilation of a large part of matter during a cosmic phase of high density. With these requirements, rotation velocities of galaxies are well described, yielding information on the average particle density and M gr ~ v2R/ ttN derived from gravitation theory, the deduced galaxy masses show a rapid fall-off to smaller radii, which can be understood by the finiteness of these systems.

No evidence has been found for galactic dark matter contributions.

Keywords: 04.60.-m, 11.15.-q, 95.35.+d, 98.62.ck, 98.62.dm/ bound state description of gravitational systems as magnetic binding of many (e-p) pairs. quantitative account of the rotation profiles of galaxies, giving rise to masses in agreement with gravitation theory by including the finite size of these systems.

I. Introduction

Bound or stationary systems are the key objects of nature, since they give rise to sta- bility of the binding energy of matter over long periods of time. Therefore, they can be considered as the building blocks of nature. These systems require an equilibrium between binding and kinetic energy, governed by the virial theorem. The description of such systems in the form of atoms, hadrons, and leptons has been discussed recently [1, 2].

Galactic systems have also the important property of stability over long time scales. How- ever, it appears to be more difficult to consider these systems as bound states, since it is known that the universe is not of static structure: starting from a cosmic system, in which all matter had been confined in a small volume of high density, it expands permanently. In addition, galaxies are known to be influenced by other galaxies. Furthermore, for a realistic description of galaxies the origin of gravitation has to be understood.

Gravitation has been mostly described by Newton's gravitation theory, often comple- mented by Einstein's theory of general relativity [3]. In the latter, gravitation is consid- ered as a deformation of space-time caused by massive objects. However, this theory is not satisfactory from a fundamental point of view: by eliminating gravity by the equivalence principle the real physical origin of the gravitational attraction rests unknown. Differently, in a (first-order) quantum theory similar to those applied to other fundamental forces, the extremely weak interaction has been tentatively interpreted [4] as tensor-exchange of "gravitons", but such spin=2 particles have not been found. Further, serious attempts have been made to describe gravity in high-dimensional string-type models [5], in which the notion of point particles is replaced by one-dimensional strings. However, these mod- els have a very complicated structure with too many parameters to be adjusted. Also it is not clear, whether (and eventually how) curved space-time has to be included in a quantum description of gravity.

Important to note that all known theories applied so far to fundamental forces have been constructed empirically and need external parameters, which have to be fixed in some way. Also general relativity is an empirical theory, in which space-time parameters related to curvature, expansion, etc. have to be adjusted to astrophysical observations. But this does not allow absolute predictions, which can be tested experimentally. Therefore, a realistic theory of fundamental forces has to be self-contained. This can be expressed by the theorem: If in a theory adjustable parameters are required, which cannot be determined from basic constraints, a (more) fundamental theory has to exist, in which these parameters can be derived from first principles.

During the last years, such a self-contained bound state theory has been developed [1, 2], in which atoms, but also hadrons and leptons can be understood without employing external parameters. One can also expect that such a fundamental theory can describe all systems bound by elementary forces. Indeed, in the study of magnetic bound states, a solution of two

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hydrogen atoms has been found [2], which has a tiny binding energy and a first-order equivalent coupling constant in agreement with Newton's gravitational constant GN. Therefore, this type of binding could be the origin of gravitation. To test this conjecture, in the present paper this formalism has been applied to the description of galactic systems.

First, we give a brief discussion of the theoretical framework with emphasis on basic boundary conditions. Then, a bound state composed of (e-p) pairs is discussed in detail, in which the parameter ambiguities could be removed by requiring a consistent account of the rotation velocity. Based on this fundamental bound state, we describe galactic systems by a large number of (e-p) pairs. But this requires a strong reduction of binding arising from annihilation of matter in the high-density phase of the universe. In this way a complete and self-consistent description of galaxies is obtained.

II. Theoretical Background and Constraints on Magnetic Bound States

The present bound state description is based on field theory, with a Lagrangian simi - lar to that of quantum electrodynamics (QED), in which the fermions $\Psi+$ and $\Psi-$ are accompanied by boson fields $A\mu$

$$\mathcal{L} = \frac{1}{\tilde{m}^2}(\bar{\Psi}^- D_\nu)\; i\gamma^\mu D_\mu (D^\nu \Psi^+) - \frac{1}{4} F_{\mu\nu}F^{\mu\nu}. \quad (1)$$

The reduced mass $\tilde{m}$ is given by $\tilde{m} = m1m2/(m1 + m2)$, where mi are the masses ofthe participating particles. The vector boson fields $A\mu$ with coupling g to fermions are contained in the covariant derivatives $D\mu = \partial\mu - igA\mu$. Further, the second term of the Lagrangian represents the Maxwell term with Abelian field strength tensors $F\mu\nu$ given by $F\mu\nu = \partial\mu A\nu - \partial\nu A\mu$, which gives rise to both electric and magnetic coupling (magnetic effects arise from the motion of fermions).

This framework has been discussed in detail in refs. [1, 2]. It leads to a bound state theory of finite structure for radii $r \to 0$ and $r \to \infty$, giving rise to matrix elements, which can be described by fermion and boson wave functions $\psi s,v(r)$ and $ws,v(r)$ (of scalar and vector structure) connected by bosonic interaction potentials. For fermions this results in two matrix elements

$$\mathcal{M}^f_{ng}(r) = \bar{\ }_{s,v}(r)\; V_{ng}(r)\; \ _{s,v}(r)\; (v/c)^2\;, \quad (2)$$

with n=2,3 and potentials of the form

$$V_{2g}(r) = \frac{\alpha^2(\hbar c)^2(2s+1)}{8\tilde{m}} \Big(\frac{d^2 w_s(r)}{dr^2} + \frac{2}{r}\frac{dw_s(r)}{dr}\Big)\frac{1}{w_s(r)} + E_o \quad (3)$$

with s=0 for scalar and s=1 for vector states, and

$$V_{3g}(r) = \frac{\alpha^3\hbar c}{\tilde{m}} \int dr'\;, w_{s,v}(r')\; v_v(r-r')\; w_{s,v}(r')\;. \quad (4)$$

The boson matrix element is of the form

$$\mathcal{M}^g(r) = \frac{\alpha^3\hbar c}{\tilde{m}}\; w_{s,v}(r)\; v_v(r)\; w_{s,v}(r)\; (v/c)\;. \quad (5)$$

In eqs. (4) and (5) $v_v(r)$ is a boson-exchange interaction, which has a radial form similar to wv(r). Further, for magnetically bound systems (v/c) is the relative velocity of different fermion and boson components, see the details in ref. [2].

An important point is that a consistent description (in which about 10 constraints have to be fulfilled) can be obtained only [1], if the energy E_o in eq. (3) is set to zero. This indicates a coupling of the theory to the (absolute) vacuum of fluctuating boson fields, which allows creation of massless fermion-antifermion pairs during overlap of boson fields. These particles are immediately bound to form simple $q\bar{q}$ mesons - q indicating massless fermions (quantons).

The binding and kinetic energies have been calculated as given in refs. [1, 2]. The mass is defined by the absolute binding energies M = |E2g| + |E3g|, where E2g and E3g are the binding energies in $V_{2g}(r)$ and $V_{3g}(r)$, respectively.

These matrix elements can be evaluated by using a simple form of the fermion and boson wave functions with $\psi s,v(r) \sim ws,v(r)$, as given in ref. [1, 2]. Further, momentum matching between fermion and boson wave functions

$$< q_g^2 >^{1/2}_{rec} + < q_f^2 >^{1/2}_{rec} = 0 \quad (6)$$

should be satisfied as well as energy-momentum conservation

$$[< q_g^2 >^{1/2} + < q_f^2 >^{1/2}]\ (v/c) + E_g - x\ M_f = 0\ , \qquad (7)$$

where $x = \sqrt{2\tilde{m}/M_f}$ and (v/c) is taken as positive.

The momenta are given by < q2 >=< q2 >rec and < q2 >=< q2>rec , but for vector particles < q2 >= ∫ q4dq ψv(q)V v (q)/ < q0 >, where the Fourier transformed quantities are given by (ψv, V v)(q) = 4π ∫ r2dr j 2(qr)(ψv, V v)(r).

Further, a mass-radius condition has been derived from the potential $V_{2_g}(r)$

$$Rat_{2g} = \frac{(\hbar c)^2\ (v/c)^2}{\tilde{m}(M_s/2) < r^2_{w_s} >} = 1\ . \qquad (8)$$

Finally it is important to note that magnetically bound vector states (with radial node) are not stable. Nevertheless, energy-momentum conservation should be fulfilled for all states.

a) Existence of a complex magnetic bound state

A solution for magnetically bound hydrogen atoms (H-H) has been discussed in ref. [2], which led to a first-order equivalent coupling constant in agreement with Newton's gravita- tional constant G_N. Therefore, this type of bound state could be the origin of gravitation. However, in more detailed work it has been found that the boundary conditions are also satisfied, if both - the slope parameter b and the relative velocity factor (v/c)2 - are mul- tiplied with the same factor. This indicates that an extra constraint is needed to obtain an unambiguous solution.

Such a constraint can be defined by requiring that the velocity (v/c) is related to the kinetic energy by

$$(v/c) = \sqrt{\frac{2E^{kin}}{M_{tot}}}\ , \qquad (9)$$

where M_{tot} = 2me+2mp is the total mass of the diatomic H-H or (e-p)2 state. By imposing this constraint, an unambiguous solution is obtained, in which all boundary conditions are satisfied, see table 1. Even for the s-state energy-momentum conservation is fulfilled for bosons and fermions separately. Important to note that also in this case the first-order equivalent coupling constant

$$\alpha_{gr} = \frac{\int V^s_{3g}(r)\ dr}{\int \frac{\hbar c}{r}\ dr} \qquad (10)$$

Table 1: Solution of a (e-p)2 state bound magnetically, using κ = 1.35 and α = 2.14. All dimensional quantities are in GeV or fm.

system	$\tilde{m}$	b	$(v/c)^2$	$< r^2_{\ s} >^{1/2}$	M_s	Rat_{2g}	α_{gr}
$(ep)^2$	0.469	0.3425	1.51 10^{-38}	0.40	2.76 10^{-38}	1.00	5.9 10^{-39}

s	$< q_g^2 >^{1/2}\ (v/c)$	$< q_f^2 >^{1/2}\ (v/c)$	$\sum < q_{g,f}^2 >^{1/2}\ (v/c)$	E_g	xM_f	$xM_f - E_g$
0	1.6±0.1 10^{-19}	1.6±0.2 10^{-19}	3.2±0.3 10^{-19}	-1.6 10^{-19}	1.6 10^{-19}	3.2 10^{-19}
1	2.2±0.2 10^{-19}	2.2±0.3 10^{-19}	4.4±0.5 10^{-19}	-2.6 10^{-19}	1.8 10^{-19}	4.4 10^{-19}

is in good agreement with Newton's gravitational constant $G_N = 6.707\ 10^{-39} (\hbar c) GeV^{-2}$. This result may be taken as convincing evidence that the origin of gravitation is magnetic binding of many atoms.

The deduced density and potentials are shown in fig. 1. In the upper part, the present interaction vv(r) is compared to a gravitational potential ~ 1/r, which shows the differ- ence between a finite interaction and a divergent one. Below, the density w2(r) and the potentials $V^{s,v}_{3g}(r)$ are given. One can see that $V^v_{3g}(r) \sim w^2_s(r)$ as required from a second geometric boundary condition [1, 2]. In the lower part of the figure the potential V2g(r) is displayed, which stabilizes the system. This potential has the same radial form as the "confinement" potentials in hadrons and leptons.

This solution shows a fermion root-mean-square (rms) radius of 0.40 fm, indicating that the protons and electrons come close to each other (giving rise to a (e-p)2 rather than a diatomic H-H state). This is consistent with the general observation from hadrons and leptons that magnetically bound systems have smaller radii than those bound electrically. Another point of interest, the ambiguity between b and (v/c)^2 - without applying the condition (9) - indicates that the first-order equivalent coupling constant αgr is the same - and thus universal - for all gravitational systems with increased or decreased density relative to the basic (e-p)^2 state.

b) Description of magnetic (gravitational) bound states of many (e-p) pairs

In the following bound states composed of many (e-p) pairs are discussed. These systems have to fulfill also boundary conditions concerning geometry, momentum and energy- momentum conservation. The geometric boundary conditions require similar radii of the boson and fermion distributions

$$< r_f^2 >_{gal}^{1/2} \sim < r_g^2 >_{gal}^{1/2} \sim N_{gal}^r < r_{g,f}^2 >_s^{1/2} \quad , \quad (11)$$

Where $< r_{f,g}^2 >_{gal}^{1/2}$ gal are the fermion and boson rms-radii of the composite systems and $< r_{g,f}^2 >_s^{1/2}$ the corresponding radii of the basic (e-p) pair. Further, momentum matching

$$< q_g^2 >_{gal}^{1/2} = < q_f^2 >_{gal}^{1/2} \quad (12)$$

as well as energy-momentum conservation should be satisfied. For bosons this reads

$$E_{gal}^g \sim (N_{gal})^3 < q_{g_s}^2 >^{1/2} (v/c) = (N_{gal})^3 E_s^g \; , \quad (13)$$

and for fermions

$$M_{gal}^f \sim (N_{gal})^3 < q_{f_s}^2 >^{1/2} (v/c)/x = (N_{gal})^3 M_s^f , \; (14)$$

where N_{gal} is the average number of basic (e-p)² states in x, y, and z-direction, which can be different from N_{gal}^r obtained from the geometrical relation (11). Further, (v/c) is the relative fermion velocity of the (e-p)² bound state, E_s^g the boson binding energy, M_s^f the mass and $x = \sqrt{2\tilde{m}/M_s^f}$, where $\tilde{m}$ is the reduced mass.

Of large importance, for a composite system of many particles the relation between poten- tial and kinetic energy is not trivial (note that for a stable bound state the virial theorem has to be valid, which relates binding and kinetic energy to its eigenvalue). The potential energy is given by

$$E_{gal}^{pot} = (N_{gal})^3 E_s^{pot} \; . \quad (15)$$

However, the initial kinetic energy $E_{gal}^{kin} = (N_{gal})^3 E_s^{kin}$ will be lowered for coherent rotation of all particles to

$$E_{gal}^{kin} = N_{gal} E_s^{kin} \; . \quad (16)$$

Due to this reduction of the kinetic energy the virial theorem is violated, and the much stronger potential energy leads to a collapse of the system1. However, formation of a stable system is possible under the special condition that the magnetic (gravitational) attraction is also reduced by a factor $(N_{gal})^{-2}$, leading to a potential energy.

$$E_{gal}^{pot} = N_{gal} E_s^{pot} \; . \quad (17)$$

Such a strong reduction of the binding energy can be explained only by assuming that a strong repulsive potential has been built up by the annihilation of matter during an early cosmic phase of high density, from which all galactic matter originates.

[1] The collapse of gravitational systems has been worried about already by I. Newton after formulating the gravitational potential, see also Bentley's paradox [6].

The radial dependence of the rotation velocity of such a galactic bound state may be calculated from a relation similar to eq. (9) by replacing the kinetic energy E_{gal}^{kin} by $N_{gal}(dE_s^{kin}(r)/dr) r_s$ and the (total) mass by $M_{gal}^t = N_{gal}^r M_s$. A further important points is that galaxies interact with other galactic matter, which gives rise to friction - (trans- formation of rotational energy to random motion (heating) - and an associated damping of the rotation).This yields

$$\frac{v_{rot}(r_{gal})}{c} = \sqrt{\frac{2 \; dE_s^{kin}(r) \; r_s}{dr \quad M_s} \frac{N_{gal}}{N_{gal}^r}} \; f_{damp} , \; (18)$$

where f_{damp} is a rotation damping factor and $dE_s^{kin}(r)/dr$ the radial derivative of the kinetic energy of the magnetic state in sect. 2.1 given by

$$\frac{dE_s^{kin}(r)}{dr} = 2\pi\psi^2(r) r^3 \left(\frac{dV_{2g}(r)}{dr} + \frac{dV_{3g}(r)}{dr}\right) . \; (19)$$

Further $\delta_{gal} = N_{gal}/N_{gal}^r$ can be understood as to the average rms-radius of the basic (e-p) pairs in the galaxy divided by the rms-radius of the free (e-p)² state. But δ_{gal} can be considered also as the normalized central density of the galaxy with respect to that of the free (e-p)² state. For $\delta_{gal} < 1$ the average density is smaller than the basic magnetic state, whereas $\delta_{gal} > 1$ would indicate a system of higher density. In this respect it is important to mention that also for bound states with $\delta_{gal} \neq 1$ the geometric relation (11) as well as the other constraints (12) - (14) are satisfied. Further, as mentioned at the end of sect. 2.1, the first-order equivalent coupling constant is unchanged (universality of G_N).

A second condition requires that the maximum rotation velocity of galaxies is related to (v/c) of the fundamental state by

$$\frac{v_{max}}{c} = (v/c) \sqrt{N_{gal}} \; f_{damp} \; . \quad (20)$$

With the geometric relation (11) and eqs. (18) and (20) the parameters δ_{gal} and f_{damp} are well determined, leading to an unambiguous determination of the galaxy masses, see eq. (14).

Finally, galaxy masses have been estimated using an (empirical) relation between maxi- mum rotation velocity and galaxy mass - derived from gravitation theory

$$M^{gr} = v_{max}^2 R/G_N \; , \quad (21)$$

where R is the radius at vmax. A comparison of the deduced masses with this estimate will be made below.

III. Rotational Velocities of Galactic Systems

Although many aspects of gravitation can be well understood within Newton's theory of gravitation, the observation of galactic rotation velocities has led in

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the past to misleading interpretations. In the solar system, the orbital velocities of the different planets follow closely a Keplerian $\sqrt{1/r}$ behavior, which can be derived directly from Newton's law $V \sim 1/r$. However, such a rapid fall-off of the velocity as a function of radius has commonly not been observed for galaxies. In contrary, for many galaxies velocities have been deduced, which increase from small radii towards the peripheral region. This fact has been interpreted as evidence for the existence of dark matter halos. There have been also alternative descriptions, e.g. by MOND [7], in which an empirical modification of Newtonian dynamics has been employed.

In the present formalism the rotation velocity has to go to zero for $r \rightarrow 0$, a physi-cal necessity for a system of finite density and interactions. This fact indicates clearly that the r-dependence of the velocity $v_{rot}(r) \sim \sqrt{G_N M/r}$, see eq. (21), can be only an approximation of the rotation velocities at larger radii.

In the upper part of fig. 2 the particle density and potentials are shown for a galactic system with a rms-radius of 3.2 kpc. The derived rotational velocity is given in the second part. On can see that the rotation curve starts from zero at r = 0 and reaches a maximum at a radius somewhat smaller than the rms-radius, then falls again to zero. A Keplerian $\sqrt{1/r}$ dependence is shown by dot-dashed line, which shows an unphysical divergence for $r \rightarrow 0$ but also for $r \rightarrow \infty$.

a) Fit of various galaxies with different radii and rotation velocities

In the lower part of fig. 2 a comparison of calculated rotation curves is made with the rotation profile of the galaxy F583-1, which is typical of many low surface brightness

Table 2: Results for bound state contributions of the galaxies in figs. 2-4, with root mean square radii $< r^2_{gal} >^{1/2}$ in kpc, maximum rotation velocities in km/s and masses in units of solar masses ($M_{sol} = 1.11574\ 10^{57} \mathrm{GeV/c^2}$). in the last column, the masses are given using the gravitational mass formula (21).

System	$< r^2_{gal} >^{1/2}$	v_{max}	N_{gal}	δ_{gal}	f_{damp}	$M_{gal}\ (M_{sol})$	$M^{gr}\ (M_{sol})$
F 583-1	13.0	78	$1.5\ 10^{34}$	$1.5\ 10^{-2}$	0.099	$8.0\ 10^{7}$	$6.6\ 10^{9}$
Draco	0.37	12.6	$1.2\ 10^{31}$	$4.2\ 10^{-4}$	0.034	$4.2\ 10^{-2}$	$4.9\ 10^{6}$
Fornax	1.25	14.5	$1.4\ 10^{32}$	$1.4\ 10^{-3}$	0.090	$6.3\ 10^{1}$	$2.2\ 10^{7}$
NGC 3379	8.5	230	$4.8\ 10^{33}$	$7.3\ 10^{-3}$	0.032	$2.7\ 10^{6}$	$2.9\ 10^{10}$
UGC 128	40.0	135	$1.4\ 10^{35}$	$4.5\ 10^{-2}$	0.026	$6.7\ 10^{10}$	$6.1\ 10^{10}$
NGC 2403	15.2	136	$2.0\ 10^{34}$	$1.7\ 10^{-2}$	0.017	$2.0\ 10^{8}$	$2.4\ 10^{10}$
NGC 5371	16.0	200	$3.0\ 10^{34}$	$2.4\ 10^{-2}$	0.010	$6.4\ 10^{8}$	$7.1\ 10^{10}$
" (2)	65.0	200	$3.7\ 10^{35}$	$7.4\ 10^{-2}$	0.009	$1.2\ 10^{12}$	$2.2\ 10^{11}$

galaxies [8]. By scaling the rotation curve in radius to the outside region a reasonable fit is obtained with a rms radius of about 13 kpc (the deviations at smaller radii could indicate another galactic component of smaller radius). The results of the present analysis are given in table 2. The deduced mass of about 8 107 solar masses is two orders of magnitude smaller than estimated with the mass formula (21). Further, the deduced value of δgal of 0.015 indicates an average galactic density of about 70 times smaller than the fundamental state. The damping factor of the rotation fdamp ~ 0.1 indicates that about 90 % of the kinetic energy is in the form of random motion (heat).

Rotation profiles for three other galaxies are shown in fig. 3, the two dwarf galaxies Draco and Fornax, and the elliptic galaxy NGC 3379, with data from refs. [9, 10]. Both, Draco and Fornax have rather small radii of about 0.4 and 1.3 kpc, respectively, whereas NGC 3379 shows a rms-radius of about 9 kpc. Apart from an increase of the rotation curves at small radius, the data are well described with the parameters given in table 2.

Rotation velocities of three further galaxies, UGC 128, NGC 2403 from ref. [8] and NGC 5371 with data from ref. [11], are given in fig. 4. These have rather large radii of about 40 kpc and 20 kpc, respectively, with results given also in table 2. For all three galaxies there are indications for inner bound state contributions with a rms-radius smaller by a factor 5. For the galaxy NGC 5371 the deduced velocities do not decrease for radii larger than 30 kpc, which may indicate a further bound state. A fit with an additional large radius component is given in fig. 4 with results given separately in table 2.

The systematic behavior of the maximum rotation velocity and the extracted values of δgal and fdamp as a function of the galaxy mass is given in fig. 5, the galaxy masses as a function of radius are shown in fig. 6. On can see that the deduced values of δgal (in the middle part of fig. 5) as well as the radius (in the lower part in fig. 6) show a very smooth mass dependence. Differently, vmax and fdamp show deviations from the average behavior, with values of fdamp, which follow closely the deviations of vmax from the solid line (for the galaxy NGC 3379 results for a lower value of vmax of 75 km/s are shown by open squares, which give a slightly larger mass of 6.1 106 Msol, but fdamp reduced to 0.026). The larger values of fdamp could be related to uncertainties in the extracted absolute velocities, but more likely due to another galaxy component with increased radius (similar to that assumed for the galaxy NGC 5371).

The overall damping of the galaxy rotation is very large, most likely a relict of the early cosmic system, heated up tremendously by annihilation photons. A reduced damping of the rotation has been observed for low mass systems, which can be explained by a faster cooling of small systems. The relative density δgal Ngal/N r shows a very smooth mass dependence, but also a fall-off to small masses. Such a regular behavior can be only expected, if all galaxies originate from the same source, an early cosmic state of high density. An average value of δgal of 10−2 corresponds to a system, in which the rms-radius of the basic (e-p) pairs is increased to 40 fm, but this is still more than a factor 103 smaller than the size of hydrogen atoms. If we assume that galaxies are mainly composed of hydrogen atoms, its average density is rather high. This may support the assumption that galaxies have been created during the high-density phase of the cosmic evolution.

IV. Discussion

The analysis of galactic systems has shown that gravitation can be well described by magnetic binding of many (e-p) pairs (or hydrogen atoms). The following three points are of particular interest

a) *Constraints on the cosmic high-density phase of matter*

As discussed above, stable bound states can exist only, if the virial theorem is fulfilled, a balance between binding and kinetic energy. Therefore, for the creation of galactic bound states one has to make strong assumptions on the annihilation mechanisms of matter, which took place during a cosmic phase of high density. In radial direction, annihilation gave rise to an enormous flow of photons, resulting in heating the surrounding matter (transformation of kinetic energy in random motion) with subsequent disintegration into countless fragments of matter, from which (among other forms of matter) galactic bound states have been formed. In these fragments the kinetic energy has been entirely due to random motion (heat). By gaining distance from the center of the cosmic event, the strong heating reduced slowly to form a coherent rotation. However, as shown in the analysis of galaxies, the damping factors of galaxies are still very small with an average rotation velocity still damped by a factor ≥10.

In both transverse directions, annihilation photons could not be produced; instead this process gave rise to a sizable repulsive potential (opposite in sign to a binding potential). This led to a significant reduction of binding, mainly responsible for the generation of stable galaxies (the required reduction of the binding energy of N−2 Ms is obtained, if half of all matter annihilated). These results should be taken as significant constraints to be respected in any attempt to understand the evolution of the universe.

b) *Relation between fundamental description and first-order theories*

A surprising result of the present study is that for large galaxies the extracted masses are in close agreement with those obtained by using the gravitational mass formula (21). At first sight, this agreement appears to be accidental, if one considers the different mechanisms involved in the present analysis. However, one should realize that the present bound state theory is based on the Lagrangian (1), which is an extension of the first-order Lagrangian of QED, see ref. [1]. By assuming DνDν = 1 the QED Lagrangian is restored, which gives rise to a Coulomb potential Vcoul = α h¯c/r and the correct binding energies of atomic states. As detailed in ref. [12], these binding energies are also reproduced in the present theory, but in a rather complicated way including many s- and p-states, which satisfy a linear quantum condition on the radius. In addition, the electric fine-structure constant α ∼ 1/137 is reproduced by the sum of first-order equivalent coupling constants αn.

For gravitation this appears to be similar, assuming DνDν = 1 leads to a first-order theory, which can be considered as a quantum description of Newton's theory of gravitation, yielding a gravitation potential Vgrav = αgr h¯c/r with a (first-order equivalent) coupling constant αgr c GN m1m2/h¯c. So, it is conceivable that also other features of Newton's theory of gravitation are recovered, as masses. This is confirmed for large galaxy masses by the present results.

However, as shown in the lower part of fig. 6, a strong fall-off of the deduced masses is obtained for decreasing radii, which is not found in the gravitational mass estimates using eq. (21). This different behavior can be well understood by the finiteness of the interaction vv(r), as shown in fig. 6. In the upper part the r-dependence of the Fourier transformed interaction vv(q) is compared to that of the gravitational potential Vgrav(q) ∼ 1/q2. For small values of r (or q) the interaction vv(q) stays finite, whereas Vgrav(q) goes to infinity. The ratio vv(q)/Vgrav(q) as a function of r goes to zero for r → 0, as shown by the solid line.

Exactly this behavior is observed in the galaxy masses, see the lower part of fig. 6. By scaling the radii and momenta to the corresponding radii and masses of galaxies, the masses from gravitation theory theory (open squares) can be fitted by a function mgr ~ Vgrav(q) q2.5/Vgrav(q) (given by the dot-dashed line). By multiplying mgr with the ratio vv(q)/Vgrav(q) given in the upper part, the solid line is obtained, which yields a good description of the radius dependence of the deduced galaxy masses. This agreement indi- cates that the drop-off of the deduced galaxy masses is due to the finiteness of the systems in question.

c) Evidence for dark matter?

An important topic, discussed extensively in the literature, is the possible existence of dark matter, which does not couple to known particles by electromagnetic forces. Corre- sponding particles have been proposed based on conclusions drawn from current particle theories [4], but the need for dark matter is also a requirement from general relativity. Therefore, large efforts have been made to detect these particles. Up to date the only experimental indication for the existence of dark matter comes from a comparison of ob- served galactic rotation velocities with Keplerian ~ 1/r rotational curves, from which the possible existence of dark matter halo contributions has been inferred, see e.g. in ref. [13]. Based on the present results in sects. 3 and 4, however, such an interpretation should be abandoned.

A similar conclusion has been drawn from MOND [7], in which an empirical modification of the Newtonian dynamics is employed. Also in this approach the rotation velocities decrease for small radii (as detailed above, the condition vrot(r) → 0 is a physical necessity for a finite system). This property gives rise to a finite range of the gravitational force, yielding a natural solution of Bentley's paradox [6].

Further, it should be mentioned that also direct searches for dark matter in particle physics experiments have given negative results. From extensions of current theories [4] the exis- tence of super-symmetric or other exotic particles has been predicted as a source of dark matter. In particular, super-symmetry has been proposed as a mechanism to understand the flavour degree of hadrons and leptons. But this degree can be well understood in the present theory [14] without the assumption of additional fields.

d) Deflection of Light

General relativity predicts a relation between space and time (space-time), which does not exist in the present framework. Evidence for this property stems from the bending of light from solar and galactic systems (lensing). However, in the present formalism the bending of light on massive systems can be described by the deflection of photons from multi-atomic bound states. This is similar to Compton scattering from the electron (which is also a magnetically bound system [2]), but also to optical deflections and the scattering of nuclei. These processes can be described in partial wave expansions (with an incoming spherical wave and an interference of outgoing scattering waves). So, one expects that all known properties of gravitation can be described in the present theory based on first principles.

V. Conclusion

The present study of systems bound by magnetic forces has shown that rotation curves of galaxies can be well understood in a self-contained and fundamental bound state theory. This fact confirms our presumption that the origin of gravitation is magnetic binding of (e-p) pairs.

Starting from a primary system of (e-p)2 system, for which all parameters are determined by severe boundary conditions, the description of galaxies as bound states of many (e-p) pairs requires extreme assumptions on the reactions following the annihilation of matter during the high-density phase of the universe: a tremendous heating by photons in radial direction and a strong reduction of binding in transverse direction.

In addition, the fact that all boundary conditions can be fulfilled only by assuming Vo = 0 in eq. (3) indicates a coupling of the theory to the (absolute) vacuum, by which matter in its simplest form could be created out of the vacuum of fluctuating boson fields during overlap of bosons. However, in this way only particles with equal fermion and antifermion content could be generated. The breaking of this symmetry in the collapse of the gen- erated matter - leading to the high-density phase of the universe - is one of the most challenging puzzles to be explained. Finally, from a study of the complex structure of the Lagrangian (1) - including derivative terms $\partial\Psi$ - a better understanding of the dynamics of these processes may be obtained.

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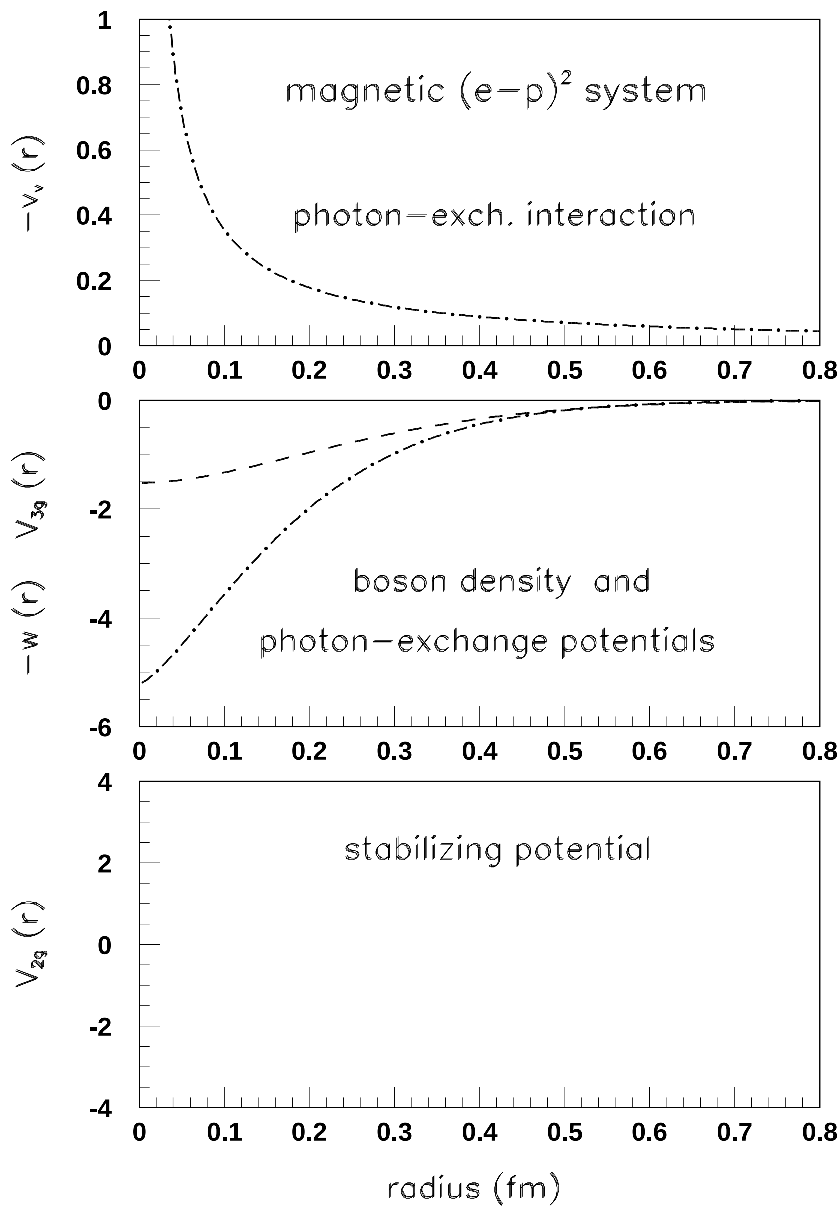

Figure 1: Radial dependence of density and potentials of a magnetically bound (e-p)2 state with a root mean square radius $< r_g^2 >^{1/2}$ of 0.4 fm. Upper part: Relative shape of the interaction $v_v(r)$ given by solid line, in comparison with the 1/r dependence of the gravitational potential (dot-dashed line). Middle part: Boson-exchange potentials V s,v(r) and (negative) boson density, given by dashed, solid and dot-dashed lines, respectively. Lower part: Stabilizing potential $V_{2g}(r)$.

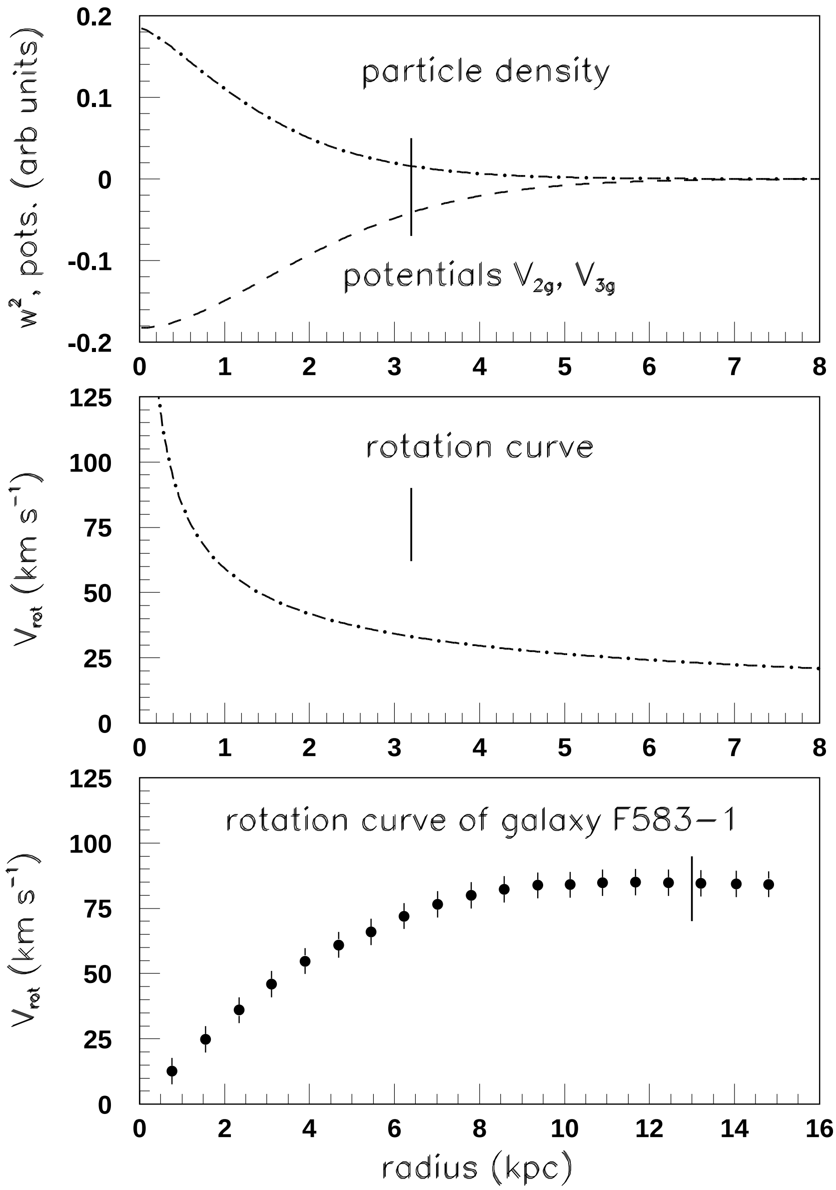

Figure 2: Upper part: Radial dependence of the density (dot-dashed line) and the poten- tials $V_{2g}(r)$ and $V_{3g}(r)$ of a galactic bound state with a rms-radius of 3.2 kpc, given by solid and dashed lines. Middle part: Deduced velocity distribution (solid line) in compar- ison to a Keplerian form (dot-dashed line), normalized to the same integral. Lower part: Velocity curve with radius fitted to the measured data of the galaxy F583-1 of ref. [8] (solid line). The vertical lines indicate the rms-radius of the density.

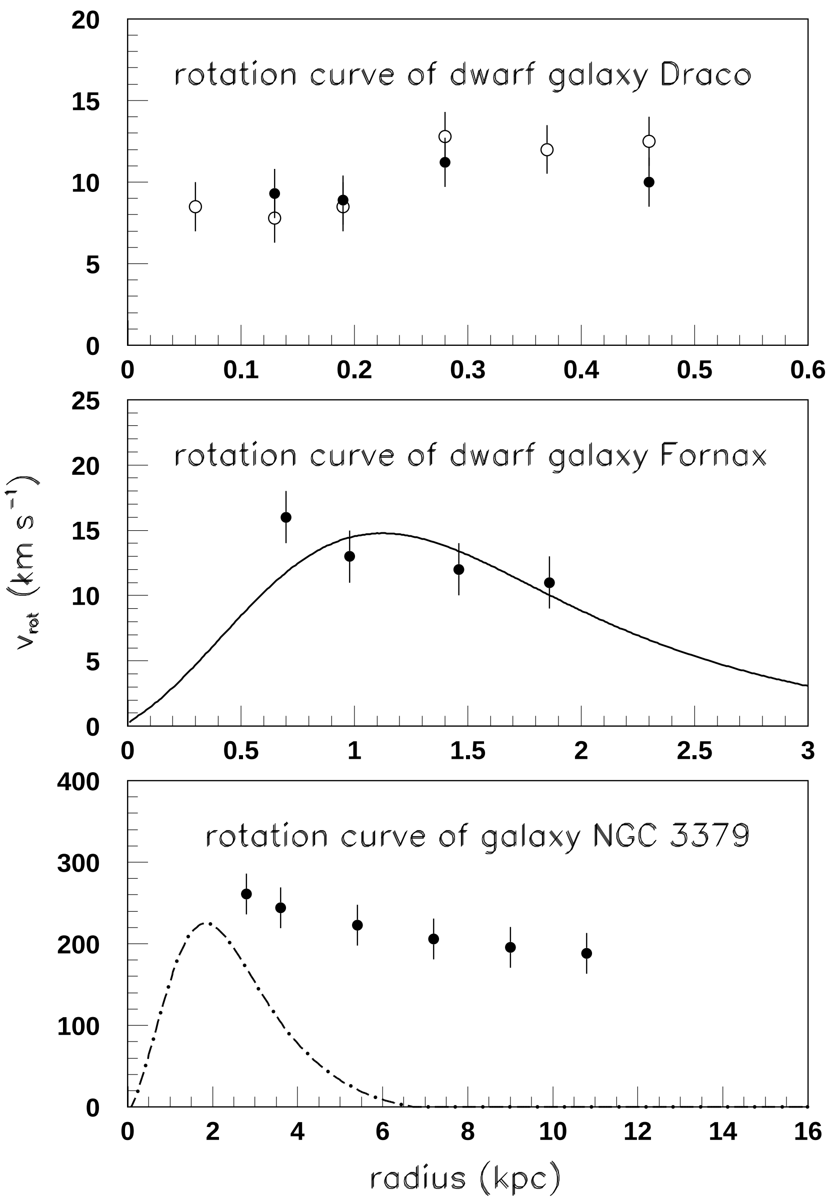

Figure 3: Radial dependence of the rotation velocities for the galaxies Draco, Fornax and NGC 3379 from ref. [9], for Draco see also ref. [10], together with rotation curves with the parameters in table 2. The increase in the rotation velocities at small radii, especially for NGC 3379, may indicate a second bound state contribution with a radius smaller by a factor 4, shown by dot-dashed line.

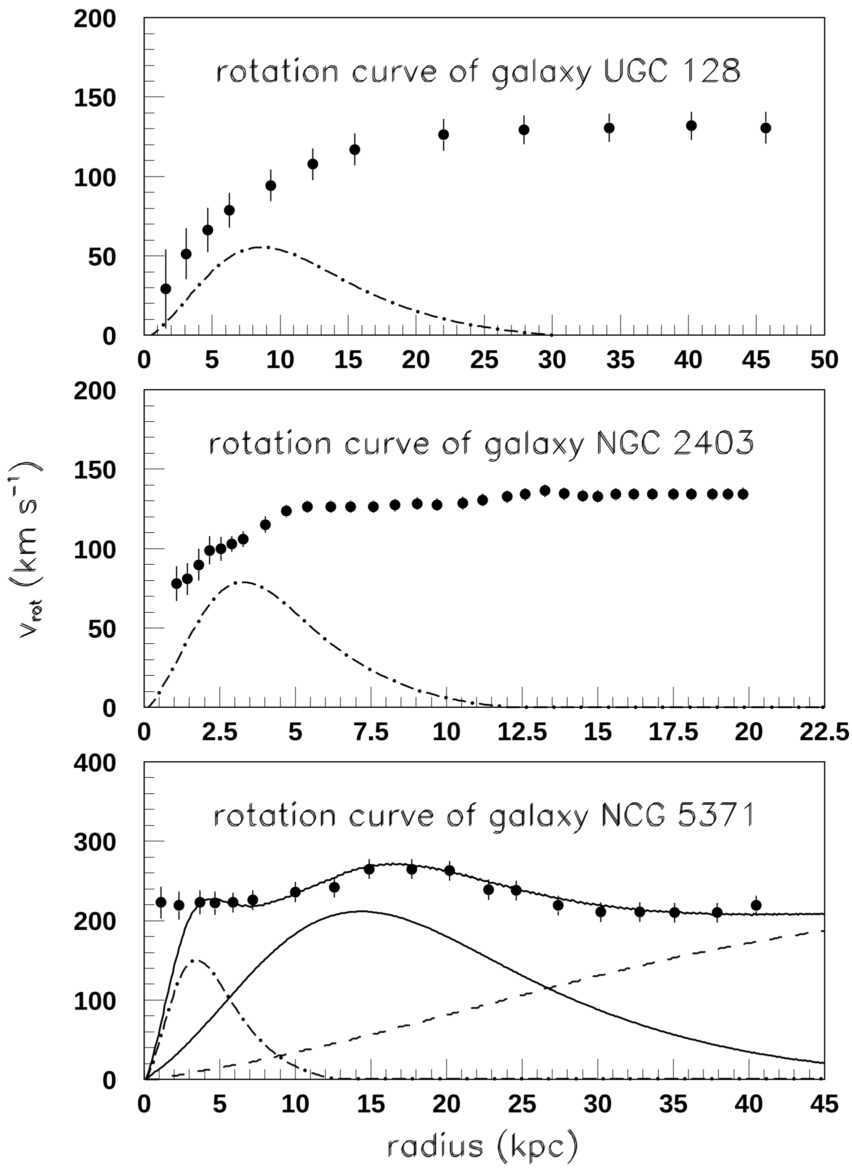

Figure 4: Rotation velocities for the galaxies UGC 128 and NGC 2403 from ref. [8], and and NGC 5371 from ref. [11] as a function of radius, together with rotation curves with the parameters in table 2. The dot-dashed lines indicate a second bound state component for each galaxy with a radius reduced to 24 %. An additional large radius component for NGC 5371 is given by dashed line.

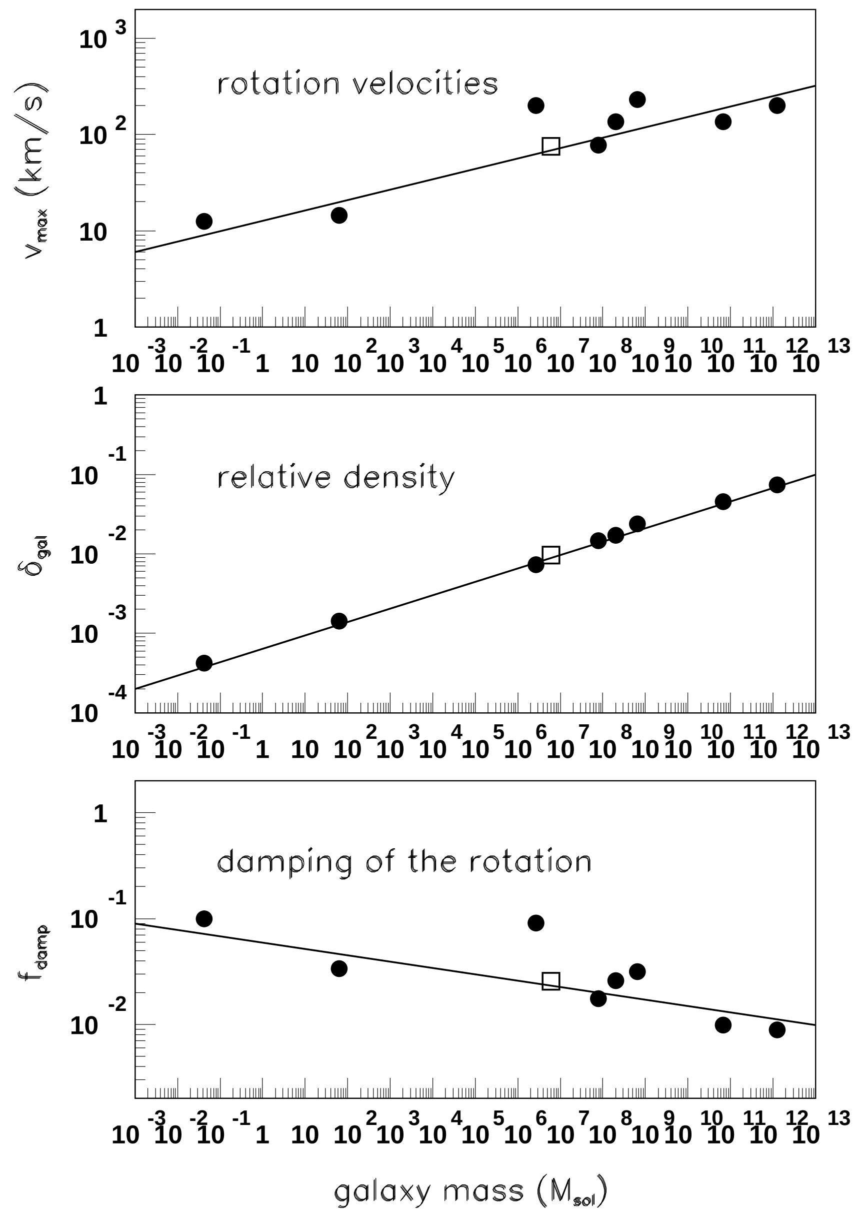

Figure 5: Mass dependence of the velocities vmax and deduced parameters δgal and fdamp for the galaxies in figs. 2-4, given by solid points. The solid lines show the average dependence of the different quantities. For the galaxy NGC 3379 the open squares are obtained by reducing vmax to 75 km/s, which gives a good agreement with the average dependencies given by solid lines.

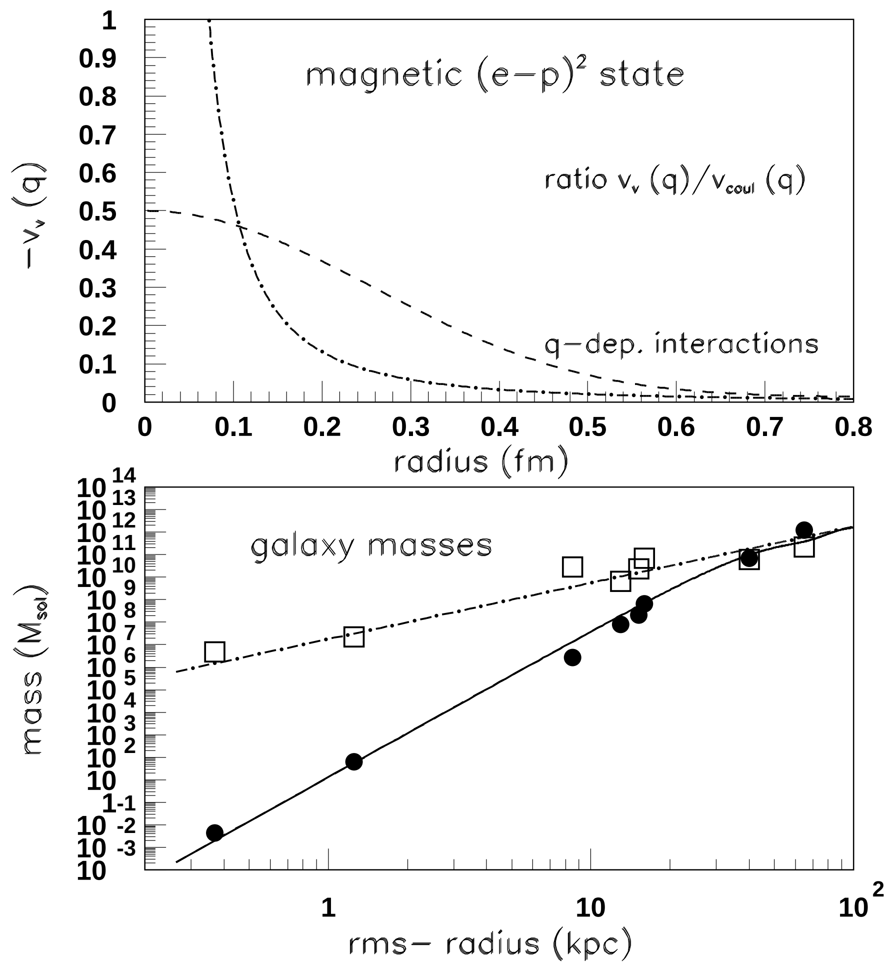

Figure 6: Upper part: Fourier transformed interaction $v_v(q)$ of the (e-p)² state in sect. 2.1 (dashed line), the gravitational potential V_{grav}(q) (dot-dashed line) and the ratio $v_v(q)/V_{grav}(q)$(solid line) as a function of radius. Lower part: Radius dependence of the deduced galaxy masses (solid points) and mass estimates using the gravitation mass formula (21) given by open squares. A fit of the latter is given by the dot-dashed line, whereas the solid line is obtained by multiplying this fit with the above $v_v(q)/V_{coul}(q)$ ratio.

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From the Electrodynamics of Maxwell,Hertz, Heaviside to Transcoordinate Electrodynamics

By F. F. Mende

Abstract- The conclusion about the absence in them of the mathematical means of the adequate description of passage from one inertial reference system to another because of the use by them of particular derived field functions on the time, which completely tie electrodynamic process to one concrete frame of reference, is made on the basis of the critical analysis of extraction from the equations of the electrodynamics of ideas about the space and period. Is proposed new approach to the development of the mathematical apparatus for electrodynamics in the direction of the more adequate description of passage from one inertial reference system to another due to the introduction into the examination of the trans-coordinate equations, which use new Galilean and trans-coordinate derivatives of field functions.

Keywords: maxwell equation, equation of electromagnetic induction, galileo transformation, the special theory of relativity, lorenz transformation, converting mende, trans-coordinate electrodynamics.

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Strictly as per the compliance and regulations of :

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I. Introduction

Past century is marked by the most great crisis in physics, when for the change to a fundamental understanding of the physical sense of natural phenomena and technical processes arrived new scientific orientators. Physicist P. Dirac proclaimed mathematical beauty by sole criterion for the selection of the way of development in theoretical physics. But mathematician M. Atya, realizing risk to be that lulled by the elegance, which is been based on unsteady soil, warned that the subordination of physics to mathematics conceals danger, since can bring into the region of the fabrications, which personify the mathematical perfection, but too distant from the physical reality or even having with it nothing in common.

The special feature of contemporary physics is its comparatively high financing with the fact that the realization of transparent and effective state and public control of the appropriate financial flows runs into the formidable difficulties. The situation, when physicists control themselves, creates favorable circumstances for all possible abuses of the hypertrophied authorities. Especially complex state of affairs occurs in the sphere of basic physical research. The extremely high level of the mathematization of scientific works in this sphere leads to the fact that even the highly skilled specialists of adjacent regions or altogether only belonging to different scientific schools begin to speak "in the different languages" and they cease to understand each other.

The scientific results of the individual scientists (such, as Einstein Khoking) proclaim immutable truth similarly to religious dogmas. But open and secret prohibitions to the critical analysis of the works of the acknowledged coryphaei are always disastrous for the scientific progress and unavoidably they lead to the stagnation. However, any criticism must be objective and design. At the basis of physics was always it must remain physical experiment, and the correspondence to physical experiment must always be the principal criterion of the truth of physical theories. The mathematical rigor of physical theories is also important, but is not less important that, so that the physical sense of phenomena and processes would not be hidden, obscured by mathematical formalizations.

Finally, one additional brake of the development of science – its excessive popularization in the commercial interests. The science, chained into the shackles of the yellow press, when on the covers of popular periodicals for the larger psychological effect are depicted allegedly the brilliant persons with the limited physical possibilities, tendentiously praised by journalists, who do not absolutely examine science itself on themselves, causes bewilderment. The high mathematization of physical theories only helps yellow press to give to physics the halo of mysticity, taking away the reader from the truth. Is preferable the qualified popularization of physics by scientists themselves, but furthermore, it must rest on the objective information about the results of physical experiments and the comprehensive disclosure of the physical sense of theoretical models.

All this gave birth to the most severe crisis in contemporary physics. But this state of affairs cannot continue eternally. Now situation in physics greatly resembles that, which preceded the fall of the system of

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Ptolemy. For the change to decrepit dogmas prepare to arrive new progressive ideas and views. So that it is better to understand, what renovation contemporary physics requires, necessary critically to analyze as why arose this deep and prolonged crisis.

Passage from comparatively simple and intuitively intelligible classical ideas about the space and time to the relativistic was critical moment. But after connecting relativity with the quantization of action, complete geometrization of gravity and propagation of the principle of geometrization on other physical interactions the imperfection of the prevailing ideas and views became obvious. The root of this imperfection consists in the fundamental disagreement between physics and mathematics, when the mathematical apparatus for physics increasingly more degenerates into mystic scholasticism, within the framework by which the objective physical sense of phenomena increasingly more slips off, and the role of the subjective consciousness of observer and unknown “magic” force of abstract mathematical formulas becomes of ever of more fundamental. One should recognize that the noted disagreement of physics and mathematics began to increase long before the victorious procession of the theory of relativity. Probably, by historically first especially “solid nut” for mathematical physics proved to be electrodynamics. Passage from the mechanics of material points and their final totalities to the formal description of continuous in the space and the time of electromagnetic field required the attraction of more powerful mathematical apparatus, but the development of mathematics, which goes in many respects according to its own internal laws, it did not chronically answer the demands of vigorously developing physics.

II. Symmetrization of the Laws of the Induction

In the initial form the system of equations of classical electrodynamics, based on the laws of electromagnetic induction, was recorded by Maxwell in his famous treatise [1] with the use of calculation of the quaternions, which allow the conversions of Galileo upon transfer from to that inertial reference system (IS) into another IS. In the treatise the works of ampere and Faraday were generalized and systematized [2,3]. However, it was immediately explained that the apparatus for quaternion calculation in mathematics was developed not so well so that physics they could it successfully apply to the wide circle of the tasks of electrodynamics. In order to draw into the electrodynamics the simpler and more effective means of mathematical physicists, Hertz and Heaviside reformulated Maxwell's equations from the language of quaternion calculation to the language of vector analysis [4-6].

At that time it seemed that the formulation of Hertz-Heaviside is equivalent to the initial formulation of Maxwell, but now already it is possible to establish that the equations, obtained by Hertz and Heaviside, are essential simplification in Maxwell's equations in the quaternions, moreover this simplification relates not only to their mathematical form, but also (that most important!) to their physical content, since in this case equations were deprived naturally Galileo- invariance of inherent in them. Nevertheless for the concretely undertaken inertial reference system (but not their totality) the equivalence of formulations occurred, by virtue of which the formulation of Hertz-Heaviside it obtained the deserved acknowledgement of scientific association it extruded in the theoretical and applied research the formulation of Maxwell himself. But this approach during writing of the equations of electrodynamics deprived the possibility of use by the substantional derivative, after rejecting from the examination its convective component.

Further development of Hertz-Heaviside ideas led to the development by Lorenz and Poincare the bases of the mathematical apparatus of the special theory of relativity (STR). This was major step forward in comparISn with the nonrelativistic theory of electromagnetic field, since it was possible to reveal the dependence of electromagnetic field on the relative speed of observer. But those leading of physics and mathematics of their time could not propose to the clear physical interpretation of their formulas. This is what writes in regard to this well-known specialist in the region of tensor analysis Rachewsky 2: “The theory of relativity arose as a result the prolonged accumulation of the experimental material, which led to the deep conversion of our physical ideas about the forms of material and motion. And other physical quantities to the newly open experimental facts it was revealed after the whole series of the attempts to adapt previous ideas about the space, time that for these purposes it is necessary to reconstruct all these concepts radically. This task was executed in basic a. By Einstein in 1905. (special theory of relativity) and in 1915. (general theory of relativity). In other the task was executed was only in the sense that given the ordered formal mathematical description of new state of affairs. The task of the deep, really physical substantiation of this mathematical diagram still stands before physics”.

At this determining moment physics proved to be on crossroads. One of the ways lay at the direction of further searches for the suitable mathematical apparatus for electrodynamics (to what, judging by everything, were inclined they themselves Lorenz and Poincare), but the physicist following Einstein it was banal along another way, who consisted in the decisive and uncompromising failure of the classical ideas about the space and the time with the passage to the relativistic ideas.

By the way of introduction into physics of known postulates, the theory of relativity in Einstein's version explained several important experimental results and in connection with this was obtained the acknowledgement of the wide circles of physicists. Relativistic ideology supported such those leading of mathematics of that time as Minkowski, Gilbert and Born. The principle of geometrization, which reflects secret dreams and expectations of many thinkers, was and remains especially attractive for the mathematicians in this ideology, beginning from the idealistic views of great Ancient Greek philosopher Plato, to reduce all fundamental laws of universe to the geometric properties of the certain idealized mathematical objects. Thus, mathematics, after yielding to temptation to subordinate to itself physics by means of the principle of geometrization so desired for it, proved to be unable to rise higher than the geometric means of thinking and it is worthy to satisfy the increasing needs of physics. Physics used that apparatus, which mathematics was ready to propose to it, and this unavoidably conducted to the creation of special, and then general theory of relativity and, further, to all to the increasing celebration of the principle of geometrization.

In accordance with them, the dependence of electromagnetic field on the speed of the motion of observer is not caused by the fundamental factors of physical nature of field itself, but it is defined by example through the dependence on it of the intervals of time and spatial distance (Lorenz transformation) under the assumption of the relativistic invariance of electric charge. However, specialists (first of all, by experimenters) discovered, that the classical electrodynamics and STR, in spite of already the more centenary myth, are located in the contradiction to each other. However, contemporary experiences on the measurement of the speed of light in one direction (but the not averaged speed "back and forth" as, for example, in Fizeau's experiments and to them analogous) [8,9] contradict postulate STR about the constancy of the speed of light and is brought into question the physical validity of Lorenz transformation.

Maxwell's ideas about the use during the writing of the laws of the electrodynamics of the substantional derivative lead to the need for the symmetrization of the equations of induction. For the first time this principle was developed in the work [10] and underwent its further development in the works [11-20].

This approach not only opened new direction in physics, but also it made it possible to predict new physical phenomenon by the name transverse plasma resonance in the confined plasma [21].

The symmetrized laws of magnetoelectric and electromagnetic induction are written

$$\oint \mathbf{E}' d\mathbf{l}' = -\int \frac{\partial \mathbf{B}}{\partial t} d\mathbf{s} + \oint [\mathbf{v}\times\mathbf{B}] d\mathbf{l}',$$
$$\oint \mathbf{H}' d\mathbf{l}' = \int \frac{\partial \mathbf{D}}{\partial t} d\mathbf{s} - \oint [\mathbf{v}\times\mathbf{D}] d\mathbf{l}'. \quad (1.2)$$

or

$$\mathrm{rot}\,\mathbf{E}' = -\frac{\partial \mathbf{B}}{\partial t} + \mathrm{rot}[\mathbf{v}\times\mathbf{B}],$$
$$\mathrm{rot}\,\mathbf{H}' = \frac{\partial \mathbf{D}}{dt} - \mathrm{rot}[\mathbf{v}\times\mathbf{D}]. \quad (2.2)$$

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

$$\mathbf{E}' = [\mathbf{v}\times\mathbf{B}],$$
$$\mathbf{H}' = -[\mathbf{v}\times\mathbf{D}]. \quad (2.3)$$

In relationships (2.1-2.3), which assume the validity of the Galileo conversions dash and not dash values present fields and elements in moving and fixed inertial system [IS] respectively. It must be noted, that conversions (2.3) earlier could be obtained only from Lorenz transformation.

Of relationships (2.1-2.3), which present the laws of induction, do not give information about how arose fields in initial fixed [IS]. They describe only laws governing the propagation and conversion pour on in the case of motion with respect to the already existing fields.

Of relationship (2.3) attest to the fact that in the case of relative motion of frame of references, between the fields of $\mathbf{E}$ and $\mathbf{H}$ there is a cross coupling, i.e., motion in the fields of $\mathbf{H}$ leads to the appearance pour on $\mathbf{E}$ and vice versa.

This connection leads to the Mende transformation, which take the form

$$\mathbf{E}'_{\uparrow} = \mathbf{E}_{\uparrow}; \quad \mathbf{E}'_{\perp} = \mathbf{E}_{\perp}\,\mathrm{ch}\frac{v}{c} + \frac{Z_0}{v}[\mathbf{v}\times\mathbf{H}_{\perp}]\,\mathrm{sh}\frac{v}{c};$$
$$\mathbf{H}'_{\uparrow} = \mathbf{H}_{\uparrow}; \quad \mathbf{H}'_{\perp} = \mathbf{H}_{\perp}\,\mathrm{ch}\frac{v}{c} - \frac{1}{vZ_0}[\mathbf{v}\times\mathbf{E}_{\perp}]\,\mathrm{sh}\frac{v}{c}, \quad (2.4)$$

where $E_{\uparrow}$ and $H_{\uparrow}$ parallel, and $E_{\perp}$ also $H_{\perp}$ normal to the speed IS of component pour on; $Z_0 = \sqrt{\mu_0/\varepsilon_0}$ – the impedance of free space; $c = 1/\sqrt{\mu_0\varepsilon_0}$ – the speed of light.

The Mende transformation are obtained from the classical symmetrized equations of the induction within the framework of the conversions of Galileo in contrast to Lorenz transformation, which are obtained on the basis of known postulates. It should be noted that the conversions examined coincide to the quadratic terms.

The Mende transformation of the aid of relationships (3.5) it is possible to explain the phenomenon of phase aberration, which did not have within the framework existing classical electrodynamics of explanations.

The principle of the symmetrization of the laws of induction opened way to the creation of the concept of scalar- vector potential, which indicates that the fields of charge, its normal to speed motions change according to the law.

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

III. From Hertz-Heaviside Electrodynamics to the Trans-coordinate Electrodynamics

The conclusion about the absence in them of the mathematical means of the adequate description of passage from one inertial reference system to another because of the use by them of particular derived field functions on the time, which completely tie electrodynamic process to one concrete frame of reference, is made on the basis of the critical analysis of extraction from the equations of the electrodynamics of ideas about the space and period. Let us examine new approach to the development of the mathematical apparatus for electrodynamics in the direction of the more adequate description of passage from one inertial reference system to another due to the introduction into the examination of the trans-coordinate equations, which use new Galilean and trans-coordinate derivatives of the field functions [22]. This generalization of electrodynamics assumes the dependence of electromagnetic field and electric charge on the speed of the motion of observer, caused not by the geometry of space-time, but by physical nature of the very field within the framework of giperkontinual ideas about the space and the time. The consequence of this approach propose the new trans-coordinate formulation of Maxwell's equations for the case of isotropic homogeneous medium without the dispersion, which generalizes the traditional formulation of Hertz-Heaviside for the same case. Let us give Maxwell's equations in the integral and differential forms in the idea of Hertz-Heaviside and in the trans-coordinate idea.

Despite the fact that Maxwell's equations both in the formulation of Maxwell himself and in the formulation of Hertz-Heaviside, are obtained within the framework classical ideas about the space and of time, who use conversions of Galileo, subsequently precisely of Maxwell's equation they became the theoretical prerequisite of the creation of the special theory of relativity (STR). As convincingly shown, for example, in [23], beSTR it consists of the identification of the natural geometry of the electromagnetic field, described by Maxwell's equations, with the geometry of world physical space-time. And now already in the contemporary works on the electrodynamics (typical example – the work [24]) of Maxwell's equation they are examined in the four-dimensional pseudo-Riemann space-time).

Is it possible to return to Maxwell's equations the original Galileo-invariance within the framework of certain new, it kind of neoclassical ideas about the space and the time, without rejecting the use of an apparatus of vector analysis during writing of equations? In this work we will show that the answer to this question is affirmative.

In the classical mechanics particle dynamics is described by the differential equations for its radius-vector, which use usual derivative of the second order on the time. Specifically, its use ensures the Galileo-invariance of equations. If we connect the set of massive material points by weightless elastic threads into the united string, i.e. fluctuation will be described by the Galileo- invariant system of differential equations. But if we complete passage to the limit, after fixing the number of material points to infinity, and their mass and the length of separate threads – to zero, then we will obtain the one-dimensional wave equation (equation of vibrations of string), not invariant relative to the conversions of Galileo, but invariant relative to the group of pseudo-orthogonal conversions (hyperbolic turnings, which preserve pseudo-Euclidean certificate). The culprit of this strange and unexpected metamorphosis upon transfer from “material- point mechanics to continuous medium – this passage to the limit with the substitution by usual derivative to the quotient, which, generally speaking, is analytically legal 25, but it narrows the region of the physical applicability of equation. The real wave process of mechanical vibrations of string remains Galileo- invariant, but its equation is already deprived of the mathematical means of the description of passage from one inertial reference system to another, and completely ties process to one concrete frame of reference, attaching in it the ends of the string.

The discovery wave equation in the mechanics did not lead to the revision of ideas about the space and the time, but to this led the discovery the same equation in the electrodynamics. In the theory of relativity the corresponding group of pseudo-orthogonal conversions for the electromagnetic waves in the vacuum (Lorenz transformation) obtained status of the subgroup of the motion of the certificate of united world physical space-time. But appears doubt about the justification of the use of traditional equations of electrodynamics, in particular, wave equation, for the adequate extraction of them of ideas about the space and the time. Easily to assume that these equations, using partial derivatives of field functions on the time, similar to the equation of mechanical fluctuations, are simply deprived of the mathematical means of the adequate description of passage from one inertial reference system to another and so completely they tie process to one concrete

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frame of reference. The question of the possibility of the suitable refinement or generalizing the equations of electrodynamics so arises, beginning from the equations of the induction of electric field by magnetic and magnetic – electrical. The thorough study of this problem in [10] led to the appearance of an idea about the fact that this improvement of electrodynamics must assume existence of the dependence of electromagnetic field on the speed of the motion of observer, caused not by the geometry of space-time, but by physical nature of field.

In the theory of relativity the electromagnetic field also depends on the speed of the motion of observer, but it is only defined by example through the dependence on it of the intervals of time and spatial distance (Lorenz transformation), the relativistic invariance of electric charge occurs result of which. However, the more fundamental (direct) dependence of field on the speed is connected with the presence of this dependence even absolute value of electric charge. Until recently this not invariance of charge was confirmed only by indirect empirical data, which were being consisted in the appearance of an electric potential on the superconductive windings and the tori during the introduction in them of direct current, or in the observation of the electric pulse of nuclear explosions [26].

In particular, 9 July 1962 of year with the explosion in space above Pacific Ocean of H-bomb with the TNT equivalent 1,4 Mt. according to the program of the USA «Starfish» the tension of electrical pour on she exceeded those forecast by Nobel laureate Bethe 1000 once. With the explosion of nuclear charge according to the program "program K", which was realized into the USSR, the radio communication and the radar installations were also blocked at a distance to 1000 km of. It was discovered, that the registration of the consequences of space nuclear explosion was possible at the large (to 10 thousand kilometers) distances from the point of impact. The electric fields of pulse led to the large electrical noise to the power cable in the lead shell, buried at the depth about ~1 m, which connects power station in Akmola with Alma-Ata. The electrical noise were so great that the automation opened cable from the power station.

However, 2015 year was marked by the already direct experimental confirmation of this phenomenon as a result of detection and study of the pulse of the electric field, which appears with the warming-up of the plasma as a result of the discharge through the dischargers of the capacitors of great capacity [26]. It turned out that in the process of the warming-up of plasma with an equal quantity in it of electrons and positive ions in it the unitary negative charge of free electrons, not compensated by slower positive ions, is formed.

This fact contradicts not only the classical, but also relativistic conversions of electromagnetic field upon transfer from one inertial reference system to another, testifying about the imperfection not only of classical, but also relativistic ideas about the space and the time. Idea about the fact that the promising electrodynamics must assume existence of the dependence of electromagnetic field on the speed of the motion of observer, caused not by the geometry of space-time, and by physical nature of field, which does not assume the invariance of electric charge, was developed in a number of the work of F. F. Mende [8, 10, 26]. In these works is given the substantiation of introduction into the electrodynamics instead of the classical and relativistic new conversions of electromagnetic field, which was called the Mende transformation.

However, the sequential development of this radical idea, as not the invariance of charge, requires the deep revision of the mathematical apparatus for electrodynamics, called to the creation of the mathematical means of the more adequate description of passage from one inertial reference system to another. Approach to precisely this development of the mathematical apparatus for electrodynamics was proposed by A. S. Dubrovin in [27]. This approach lies within the framework the sequential revision of ideas about the space and the time with the failure of the relativistic and the passage to the new ideas, which call giperkontinual.

The concept of time-spatial giperkontinuum is introduced in [28] as a result the joint study of the algebraic and geometric structures of the commutative algebras with one, elements of which are the functions of sine waves. The hypothesis of giperkontinuum (about the hierarchical giperkontinual structure of world physical space-time) is starting point of scientific studies, directed toward the generalization of ideas about the structure of space and time in the course of passage from the contemporary quantum scientific paradigm to the new system, that simultaneously structurally connecting up its framework continuity and the discretion, dynamicity and static character, and also globality and the locality.

In [27] is proposed new approach to the development of the mathematical apparatus for electrodynamics in the direction of the more adequate description of passage from one inertial reference system to another on the basis of giperkontinual ideas about the space and in the time due to the improvement of differential calculus of the field functions under the assumption of their dependence on the speed of the motion of observer. Let us accept for the basis this approach.

Two inertial reference systems with the time united for them will examine $t \in \mathbb{R}$. One of them (with the system of rectangular Cartesian space coordinates $OXYZ$) let us name laboratory (not hatch) and we will interpret it as relatively fixed. The second (with the system of rectangular Cartesian space coordinates $O'X'Y'Z'$) let us name substantive (hatch) and we will interpret it as connected with the certain moving real or imaginary medium. Let us assume that with $t=0$ the system of space coordinates of both frame of references they coincide. Let us introduce the indices $\alpha=\overline{1,3}$, $\beta=\overline{1,3}$. Coordinates along the axes OX, OY, OZ $O'X'$, $O'Y'$, $O'Z'$ we will assign by variables x^{α} and x'^{α} respectively. Unit vectors along the axes OX and $O'X'$, the axes OY and $O'Y'$, the axes OZ $O'Z'$ let us designate through $\mathbf{e}_{\beta}=\left(e_{\beta}^{\alpha}\right)$, moreover $e_{\beta}^{\alpha}=\delta_{\alpha\beta}$, where $\delta_{\alpha\beta}$ – Kronecker's symbol. Through $\mathbf{v}=\left(v^{\alpha}\right)v$ let us designate the velocity vector of the motion of substantive frame of reference relative to laboratory and the module of this vector. Directing a unit vector $\mathbf{e}_1$ $\mathbf{v}$, we lengthwise have: $\mathbf{v}=v\mathbf{e}_1=\left(v^{\alpha}\right)$, $v^{\alpha}=v\delta_{\alpha 1}$. Event in the data two frame of references takes the form $\mathbf{x}=(\mathbf{r},t)=\left(x^{\alpha},t\right)$; $\mathbf{x}'=(\mathbf{r}',t)=\left(x'^{\alpha},t\right)$, where $\mathbf{r}=\left(x^{\alpha}\right)$, $\mathbf{r}'=\left(x'^{\alpha}\right)$ – the radius-vectors. We will consider that the physical equivalence of events $\mathbf{x}$ $\mathbf{x}'$ indicates the validity of the Galileo transformation

$$\mathbf{r}=\mathbf{r}'+t\mathbf{v} \tag{3.1}$$

or, otherwise, substituting vector idea by the component,

$$x^{\alpha}=x'^{\alpha}+tv\delta_{\alpha 1} \tag{3.2}$$

Classical physical field is described in the laboratory and substantive frame of references by its field functions $\Phi(\mathbf{r},t)$ and $\Phi'(\mathbf{v},\mathbf{r}',t)$, moreover $\Phi'(\mathbf{0},\mathbf{r}',t)=\Phi(\mathbf{r}',t)$, and equality $\mathbf{v}=\mathbf{0}$ indicates $v^{\alpha}=0$. Their values are called field variables. For pour on different physical nature they can be suitable the different mathematical ideas of field functions, so that field variables can be, for example, scalar or vector with the material or complex values of their most variable or vector components. If in the role of this field electric field comes out, then in this role can come out the functions of its tension $\mathbf{E}=\Phi(\mathbf{r},t)$, $\mathbf{E}'=\Phi'(\mathbf{v},\mathbf{r}',t)$, and in the case of magnetic field we have functions of the magnetic induction $\mathbf{B}=\Phi(\mathbf{r},t)$, $\mathbf{B}'=\Phi'(\mathbf{v},\mathbf{r}',t)$.

In the classical nonrelativistic field theory it is considered that the equality occurs

$$\Phi(\mathbf{r}'+t\mathbf{v},t)=\Phi'(\mathbf{v},\mathbf{r}',t) \tag{3.3}$$

mathematically expressing the physical concept of the invariance of field relative to the speed of the motion of observer. In the theory of relativity (3.3) no longer it is carried out, but Lorenz transformation are used instead of the conversions of Galileo. But this not invariance of field does not have fundamental, that not connected with the geometry of the space-time of physical nature, but it occurs simply the consequence of the effects of the reduction of lengths and time dilation in the moving frame of references. The proposed by us giperkontinual ideas about the space and the time 28 provide for the great possibilities of the invariance of various physical processes relative to various transformation groups of coordinates with the fact that special role in time-spatial giperkontinuume play the conversions of Galileo (3.1), since they in this case they treat as the level conversions of Lorenz of infinitely high level and, thus, they make it possible in a united manner to synchronize all events in all separate continua, hierarchically structure into united giperkontinuum. Natural to consider that in giperkontinuum the field also not is invariant relative to the speed of the motion of observer, but to explain this by the already fundamental properties of field, not connected with the geometry of separate continua.

Arises the question about the possible versions of complete differentiation concerning the time of field function in the laboratory frame of reference $\Phi(\mathbf{r},t)$, of that produced depending on substantive frame of reference. In fluid mechanics and classical mechanics widely is used the derivative of Lagrange (the substantional derivative), which has the same arguments as the initial field function:

$$\frac{d\,\Phi(\mathbf{r},t)}{dt}=\frac{d\,\Phi(\mathbf{r}'+t\mathbf{v},t)}{dt}=\lim_{\Delta t\to 0}\frac{\Phi(\mathbf{r}'+(t+\Delta t)\mathbf{v},t+\Delta t)-\Phi(\mathbf{r}'+t\mathbf{v},t)}{\Delta t} \tag{3.4}$$

But it is possible to examine also the derivative (let us name its derivative of Galileo), whose arguments will coincide with the arguments of field function no longer in the laboratory, but in the substantive frame of reference:

$$\frac{\partial'\Phi}{\partial t}(\mathbf{v},\mathbf{r}',t)=\frac{d\,\Phi(\mathbf{r}'+t\mathbf{v},t)}{dt}=\lim_{\Delta t\to 0}\frac{\Phi(\mathbf{r}'+(t+\Delta t)\mathbf{v},t+\Delta t)-\Phi(\mathbf{r}'+t\mathbf{v},t)}{\Delta t} \tag{3.5}$$

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If the arguments of the derivatives of Lagrange and Galileo are connected with equality (3.1), that their corresponding values are equal and are decomposed into one and the same sum of quotient on the time and the convective derivative of field function in the laboratory frame of reference:

$$\frac{\partial' \Phi}{\partial t}(\mathbf{v},\mathbf{r}',t)=\frac{d\,\Phi(\mathbf{r},t)}{dt}=\frac{\partial\,\Phi(\mathbf{r}'+t\mathbf{v},t)}{\partial t}+(\mathbf{v}\cdot\nabla)\Phi(\mathbf{r}'+t\mathbf{v},t) \tag{3.6}$$

Let us explain a difference in the physical sense of the Lagrange and Galilean derivatives of field function. Lagrange's derivative (3.4) is complete time derivative of the function of field in the laboratory frame of reference, measured at the point of space, which in the laboratory frame of reference at the moment of time t has a radius-vector $\mathbf{r}$, determined by the equality (3.1). But Galileo's derivative (3.5) is complete time derivative of the function of field in the laboratory frame of reference, measured at the point of space, which in the substantive frame of reference has a radius-vector $\mathbf{r}'$. The concepts of Lagrange and Galilean derivatives (3.4)-(3.6) naturally are generalized to the case derivative of higher order ($n=\overline{1,\infty}$):

$$\frac{d^1\,\Phi(\mathbf{r},t)}{dt^1}=\frac{d\,\Phi(\mathbf{r},t)}{dt};\ \frac{d^{n+1}\,\Phi(\mathbf{r},t)}{dt^{n+1}}=\frac{d}{dt}\frac{d^n\,\Phi(\mathbf{r},t)}{dt^n};$$

$$\frac{\partial'^1\,\Phi}{\partial t^1}(\mathbf{v},\mathbf{r}',t)=\frac{\partial'\,\Phi}{\partial t}(\mathbf{v},\mathbf{r}',t);\frac{\partial'^n\,\Phi}{\partial t^n}(\mathbf{v},\mathbf{r}',t)=\frac{d^n\,\Phi(\mathbf{r},t)}{dt^n}$$

Within the framework concepts of the invariance of field relative to the speed of the motion of observer, i.e., with fulfillment condition (3), we have:

$$\frac{\partial'\,\Phi}{\partial t}(\mathbf{v},\mathbf{r}',t)=\frac{d\,\Phi(\mathbf{r}'+t\mathbf{v},t)}{dt}=\frac{d\,\Phi'(\mathbf{v},\mathbf{r}',t)}{dt}=\frac{\partial\,\Phi'(\mathbf{v},\mathbf{r}',t)}{\partial t}, \tag{3.7}$$

i.e., Galilean the derivative of field in the laboratory frame of reference is not distinguished from the particular time derivative of the function of field in the substantive frame of reference. Therefore introduction within the framework to this concept of the derivative of Galileo as some new mathematical object with its independent physical sense, is superfluous. However, within the framework relativistic ideas examination by Galileo's derivative is empty because of the emptiness of very conversions of Galileo (in contrast to Lorenz transformation). But giperkontinual ideas about the space and the time make Galilean derived completely by that claimed, and equality (3.7) – to false.

This view on the space, the period and the electromagnetic field in conjunction with the application of Galileo's derivative leads to the new, trans-coordinate formulation of the electrodynamics [27]. It generalizes the conventional formulation of Hertz-Heaviside, which will be examined below.

Electromagnetic field in the IStropic homogeneous medium without the dispersion is described in the laboratory and substantive frame of references by its variables (tension of electric field $\mathbf{E}=(E^\alpha)$, $\mathbf{E}'=(E'^\alpha)$ and magnetic induction $\mathbf{B}=(B^\alpha)$, $\mathbf{B}'=(B'^\alpha)$, by constants (electrical ε_0 and magnetic μ_0, and also expressed as them speed of light in the vacuum $c=1/\sqrt{\varepsilon_0\mu_0}$), by the parameters (dielectric and magnetic constant ε and μ, and also the density of strange electric charge ρ, ρ', the electric current density of conductivity $\mathbf{j}=(j^\alpha)$, $\mathbf{j}'=(j'^\alpha)$, electric charge Q, Q', electric current I, I'), by field functions $\mathbf{E}=\mathbf{E}(\mathbf{r},t)=(E^\alpha(\mathbf{r},t))$, $\mathbf{B}=\mathbf{B}(\mathbf{r},t)=(B^\alpha(\mathbf{r},t))$, $\mathbf{E}'=\mathbf{E}'(v,\mathbf{r}',t)=(E'^\alpha(v,\mathbf{r}',t))$, $\mathbf{B}'=\mathbf{B}'(v,\mathbf{r}',t)=(B'^\alpha(v,\mathbf{r}',t))$, moreover

$$\mathbf{E}'(0,\mathbf{r}',t)=\mathbf{E}(\mathbf{r}',t);\mathbf{B}'(0,\mathbf{r}',t)=\mathbf{B}(v,\mathbf{r}',t). \tag{3.8}$$

In the classical nonrelativistic electrodynamics it is relied:

$$\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)=\mathbf{E}'(v,\mathbf{r}',t);\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)=\mathbf{B}'(v,\mathbf{r}',t) \tag{3.9}$$

What is the application of a general formula (3.3) of the invariance of field relative to the speed of the motion of observer for the case of electromagnetic field. The proposed by us giperkontinual ideas about the space and the time [28] exceed the scope of this concept, but is explained nature of this not invariance not by the geometry of united space-time similar to the theory of relativity, but by the fundamental properties of field.

The integral form of Maxwell's equations in the idea of Hertz-Heaviside with the above-indicated conditions (isotropy, the uniformity of medium, the absence in it of dispersion) is the following system of four integral equations of the electrodynamics:

$$\oint_s \mathbf{E}\cdot ds = \mathrm{Q}/(\varepsilon\varepsilon_0);\ \oint_s \mathbf{B}\cdot ds = 0;\ \oint_l \mathbf{E}\cdot dl = -\frac{d}{dt}\int_s \mathbf{B}\cdot ds;\ \frac{c^2}{\varepsilon\mu}\oint_l \mathbf{B}\cdot dl = \frac{\mathrm{I}}{\varepsilon\varepsilon_0} + \frac{d}{dt}\int_s \mathbf{E}\cdot ds, \tag{3.10}$$

where s, l – the arbitrary two-dimensional closed (for the first two equations) or open (for the second two equations) surface and its limiting locked outline, which not not compulsorily coincides with the electric circuit.

If we on Wednesday put the even additional condition of the absence of free charges and currents, then last two equations (3.10) will take the form:

$$\oint_l \mathbf{E}\cdot dl = -\frac{d}{dt}\int_s \mathbf{B}\cdot ds,\ \oint_l \mathbf{B}\cdot dl = \frac{\varepsilon\mu}{c^2}\frac{d}{dt}\int_s \mathbf{E}\cdot ds. \tag{3.11}$$

They are the integral form of the law of the induction of Faraday and circulation theorem of magnetic field in the laboratory frame of reference for this special case of medium.

These two laws take the mutually symmetrical form with an accuracy to of scalar factor, by virtue of which their analysis it is identical. Let us examine the first law in more detail, for example. In Faraday's experiences it is experimentally established that in the outline the identical currents appear regardless of the fact, this outline relative to the current carrying outline does move or it rests, and the current carrying outline moves, provided their relative motion in both cases was identical (Galilean invariance of Farrday law). Therefore the flow through the outline can change as a result of a change of the magnetic field with time, and the position of its boundary also because with the displacement of outline changes [29]. The corresponding generalization of laws (3.11) to the case of the outline, which moves in the laboratory and which is rested in the substantive frame of reference, takes the form:

$$\oint_l \mathbf{E}'\cdot dl = -\frac{d}{dt}\int_s \mathbf{B}\cdot ds\ \oint_l \mathbf{B}'\cdot dl = \frac{\varepsilon\mu}{c^2}\frac{d}{dt}\int_s \mathbf{E}\cdot ds \tag{3.12}$$

Where $\mathbf{E}'$ and $\mathbf{B}'$ are described fields in the element dl in the substantive frame of reference, i.e., in such inertial reference system, in which dl it rests; specifically, such electric field causes the appearance of a current in the case of the presence of real electric circuit in this place. Equations (3.12) are completely interesting and uncommon from a mathematical point of view, since they mutually connect field variables in the different inertial reference systems (let us name such equations trans-coordinate). Specifically, the use of trans-coordinate equations makes it possible to adequately describe physical fields in giperkontinuum. At the same time in this case the discussion deals not simply about the trans-coordinate of equations (3.12), and with their global trans-coordinate, ensured by use by the Galilean derivative (connected by them inertial reference systems they can move relative to each other with the arbitrary speed, and not compulsorily with infinitely small).

Returning to the system of equations (3.10), it is possible to establish that the region of its applicability is limited by the requirement of the state of rest of outline l in the laboratory frame of reference. If we remove this limitation, after requiring only the states of rest of outline l in the substantive frame of reference, then will come out the known idea of Maxwell's equations (we we call his trans-coordinate [27]), integral form of which will be in it the system of the generalizing (3.10) four integral equations of the electrodynamics of the moving media:

$$\oint_s \mathbf{E}\cdot ds = \mathrm{Q}/(\varepsilon\varepsilon_0);\ \oint_s \mathbf{B}\cdot ds = 0;\ \oint_l \mathbf{E}'\cdot dl = -\frac{d}{dt}\int_s \mathbf{B}\cdot ds;\ \frac{c^2}{\varepsilon\mu}\oint_l \mathbf{B}'\cdot dl = \frac{\mathrm{I}'}{\varepsilon\varepsilon_0} + \frac{d}{dt}\int_s \mathbf{E}\cdot ds. \tag{3.13}$$

If the trans-coordinate idea of the equations of Maxwell (both in that examined by integral and in that examined lower than the differential forms) to interpret in the context of the description of electromagnetic field in time-spatial giperkontinuume, then it is necessary to consider that the equalities (3.8) are always carried out, but (3.9) – in the general case no.

Equations (3.12) and (3.13) are known in the classical electrodynamics [29, 30]. Arises question, as to pass from the equations in the integral form (3.12) and (3.13) to the corresponding to equations in the differential form adequate of physical reality by means. The differential form of Maxwell's equations in the idea of Hertz-Heaviside is following system of four of those corresponding to the integral equations (10) of the differential equations of electrodynamics, which relate to the laboratory frame of reference:

$$\nabla \cdot \mathbf{E} = \rho/(\varepsilon\varepsilon_0);\ \nabla \cdot \mathbf{B} = 0;\ \nabla \times \mathbf{E} = -\partial \mathbf{B}/\partial t;\ \nabla \times \mathbf{B} = \mu\mu_0 \mathbf{j} + \left(\varepsilon\mu/c^2\right)(\partial \mathbf{E}/\partial t). \tag{3.14}$$

Equations (3.14) traditionally successfully are used in the electrodynamics, but, as it will be shown below, they have essential deficiency – the region of their applicability it is limited by the case of agreeing the laboratory and substantive frame of references $(v = 0)$, i.e. these equations are deprived of the mathematical means of the adequate description of passage from one inertial reference system to another, completely tying process to one (laboratory) frame of reference.

In[29] based on the example of Farrday law is formulated the following approach to the passage from the integral to the differential form of equations electrodynamics: "Farrday law can be written down also in the differential form, if we use ourselves the Stokes' theorem and to consider outline as that being resting in the selected frame of reference (so that $\mathbf{E}$ and $\mathbf{B}$ they would be determined in one and the same frame of reference)". This approach answers the concept of the invariance of physical field relative to the speed of the motion of observer, assuming simple failure of the trans-coordinateawn of equations by means of the application (9). But, rejecting this concept, it is necessary to reject this approach. Thus, the differential form of the corresponding equations must be the same trans-coordinate as integral (3.12), (3.13).

In accordance with the given traditional approach, in [30] is introduced the operation of differentiation with respect to time in the moving (substantive) frame of reference, designated there through $\partial'/\partial t$. In this case it is secretly assumed that at the point of space, which in the substantive frame of reference has a radius-vector $\mathbf{r}'$, measurement by field variable in the laboratory frame of reference equivalent to its measurement in the same substantive frame of reference. But these measurements are not equivalent out of the concept of the invariance of physical field relative to the speed of the motion of observer. Therefore measurement must be limited by laboratory frame of reference, not perenosya its results for the substantive. Thus, we come to the derivative of Galileo (3.5), of the electrodynamics in the differential form leaving equations globally trans-coordinate.

Unknown globally trans-coordinate differential equations of electrodynamics, which correspond to integral equations (3.12) and which use the Galilean derivative:

$$\nabla \times \mathbf{E}' = -\frac{\partial' \mathbf{B}}{\partial t},\ \nabla \times \mathbf{B}' = \frac{\varepsilon\mu}{c^2}\frac{\partial' \mathbf{E}}{\partial t}. \tag{3.15}$$

They are generalization to the case of the noncoincidence of the laboratory and substantive frame of references ($\mathbf{v} \neq \mathbf{0}$) of the known differential equations of Maxwell

$$\nabla \times \mathbf{E} = -\frac{\partial \mathbf{B}}{\partial t},\ \nabla \times \mathbf{B} = \frac{\varepsilon\mu}{c^2}\frac{\partial \mathbf{E}}{\partial t}. \tag{3.16}$$

The differential form of Maxwell's equations in the trans-coordinate idea for the case of IStropic, homogeneous medium without the dispersion is the following system of four new globally trans-coordinate differential equations of the electrodynamics:

$$\nabla \cdot \mathbf{E}(\mathbf{r},t) = \frac{\rho(\mathbf{r},t)}{\varepsilon\varepsilon_0};\ \nabla \cdot \mathbf{B}(\mathbf{r},t) = 0; \tag{3.17}$$

$$\nabla \times \mathbf{E}'(v,\mathbf{r}',t) = -\frac{\partial' \mathbf{B}}{\partial t}(v,\mathbf{r}',t);\ \nabla \times \mathbf{B}'(v,\mathbf{r}',t) = \mu\mu_0 \mathbf{j}'(v,\mathbf{r}',t) + \frac{\varepsilon\mu}{c^2}\frac{\partial' \mathbf{E}}{\partial t}(v,\mathbf{r}',t), \tag{3.18}$$

where $\partial'\mathbf{E}/\partial t$, $\partial'\mathbf{B}/\partial t$ – the derivatives of Galileo of field functions, expressed as particular time derivatives and convective derivatives of the same field functions in the laboratory frame of reference by the following equalities:

$$\frac{\partial' \mathbf{E}}{\partial t}(v,\mathbf{r}',t) = \frac{\partial \mathbf{E}(\mathbf{r}' + tv\mathbf{e}_1, t)}{\partial t} + (v\mathbf{e}_1 \cdot \nabla)\mathbf{E}(\mathbf{r}' + tv\mathbf{e}_1, t); \tag{3.19}$$

$$\frac{\partial' \mathbf{B}}{\partial t}(v,\mathbf{r}',t) = \frac{\partial \mathbf{B}(\mathbf{r}' + tv\mathbf{e}_1, t)}{\partial t} + (v\mathbf{e}_1 \cdot \nabla)\mathbf{B}(\mathbf{r}' + tv\mathbf{e}_1, t). \tag{3.20}$$

With $v = 0$ (3.17)-(3.18) it passes in (3.14). In the particular case the absences of free charges and currents of equation (3.17)-(3.18) will take the form:

$$\nabla \cdot \mathbf{E}(\mathbf{r},t)=0\,;\nabla \cdot \mathbf{B}(\mathbf{r},t)=0\,; \tag{3.21}$$

$$\nabla \times \mathbf{E}'(v,\mathbf{r}',t)=-\frac{\partial' \mathbf{B}}{\partial t}(v,\mathbf{r}',t);\ \nabla \times \mathbf{B}'(v,\mathbf{r}',t)=\frac{\varepsilon\mu}{c^2}\frac{\partial' \mathbf{E}}{\partial t}(v,\mathbf{r}',t). \tag{3.22}$$

With $v=0$ (3.21)-(3.22) it passes into the well-known system of equations of Maxwell:

$$\nabla \cdot \mathbf{E}(\mathbf{r},t)=0\,;\ \nabla \cdot \mathbf{B}(\mathbf{r},t)=0\,;\ \nabla \times \mathbf{E}(\mathbf{r},t)=-\frac{\partial \mathbf{B}(\mathbf{r},t)}{\partial t};\ \nabla \times \mathbf{B}(\mathbf{r},t)=\frac{\varepsilon\mu}{c^2}\frac{\partial \mathbf{E}(\mathbf{r},t)}{\partial t}. \tag{3.23}$$

By the vector product of nabla to both parts of the equations (3.16) with their mutual substitutioninto each other obtains the known wave differential equations

$$c^2\nabla^2\mathbf{E}=\varepsilon\mu\frac{\partial^2\mathbf{E}}{\partial t^2},c^2\nabla^2\mathbf{B}=\varepsilon\mu\frac{\partial^2\mathbf{B}}{\partial t^2} \tag{3.24}$$

The absence of trans-coordinateawn is their drawback, they are valid only in the case of agreeing the laboratory and substantive frame of references ($\mathbf{v}=\mathbf{0}$). It is analogous, i.e., by the vector product of nabla to both parts of the equations (3.15) with their mutual substitution into each other, we will obtain the new equations of electrodynamics – the globally trans-coordinate wave differential equations, which use Galilean derivative of field functions and generalizing equations (24) in the case $\mathbf{v}\neq\mathbf{0}$:

$$c^2\nabla^2\mathbf{E}'=\varepsilon\mu\frac{\partial'^2\mathbf{E}}{\partial t^2},c^2\nabla^2\mathbf{B}'=\varepsilon\mu\frac{\partial'^2\mathbf{B}}{\partial t^2} \tag{3.25}$$

We investigate in more detail the equation of form (3.25) in connection with to arbitrary field functions $\Phi(x,t)$, also, $\Phi'(v,x',t)$ for the case of plane wave with the wave vector, collinear to vector $\mathbf{v}=(v,0,0)$ and to axes OX, $O'X'$, coordinates along which are assigned by the variables x, x'. In this case the equation proves to be one-dimensional, and field functions – scalar:

$$c^2\frac{\partial^2}{\partial x'^2}\Phi'(v,x',t)=\varepsilon\mu\frac{\partial'^2\Phi}{\partial t^2}(v,x',t)=\varepsilon\mu\frac{d^2}{dt^2}\Phi(x'+vt,t) \tag{3.26}$$

If we differentiate in the right side (3.26), this equation of signs the form:

$$\frac{c^2}{\varepsilon\mu}\frac{\partial^2}{\partial x'^2}\Phi'(v,x',t)=\left(\frac{\partial^2}{\partial t^2}+2v\frac{\partial^2}{\partial t\partial x}+v^2\frac{\partial^2}{\partial x^2}\right)\Phi(x'+vt,t)=\left(\frac{\partial}{\partial t}+v\frac{\partial}{\partial x}\right)^2\Phi(x'+vt,t) \tag{3.27}$$

With $v=0$ (3.26) and (3.27) it degenerates into the one-dimensional version of the wave equation of the form (3.24):

$$c^2\frac{\partial^2}{\partial x^2}\Phi(x,t)=\varepsilon\mu\frac{\partial^2}{\partial t^2}\Phi(x,t) \tag{3.28}$$

Any solution (3.28) is determined by the proper superposition of the simple harmonic waves

$$\Phi(x,t)=A\cos(\omega t-k_x x+\varphi) \tag{3.29}$$

with the approximate values of the parameters $A\geq 0$, $\omega>0$, $k_x\neq 0$, $\varphi\in\mathbb{R}$ – amplitude, angular frequency, the projection of wave vector on the axis OX and the initial phase of wave. In this case all waves (3.29) must have one and the same phase speed $\omega/k=c/\sqrt{\varepsilon\mu}$, where $k=|k_x|$ – wave number. We will search for function $\Phi'(v,x',t)$, satisfying (3.26)-(3.29), also in the form of simple harmonic wave, but with those depending on v by the parameters $A'(v)$, $\omega'(v)$, $k_x'(v)$, $\varphi'(v)$:

$$\Phi'(v,x',t)=A'(v)\cos(\omega'(v)t-k_x'(v)x'+\varphi'(v)) \tag{3.30}$$

$\Phi'(0,x',t)=\Phi(x',t)$, $A'(0)=A$, $\omega'(0)=\omega$, $k_x'(0)=k_x$, $\varphi'(0)=\varphi$. Let us substitute (3.29)-(3.30) in (3.27):

$$c^2 k_x'^2(v) A'(v)\cos(\omega'(v)t - k_x'(v)x' + \varphi'(v)) = \varepsilon\mu(\omega - k_x v)^2 A\cos(\omega t - k_x(x' + vt) + \varphi) \quad (3.31)$$

Equalizing the similar parameters of wave on the left side (3.31) and in the right, we have:

$$A'(v) = \left(\operatorname{sgn} k_x - \frac{\sqrt{\varepsilon\mu}}{c} v\right)^2 A,\ \omega'(v) = |\omega - k_x v| = \left|1 - \frac{\sqrt{\varepsilon\mu}}{c} v \operatorname{sgn} k_x\right| \omega, \quad (3.32)$$

$$k_x'(v) = k_x \operatorname{sgn}(\omega - k_x v),\ k'(v) = |k_x'(v)| = k,\ \varphi'(v) = \varphi \operatorname{sgn}(\omega - k_x v),\ |\varphi'(v)| = |\varphi|. \quad (3.33)$$

Thus, upon transfer from the laboratory to the substantive frame of reference change amplitude and frequency (3.32) of simple harmonic wave, and its wave number and module of initial phase (3.33) remain constant. In this case the frequency changes in such a way that phase wave velocity in the substantive frame of reference is obtained according to the classical summation rule of speeds from its phase speed in the laboratory frame of reference and speed of substantive frame of reference relative to the laboratory:

$$\omega'(v)/k_x'(v) = \omega'(v)/k_x = \omega/k_x - v,\ \omega'(v)/k'(v) = |\omega/k - v \operatorname{sgn} k_x| = \left|c/\sqrt{\varepsilon\mu} - v \operatorname{sgn} k_x\right|. \quad (3.34)$$

From (3.32)-(3.34) it is evident that if the vector of phase wave velocity in the laboratory frame of reference coincides with the velocity vector of substantive frame of reference in it ($k_x > 0$, $v = \omega/k$), that in the substantive frame of reference wave generally disappears ($A'(v) = 0$). Thus, in contrast to the theory of relativity, in the theory of giperkontinuuma this wave always can be destroyed by the suitable selection of frame of reference. But if relative to laboratory frame of reference substantial frame of reference outdistances wave, then upon transfer from the laboratory frame of reference to the substantive the direction of propagation of wave changes by the opposite. If in the laboratory frame of reference wave is propagated in the positive direction, then upon transfer into the substantive it will satisfy wave equation (3.35), while if in the negative, then to the equation (3.36):

$$\left(c/\sqrt{\varepsilon\mu} - v\right)^2 \partial^2 \Phi'(v, x', t)/\partial x'^2 = \partial^2 \Phi'(v, x', t)/\partial t^2; \quad (3.35)$$

$$\left(c/\sqrt{\varepsilon\mu} + v\right)^2 \partial^2 \Phi'(v, x', t)/\partial x'^2 = \partial^2 \Phi'(v, x', t)/\partial t^2 \quad (3.36)$$

The selection of inertial reference system to the role of laboratory is, generally speaking, conditional. Thus, substantial frame of reference it is possible in turn to accept for the laboratory, and in the role of substantial to examine certain by third (twice shtrikhovannuyu) inertial reference system with that directed to the same side, that also OX, $O'X'$, by attitude reference $O''X''$, the coordinate along which is assigned by the variable x''. Let, for example, the point O'' move in the positive direction of axis $O'X'$ with the speed Δv. Wave in the new laboratory and substantive frame of references will have an identical wave number and a module of initial phase and will be described by field functions $\Phi'(v, x', t)$ and $\Phi'(v + \Delta v, x'', t)$ respectively. The role of equation (3.28) plays (3.35) or (3.36), the role of the function of wave (3.29) – function (3.30), while the role of equations (3.35), (3.36) – the following wave equations:

$$\left(c/\sqrt{\varepsilon\mu} - (v + \Delta v)\right)^2 \partial^2 \Phi'(v + \Delta v, x'', t)/\partial x''^2 = \partial^2 \Phi'(v + \Delta v, x'', t)/\partial t^2, \quad (3.37)$$

$$\left(c/\sqrt{\varepsilon\mu} + (v + \Delta v)\right)^2 \partial^2 \Phi'(v + \Delta v, x'', t)/\partial x''^2 = \partial^2 \Phi'(v + \Delta v, x'', t)/\partial t^2. \quad (3.38)$$

For (3.37) the role of equalities (3.32), (3.33) play the following transformations of the parameters of the wave:

$$A''(v+\Delta v)=\left(\operatorname{sgn} k'_x(v)-\frac{\sqrt{\varepsilon\mu}\cdot\Delta v}{c-\sqrt{\varepsilon\mu}\cdot v}\right)^2 A'(v)\ \omega''(v+\Delta v)=\left|\omega'(v)-k'_x(v)\right|\Delta v\,, \tag{3.39}$$

$$k''_x(v+\Delta v)=k'_x(v)\operatorname{sgn}(\omega'(v)-k'_x(v)\Delta v)\,,\quad \varphi''(v+\Delta v)=\varphi'(v)\operatorname{sgn}(\omega'(v)-k'_x(v)\Delta v). \tag{3.40}$$

For (3.38) the corresponding (3.39)-(3.40) conversions of the parameters are determined analogously.

Sequential passage from not hatch to hatch and is further to the twice hatch frame of reference equivalent to direct passage from not hatch to twice hatch. For example, with $\operatorname{sgn} k'_x(v)=\operatorname{sgn} k_x=1$ from (3.32), (3.39) it is possible to obtain

$$A''(v+\Delta v)=\left(1-\sqrt{\varepsilon\mu}\,(v+\Delta v)/c\right)^2 A \tag{3.41}$$

which is obtained also upon direct transfer to the twice hatch frame of reference, since (3.41) it is obtained from (3.32) by replacement v on $v+\Delta v$. In this case the role of equation (3.27) plays.

$$\left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2\frac{\partial^2\Phi'(v+\Delta v,x'',t)}{\partial x''^2}=\frac{\partial^2\Phi'(v,x''+\Delta vt,t)}{\partial t^2}+\left(2\Delta v\frac{\partial^2}{\partial t\partial x'}+\Delta v^2\frac{\partial^2}{\partial x'^2}\right)\Phi'(v,x''+\Delta vt,t) \tag{3.42}$$

For the derivatives of arbitrary n- GO of order $\partial^n\Phi'(v+\Delta v,x'',t)/\partial x''^n$ $\partial^n\Phi'(v,x',t)/\partial x'^n$ it is possible to use a united designation $\partial^n\Phi'(v+\Delta v,x,t)/\partial x^n$ and $\partial^n\Phi'(v,x,t)/\partial x^n$ ($n=\overline{1,\infty}$), respectively indicating simply derived on the second argument. In accordance with this, after substitution (3.35) in (3.42) we will obtain:

$$\left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2\frac{\partial^2}{\partial x^2}\left(\frac{\Phi'(v+\Delta v,x,t)-\Phi'(v,x+\Delta vt,t)}{\Delta v}\right)=\left(2\frac{\partial^2}{\partial t\partial x}+\Delta v\frac{\partial^2}{\partial x^2}\right)\Phi'(v,x+\Delta vt,t) \tag{3.43}$$

Let $\Delta v\to 0$. Let us introduce one additional new derivative, which let us name trans-coordinate, and which in the case of the one-dimensional system of space coordinates takes the form:

$$\frac{\partial'\Phi'(v,x,t)}{\partial' v}=\lim_{\Delta v\to 0}\frac{\Phi'(v+\Delta v,x,t)-\Phi'(v,x+\Delta vt,t)}{\Delta v} \tag{3.44}$$

In the determination (3.44) of value $\Phi'(v,x+\Delta vt,t)$ $\Phi'(v+\Delta v,x,t)$ is described physical field at one and the same point of space, but in the different frame of references (hatch and moving relative to it with speed Δv twice hatch respectively). Within the framework they are equal to the concept of the invariance of field relative to the speed of the motion of observer:

$$\Phi'(v,x+\Delta vt,t)=\Phi'(v+\Delta v,x,t), \tag{3.45}$$

The equalities (3.3) (3.45) making identical physical sense, but in connection with to the different pairs of frame of references. However, out of the framework of the indicated concept upon transfer from hatch to the twice hatch frame of reference the field function at the particular point of space experiences the increase, the limit of relation of which k Δv with $\Delta v\to 0$ gives the trans-coordinate derivative (3.44). It is possible to generalize it to the case of the higher orders ($n=\overline{1,\infty}$):

$$\frac{\partial'^1\Phi'(v,x,t)}{\partial' v^1}=\frac{\partial'\Phi'(v,x,t)}{\partial' v}\ ;\quad \frac{\partial'^{n+1}\Phi'(v,x,t)}{\partial' v^{n+1}}=\lim_{\Delta v\to 0}\frac{\dfrac{\partial'^n\Phi'(v+\Delta v,x,t)}{\partial' v^n}-\dfrac{\partial'^n\Phi'(v,x+\Delta vt,t)}{\partial' v^n}}{\Delta v} \tag{3.46}$$

Using trans-coordinate derivatives of the first two orders (3.46), it is possible to represent increase in the field function of in the form corresponding partial summation of series of Taylor:

$$\Phi'(v+\Delta v,x,t)-\Phi'(v,x+\Delta vt,t)\approx\frac{\partial'\Phi'(v,x,t)}{\partial' v}\Delta v+\frac{1}{2}\frac{\partial'^2\Phi'(v,x,t)}{\partial' v^2}\Delta v^2 \quad (3.47)$$

Substituting (3.47) in (3.43), equalizing between themselves members with the identical degrees Δv in the left and right sides of the received equality, fixing $\Delta v\to 0$, taking into account that the fact that in this case $\Phi'(v,x+\Delta vt,t)\to\Phi'(v,x,t)$ and by adding equality (3.35) in the new form of record (with the use by variable x instead of x' , we will obtain the following system of three equations:

$$\begin{cases}\left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2\frac{\partial^2\Phi'(v,x,t)}{\partial x^2}=\frac{\partial^2\Phi'(v,x',t)}{\partial t^2},\\ \left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2\frac{\partial\partial'\Phi'(v,x,t)}{\partial x\partial' v}=2\frac{\partial\Phi'(v,x',t)}{\partial t},\\ \left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2\frac{\partial'^2\Phi'(v,x,t)}{\partial' v^2}=2\Phi'(v,x',t)\end{cases} \quad (3.48)$$

System of equations (3.48) can be written down in following that indexed on α the form:

$$\left(\left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2\frac{\partial^{2-\alpha}\partial'^{\alpha}}{\partial x^{2-\alpha}\partial' v^{\alpha}}-2^{\operatorname{sgn}\alpha}\frac{\partial^{2-\alpha}}{\partial t^{2-\alpha}}\right)\Phi'(v,x',t)=0 \qquad \alpha=\overline{0,2} \quad (3.49)$$

or in the operator form

$$\text{۞}\Phi'(v,x',t)=0, \quad (3.50)$$

Where ۞ $=($۞$^{\alpha})$; ۞$^{\alpha}$

$$=\left(\left(\frac{c}{\sqrt{\varepsilon\mu}}-v\right)^2\frac{\partial^{2-\alpha}\partial'^{\alpha}}{\partial x^{2-\alpha}\partial' v^{\alpha}}-2^{\operatorname{sgn}\alpha}\frac{\partial^{2-\alpha}}{\partial t^{2-\alpha}}\right)$$

the suitable version of the one-dimensional (case of one axis of space coordinates) differential operator of Dubrovin, which generalizes d'Alembert's operator □, who occurs one of his three (zero) components for the laboratory frame of reference, i.e., $\alpha=0$, $v=0$. Differential equation (3.49) or (3.50) is the giperkontinual one-dimensional homogeneous wave equation, which generalizes, similar to differential equation (3.26) or (3.27), the known one-dimensional homogeneous wave equation (28). The vital difference between them (3.26)-(3.27) is lies in the fact that the globally trans-coordinate form of giperkontinual wave equation, and (3.49)-(3.50) – by its locally trans-coordinate form. Local trans-coordinateawn means that the equation connects the inertial reference systems, which move relative to each other with the infinitely low speed.

The trans-coordinateawn of giperkontinual wave equations is ensured by the use in them of the suitable derived field functions. Namely, use by Galileo's derivative reports to equation global trans-coordinateawn, and by trans-coordinate derivative – local.

Thus, is proposed the new approach to the development of the mathematical apparatus for electrodynamics in the direction of the more adequate description of passage from one inertial reference system to another on the basis of giperkontinual ideas about the space and in the time due to the introduction into the examination of the globally and locally trans-coordinate equations, which use new Galilean and trans-coordinate derivatives of field functions, and also the new differential operator of Dubrovin, which generalizes d'Alembert's operator. This approach leads to the reformulation of electrodynamics with the passage from the traditional formulation of Hertz-Heaviside to the new trans-coordinate. In this case immediately arise the question about what form they have conversions of electromagnetic field upon transfer from one inertial reference system to another, and will be these conversions the Mende transformation[31].

The convective derivatives of field functions in (19)-(20) can be written down in the form:

$$(v\mathbf{e}_1\cdot\nabla)\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)=v(\nabla\cdot\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t))\mathbf{e}_1-\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)) \tag{3.51}$$

$$(v\mathbf{e}_1\cdot\nabla)\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)=v(\nabla\cdot\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t))\mathbf{e}_1-\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)) \tag{3.52}$$

We have in view of the first two (3.22) equations taking into account (3.1)-(3.2) :

$$\nabla\cdot\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)=0\,;\,\nabla\cdot\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)=0 \tag{3.53}$$

After substituting (3.53) in (3.51)-(3.52), we will obtain equalities for the convective derivatives:

$$(v\mathbf{e}_1\cdot\nabla)\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)=-\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t))\,; \tag{3.54}$$

$$(v\mathbf{e}_1\cdot\nabla)\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)=-\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)). \tag{3.55}$$

After substitution (3.54)-(3.55) in (3.19)-(3.20) we take another form of the Galilean derivatives:

$$\frac{\partial'\mathbf{E}}{\partial t}(v,\mathbf{r}',t)=\frac{\partial\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)}{\partial t}-\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t))\,; \tag{3.56}$$

$$\frac{\partial'\mathbf{B}}{\partial t}(v,\mathbf{r}',t)=\frac{\partial\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)}{\partial t}-\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)). \tag{3.57}$$

The substitution of Galilean derivatives (3.56)-(3.57) into the last two equalities (3.22) gives:

$$\nabla\times\mathbf{E}'(v,\mathbf{r}',t)=-\partial\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)/\partial t+\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t))\,; \tag{3.58}$$

$$\nabla\times\mathbf{B}'(v,\mathbf{r}',t)=\left(\varepsilon\mu/c^2\right)(\partial\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)/\partial t-\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t))). \tag{3.59}$$

After substituting last two equations (3.23) in (3.58)-(3.59), we will obtain:

$$\nabla\times\mathbf{E}'(v,\mathbf{r}',t)=\nabla\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)+\nabla\times(v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t))\,; \tag{3.60}$$

$$\nabla\times\mathbf{B}'(v,\mathbf{r}',t)=\nabla\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)-\left(\varepsilon\mu/c^2\right)\nabla\times(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)) \tag{3.61}$$

Let us omit the operation of rotor both parts of the equalities (3.60)-(3.61):

$$\mathbf{E}'(v,\mathbf{r}',t)=\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)+v\mathbf{e}_1\times\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)\,; \tag{3.62}$$

$$\mathbf{B}'(v,\mathbf{r}',t)=\mathbf{B}(\mathbf{r}'+tv\mathbf{e}_1,t)-\left(\varepsilon\mu/c^2\right)(v\mathbf{e}_1\times\mathbf{E}(\mathbf{r}'+tv\mathbf{e}_1,t)) \tag{3.63}$$

Besides the hatch frame of reference, which moves relative to laboratory with speed v let us introduce also relatively mobile frame of reference – twice shtrikhovannuyu, that moves in the same direction with another speed $v+\Delta v$ relative to laboratory. Thus, the twice shtrikhovannaya frame of reference moves with relatively hatch with speed Δv, the so that shtrikhovannuyu frame of reference can be accepted for the new laboratory (relatively fixed), and twice shtrikhovannuyu – for the new substantive.

Equalities (62)-(63) for them let us write down taking into account the replacement of radius-vector $\mathbf{r}'$ on $\mathbf{r}''$:

$$\mathbf{E}'(v+\Delta v,\mathbf{r}'',t)=\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)+\Delta v\mathbf{e}_1\times\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)\,; \tag{3.64}$$

$$\mathbf{B}'(v+\Delta v,\mathbf{r}'',t)=\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)-\left(\varepsilon\mu/c^2\right)\Delta v\mathbf{e}_1\times\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t), \tag{3.65}$$

Let us write down equalities (3.64)-(3.65) in the following form:

$$\frac{\mathbf{E}'(v+\Delta v,\mathbf{r}'',t)-\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)}{\Delta v}=\mathbf{e}_1\times\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t); \tag{3.66}$$

$$\frac{\mathbf{B}'(v+\Delta v,\mathbf{r}'',t)-\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)}{\Delta v}=-\frac{\varepsilon\mu}{c2}\mathbf{e}_1\times\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t). \tag{3.67}$$

In (3.66)-(3.67) the values $\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)$, $\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)$ $\mathbf{E}'(v+\Delta v,\mathbf{r}'',t)$, $\mathbf{B}'(v+\Delta v,\mathbf{r}'',t)$ is described the electromagnetic field at one and the same point of space (medium), but in the different frame of references (hatch and by twice hatch). Within the framework they are equal to the concept of the invariance of field relative to the speed of the motion of observer:

$$\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)=\mathbf{E}'(v+\Delta v,\mathbf{r}'',t);\ \mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)=\mathbf{B}'(v+\Delta v,\mathbf{r}'',t), \tag{3.68}$$

The equalities (9) (68) making identical physical sense, but in connection with to the different pairs of frame of references. However, out of the framework of the indicated concept upon transfer from hatch to the twice hatch frame of reference the field function at the particular point of space experiences the increase, the limit of relation of which k Δv with $\Delta v\to 0$ gives that for the first time introduced into 27 the trans-coordinate derivative of the field function:

$$\frac{\partial'\mathbf{E}'(v,\mathbf{r}'',t)}{\partial' v}=\lim_{\Delta v\to 0}\frac{\mathbf{E}'(v+\Delta v,\mathbf{r}'',t)-\mathbf{E}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)}{\Delta v}; \tag{3.69}$$

$$\frac{\partial'\mathbf{B}'(v,\mathbf{r}'',t)}{\partial' v}=\lim_{\Delta v\to 0}\frac{\mathbf{B}'(v+\Delta v,\mathbf{r}'',t)-\mathbf{B}'(v,\mathbf{r}''+t\Delta v\mathbf{e}_1,t)}{\Delta v}. \tag{3.70}$$

Equalities (3.66)-(3.67) with $\Delta v\to 0$ taking into account (3.69)-(3.70) after replacement $\mathbf{r}''$ on $\mathbf{r}$ take the form:

$$\frac{\partial'\mathbf{E}'(v,\mathbf{r}',t)}{\partial' v}=\mathbf{e}_1\times\mathbf{B}'(v,\mathbf{r}',t);\ \frac{\partial'\mathbf{B}'(v,\mathbf{r}',t)}{\partial' v}=-\frac{\varepsilon\mu}{c^2}\mathbf{e}_1\times\mathbf{E}'(v,\mathbf{r}',t). \tag{3.71}$$

If equations (3.22) are the globally trans-coordinate differential equations of electrodynamics for the case of IStropic homogeneous medium without the dispersion in the absence of free charges and currents, then equations (3.71) are the locally trans-coordinate differential equations of electrodynamics for the same case. The locality of trans-coordinateawn, ensured by use by trans-coordinate derivative, means that the connected by differential equations inertial reference systems (conditionally speaking, shtrikhovannaya and twice shtrikhovannaya) they move relative to each other with the infinitely low speed Δv. Equations (3.71) form the system, by solving which, it is possible to obtain the conversions of electromagnetic field upon transfer of one inertial reference system into another.

Let us use system of equations (3.71) for obtaining the conversions of electromagnetic field upon transfer from the laboratory frame of reference to the substantive.

Lowering the arguments of functions, let us write down vector products in (3.71) in the form:

$$\mathbf{e}_1\times\mathbf{B}'=\mathbf{e}_1\times\left(B'^1\mathbf{e}_1+B'^2\mathbf{e}_2+B'^3\mathbf{e}_3\right)=B'^2\mathbf{e}_3-B'^3\mathbf{e}_2; \tag{3.72}$$

$$\mathbf{e}_1\times\mathbf{E}'=\mathbf{e}_1\times\left(E'^1\mathbf{e}_1+E'^2\mathbf{e}_2+E'^3\mathbf{e}_3\right)=E'^2\mathbf{e}_3-E'^3\mathbf{e}_2. \tag{3.73}$$

Taking into account (3.72)-(3.73) the system of equations (3.71) is divided off into two independent systems of two equations each and two additional independent equations:

$$\begin{cases} \dfrac{\partial' E'^2}{\partial' v} = -B'^3, \\ \dfrac{\partial' B'^3}{\partial' v} = -\dfrac{\varepsilon\mu}{c^2} E'^2; \end{cases} \begin{cases} \dfrac{\partial' E'^3}{\partial' v} = B'^2, \\ \dfrac{\partial' B'^2}{\partial' v} = \dfrac{\varepsilon\mu}{c^2} E'^3; \end{cases} \frac{\partial' E'^1}{\partial' v} = 0; \ \frac{\partial' B'^1}{\partial' v} = 0. \tag{3.74}$$

We differentiate the first equations of systems (3.74) and will substitute them the secondly:

$$\frac{\partial'^2 E'^2}{\partial' v^2} = \frac{\varepsilon\mu}{c^2} E'^2; \ \frac{\partial'^2 E'^3}{\partial' v^2} = \frac{\varepsilon\mu}{c^2} E'^3; \ \frac{\partial'^2 B'^2}{\partial' v^2} = \frac{\varepsilon\mu}{c^2} B'^2; \ \frac{\partial'^2 B'^3}{\partial' v^2} = \frac{\varepsilon\mu}{c^2} B'^3. \tag{3.75}$$

The general solution of equations (3.75) is expressed as the arbitrary constants $C_1,\ldots,C_{10}$:

$$E'^1 = C_1; E'^2 = C_2 \cosh\frac{\sqrt{\varepsilon\mu}v}{c} + C_3 \sinh\frac{\sqrt{\varepsilon\mu}v}{c}; E'^3 = C_4 \cosh\frac{\sqrt{\varepsilon\mu}v}{c} + C_5 \sinh\frac{\sqrt{\varepsilon\mu}v}{c}; \tag{3.76}$$

$$B'^1 = C_6; B'^2 = C_7 \cosh\frac{\sqrt{\varepsilon\mu}v}{c} + C_8 \sinh\frac{\sqrt{\varepsilon\mu}v}{c}; B'^3 = C_9 \cosh\frac{\sqrt{\varepsilon\mu}v}{c} + C_{10} \sinh\frac{\sqrt{\varepsilon\mu}v}{c}. \tag{3.77}$$

Since we search for the conversions of electromagnetic field upon transfer from the laboratory frame of reference, then the desired particular solutions of equations (3.75) must with $v = 0$ describe electromagnetic field in the laboratory frame of reference, i.e., satisfy equalities (8) and (74), and the, which means, following totality of the equalities:

$$E'^1(0,\mathbf{r}',t) = E^1(\mathbf{r}',t); \ E'^2(0,\mathbf{r}',t) = E^2(\mathbf{r}',t); \ E'^3(0,\mathbf{r}',t) = E^3(\mathbf{r}',t); \tag{3.78}$$

$$B'^1(0,\mathbf{r}',t) = B^1(\mathbf{r}',t); \ B'^2(0,\mathbf{r}',t) = B^2(\mathbf{r}',t); \ B'^3(0,\mathbf{r}',t) = B^3(\mathbf{r}',t); \tag{3.79}$$

$$\frac{\partial' E'^2(0,\mathbf{r}',t)}{\partial' v} = -B^3(\mathbf{r}',t); \ \frac{\partial' E'^3(0,\mathbf{r}',t)}{\partial' v} = B^2(\mathbf{r}',t); \tag{3.80}$$

$$\frac{\partial' B'^2(0,\mathbf{r}',t)}{\partial' v} = \frac{\varepsilon\mu}{c^2} E^3(\mathbf{r}',t); \ \frac{\partial' B'^3(0,\mathbf{r}',t)}{\partial' v} = -\frac{\varepsilon\mu}{c^2} E^2(\mathbf{r}',t). \tag{3.81}$$

By substitution (3.76)-(3.77) in (3.78)-(3.81) let us find the values of constants $C_1,\ldots,C_{10}$, as a result what after the substitution of these constants in (3.76)-(3.77) we will obtain the resultant expression in the component form for the desired conversions of electromagnetic field upon transfer from the laboratory frame of reference to the substantive:

$$E'^1(v,\mathbf{r}',t) = E^1(\mathbf{r}',t); \ B'^1(v,\mathbf{r}',t) = B^1(\mathbf{r}',t); \tag{3.82}$$

$$E'^2(v,\mathbf{r}',t) = E^2(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c} - \frac{c}{\sqrt{\varepsilon\mu}} B^3(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}; \tag{3.83}$$

$$E'^3(v,\mathbf{r}',t) = E^3(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c} + \frac{c}{\sqrt{\varepsilon\mu}} B^2(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}; \tag{3.84}$$

$$B'^2(v,\mathbf{r}',t)=B^2(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}+\frac{\sqrt{\varepsilon\mu}}{c}E^3(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}; \tag{3.85}$$

$$B'^3(v,\mathbf{r}',t)=B^3(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}-\frac{\sqrt{\varepsilon\mu}}{c}E^2(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}. \tag{3.86}$$

In the vector form the same conversions take the following form:

$$\mathbf{E}'(v,\mathbf{r}',t)=\mathbf{E}(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}+\frac{c}{\sqrt{\varepsilon\mu}}\mathbf{e}_1\times\mathbf{B}(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}; \tag{3.87}$$

$$\mathbf{B}'(v,\mathbf{r}',t)=\mathbf{B}(\mathbf{r}',t)\cosh\frac{\sqrt{\varepsilon\mu}v}{c}-\frac{\sqrt{\varepsilon\mu}}{c}\mathbf{e}_1\times\mathbf{E}(\mathbf{r}',t)\sinh\frac{\sqrt{\varepsilon\mu}v}{c}. \tag{3.88}$$

It is easy to see that the conversions (3.82)-(3.88) are known Mende transformation.

IV. Conclusion

Thus, the Mende transformation obtain a sufficient theoretical substantiation within the framework of the trans-coordinate formulation of electrodynamics, connected with the giperkontinual ideas about the space and the time, and also with the concept not of the invariance of electric charge relative to the speed of the motion of observer. Together with that been in [26] direct experimental confirmation of the concept not of the invariance of electric charge, this is convincing evidence of their larger adequacy of physical reality on the comparison not only with the classical, but also with the relativistic conversions of electromagnetic field, or the convincing evidence of the justification of the transfer of electrodynamics from the traditional formulation of Hertz-Heaviside to the the trans-coordinate. The sequential development of trans-coordinate electrodynamics is capable of not only deriving on the new qualitative level of idea about the space and the time, but also of opening the fundamentally new horizons of the development engineering and technologies due to the discovery and the mastery of new physical phenomena and effects.

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Reduction Electrode Mechanism of Pesticides Having Different Electro Active Centres at Carbon Nano Tubes Paste Electrode

By P. Sujana & T. Raveendranath Babu
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Abstract- Electrochemical behaveour and schme of reduction at electrode of pesticides having different electro active groups to be reduced that is azomethine and double bond carbons at carbon nano tubes paste electrode Using universal buffer as supporting electrolyte and techniques cyclic voltammetry, differential pulse adsorptive stripping voltammetry, milliccoulometry have been studied. All investigatios was made from water samples. The average recoveries obtained for two samples ranged from 97.00% to 99.46%.

Keywords: *binapycril, isoxydifen, carbon nano tubes paste electrode, universal buffer.*

GJSFR-A Classification : *FOR Code: 240504*

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Strictly as per the compliance and regulations of :

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I. Introduction

Despite the fact that pesticides have many harmful effects on environment they have been used in agriculture field to increase yield, improve food quality and save time and money. But the uniform use of pesticides can cause soil, water and food contamination. Their detection concerns agriculture health care professionals and regulatory agencies. At present, they are mostly determined in the laboratory by methods such as chromatographic and spectroscopic methods. Although they have high sensitivity, these methods suffer from many disadvantages, in requiring skilled technicians, being complex, costly and time consuming and their use online for continuous monitoring is impractical. Because large number of samples have to be measured, the development of fast automated and inexpensive methods are of great interest. voltammetric methods are suitable, sensitive and reproducible. In present investigation two pesticides having >C=C< and >C=N- as electro active centres are examined.

a) Binapacryl

Binapicrylis registered as dinitrophenol acaricide (bird repellenent) Mauro De Paoli, M. Taccheo Barbina[1] determined pesticide by using Solid-phase extraction and gas chromatographic determination acaricide residues in honey. Bissacot DZ, Vassilieff [2] applied HPLC determination of binapicryl., deltamethrin, cypermethrin, and cyhalothrin residues in the milk and blood of lactating dairy cows. Zhou J, Xue X, et.al[3] employed Rapid and sensitive determination of two degradation products of binapicryl in honey by ultrasonically assisted extraction and gas chromatography with electron capture detection. Bissacot, et.al[4] employed HPLC Determination of Flumethrin, Deltamethrin, Cypermethrin, and Cyhalothrin Residues in the Milk and Blood of Lactating Dairy Cows. Sassine et al. [5] employed cypermethrin Residues Determination in the Milk of a Lactating Dairy Cow by Gas Chromatography-Ion Trap Mass Spectrometry. Ravi et al. [6,7] employed Negative Ion Chemical Ionization-Gas Chromatographic–Mas Spectrometric Determination of Residues of Different pesticides in Whole Blood and Serum. Wang [8] subjected Chromatographic methods for the determination of pesticide residues in crops, foods and environmental samples. Sanghavi et al.[9-13] reported voltammetric determination of pesticides having various electro active groups.

b) Isoxadifen

Isoxidifen is registered as herbicide which leads to accumulation in soil and crops that have been treated directly[14]. Prevention of negative effects of herbicides requires a systemic control of their residues in agricultural products, food, soil and water. Several analytical methods have been developed for the determination of herbicides in soil, water and agricultural products. Tanogai et al.[15] developed chromatographic method for the determination of a herbicides in food crops. Tanabe et al.[16] developed a GC/MS method for the determination of residues Gas chromatography with atomic emission [17-21].

II. Experimental

a) Apparatus and Electrodes

Voltammetric determinations were performed using a model meterohm Auto Lab 101 PG stat (Netherlands). CNTPE was used as working electrode for differential pulse adsorptive stripping voltammery and cyclic voltammetry. pH measurements were carried out with an Eutech PC_510 cyber scan. Meltzer Toledo

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(Japan)Xp26 delta range micro balancer were used to weigh the samples during the preparation of standard solutions. All the experiments were performed at 25^{0}C.

Fig. 1

b) Reagents and Solutions

All reagents used are analytical reagent grade. Double distilled water was used throughout the analysis. In the present investigation universal buffers of pH range 2.0 to 6.0 are used as supporting electrolytes and are prepared by using 0.2 M boric acid, 0.05M citric acid and 0.1Mtrisodium orthophosphate solutions. Samples obtained from nagarjuna agrichem and syngat india limited.

III. Characterisation of Peaks/Waves

Binapycril and isoxydefen are found to a give a single well defined peak in acidic solutions (2 < pH < 6). Increase of pH from 4.0 leads to decrease of the peak current. In the acidic medium, the peak of the compound is due to the reduction of >C=C< and-C=N- group in two electron process(scheme-1). Typical cyclic voltammograms of Binapycril and isoxydefen are shown in Fig.1.0

IV. Nature of the Electrode Process

The reduction process in Binapycril and isoxydefen found to be diffusion controlled and adsorption on the electrode surface in the buffer systems studied as evidenced from linear plot $i_p$vs $v^{1/2}$ passing through origin (Fig.2.0.).The shift of peak potential (E_p) towards more negative values with increase in concentration of depolarizer, shows that the electrode process is irreversible. This is further confirmed by log-plot analysis. The variation of peak potentials with scan rates and absence of anodic peak in the reverse scan in cyclic voltammetry indicates the irreversible nature of the electrode processes. The dependence of i_p/pH curves shows a behaviour in accordance with a process in which a proton transfer provides the reduction of the acid form to form an electroactive species. The number of protons taking part in the rate determining step is two.

V. Identification of Reduction Products

Millicoulometry employed to find out the number of electrons involved in the electrode process. The results obtained from millicoulometry have shown that the number of electrons is two for Binapycril and isoxydefen. The number of protons involved in the rate determining step of the electrode process is two. Controlled potential electrolysis experiments were carried out at -0.80 V vs. SCE at pH 4.0.

VI. Kinetic Data

Kinetic data such as diffusion coefficient, transfer coefficient and heterogeneous forward rate constants obtained with different methods for Binapycril and isoxydefen summarised in Table 1.0. The diffusion coefficient values were noticed to be in good agreement from cyclic voltammetry. The heterogeneous forward rate constants were decreasing with an increase in pH of the supporting electrolyte, which may responsible for the shift of reduction potentials towards more negative values with increase in pH. This trend is particularly evident where the proton transfer is involved in the electrode process.

VII. Differential Pulse-Adsorptive Stripping Voltammetric Studies

DP-AdSV peaks of Binapycril and isoxydefen at CNTPE (Fig.3.0) is attributed to two electron reduction of Binapycril and isoxydefen this peak followed to establish the optimum conditions. The standard addition and calibration methods have been employed to estimate the compound in water and soil samples.

a) Analysis

Well defined and well resolved AdSV waves/ peaks obtained at pH 4.0 were used for the quantitative estimation of Binapycril and isoxydefen in water samples. Both calibration and standard addition methods were used for the quantitative determination of the Binapycril and isoxydefen. From the calibration method, it is observed that the peak current shows a trend found to be linear over the concentration range 3.0 x 10^{-8}M to 1.0 x 10^{-4} with lower detection limit 0.89 x 10^{-6} M for Binapycril and isoxydefen for 6 replicates, relative standard deviation and correlation coefficient were found to be 0.95% , 0.994 and 0.94%,0.985 respectively for Binapycril and isoxydefen

b) Recommended Analytical Procedure

The stock solution (1.0 x 10^{-3} M) of samples prepared by dissolving the required quantity of the electroactive species in methanol. Standard solutions prepared by dilution of stock solution with fitting amount of methanol. 1 mL of the standard solution is transferred into voltammetric cell and added with 9 mL of the supporting electrolyte and then de gasified by bubbling oxygen free nitrogen gas for 10 min. After recording the voltammogram, small amout of standard solutions added and then voltammograms recorded for each addition under similar experimental conditions.

c) Determination Binapycril and Isoxydefen in Spiked Water Samples

The above mentioned procedure has been successfully applied for the determination of pesticides in water samples. A100 mL sample of water is spiked with known concentrations pesticides and shaken for few minutes and filtered through a Whatman Nylan® membrane filter (0.45 nm pore size) and filtrate passed through a sep-pakc$_{18}$ cartridge previously activated with 10 mL of methanol. Elution carried out with 30 mL of methanol. The organic phase was evaporated. The residues dissolved in methanol and added to cell containing a buffer solution. The average recoveries obtained for two samples ranged from 97.00% to 99.46% and are given in Table 2.0.

VIII. Conclusion

Though several methods reported regarding pesticide analysis in the reported less tedious method consumption of sample is reduced in quantitie and pollution arises due to heavy metal electrodes is avoided.

Table 1: Typical cyclic voltammetric data at CNTPE concentration: 0.5 mM, scan rate: 50 mVs^{-1} pH=4.0.

Sample	-Ep/V	Ip/nA	$\alpha\ n_a$	$\frac{D \times 10^6}{cm^2\ s^{-1}}$	$\frac{k^0_{f,h}}{cm\ s^{-1}}$
Binapicryl	1.04	5.80	0.44	1.50	2.13 x 10^{-10}
Isoxydefen	1.08	7.80	0.36	1.41	1.32 x 10^{-10}

Table 2: Recoveries of pesticides at CNTPE in spiked water samples

Sample	Amount added (µg/mL)	Amount found (µg/mL)	Recovery%	Standard deviation
Binapicryl	10.0	9.70	97.00	0.021
Isoxydefen	10.0	9.91	99.10	0.014

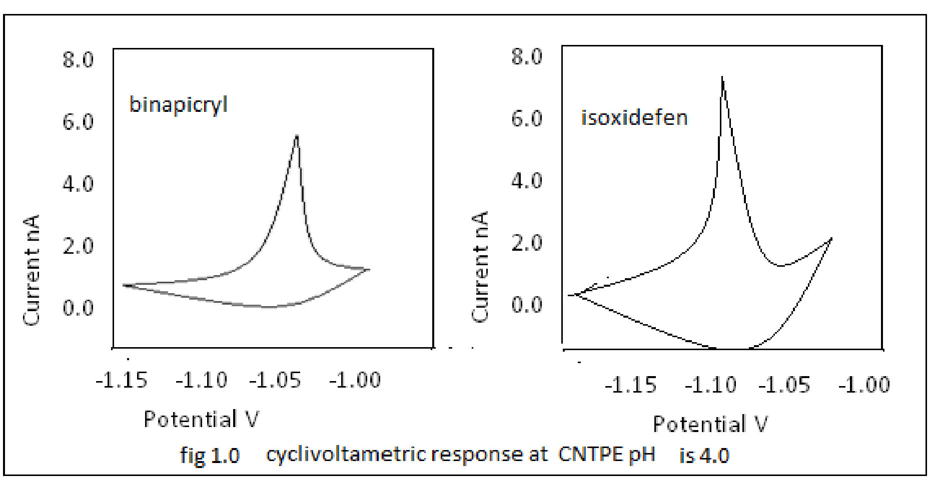
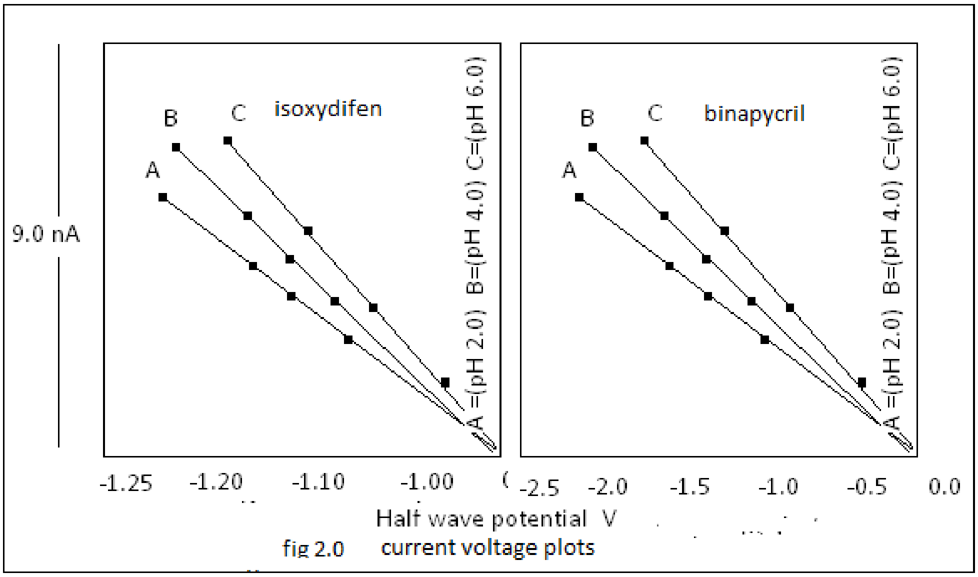
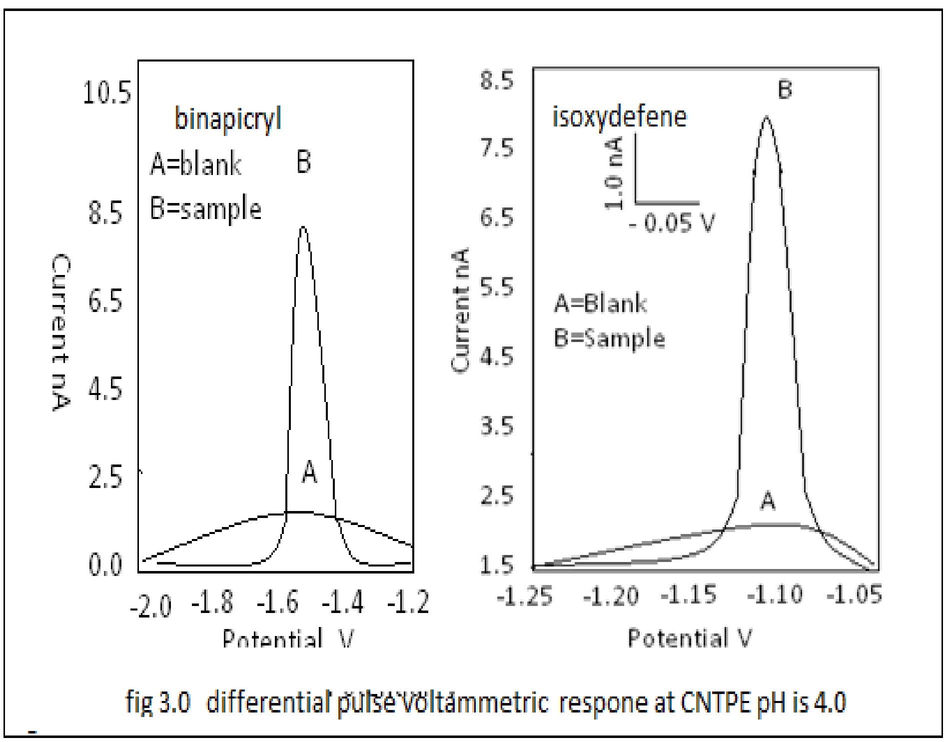


Fig. 2



9.0 nA
B
C
isoxydifen
A
A =(pH 2.0) B=(pH 4.0) C=(pH 6.0)
B
C
binapycril
A
A =(pH 2.0) B=(pH 4.0) C=(pH 6.0)
-1.25
-1.20
-1.10
-1.00
-2.5
-2.0
-1.5
-1.0
-0.5
0.0
Half wave potential V
fig 2.0 current voltage plots

Fig. 3



10.5
8.5
6.5
4.5
2.5
0.0
Current nA
binapicryl
A=blank
B=sample
B
A
-2.0
-1.8
-1.6
-1.4
-1.2
Potential V
8.5
7.5
6.5
5.5
4.5
3.5
2.5
1.5
Current nA
isoxydefene
1.0 nA
- 0.05 V
A=Blank
B=Sample
B
A
-1.25
-1.20
-1.15
-1.10
-1.05
Potential V
fig 3.0 differential pulse voltammetric respone at CNTPE pH is 4.0

Fig. 4

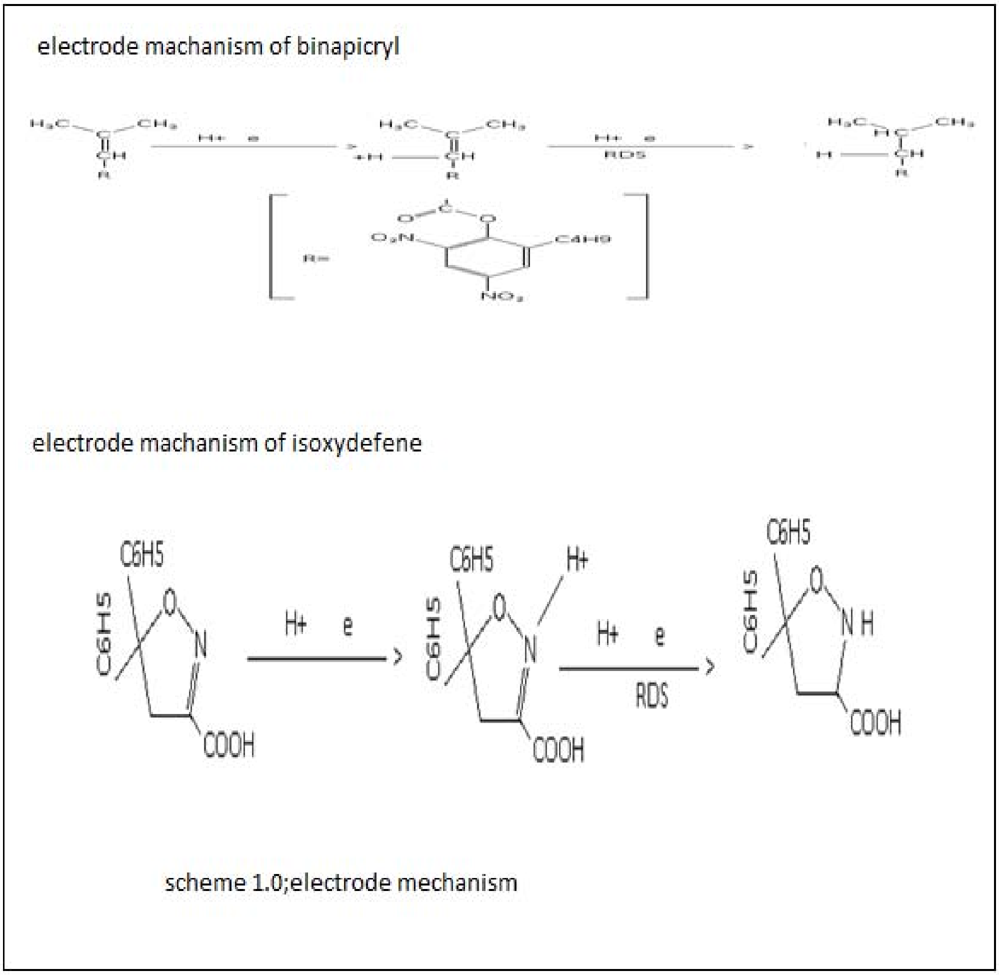


Fig. 5

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"Anomalies" in Thermoelectricity and Reality are Local Thermo-EMFS

By S.V. Ordin

Ioffe Institute of the Russian Academy of Sciences

Abstract- Discovered at the contacts of the giant thermoelectric power before, because their magnitude did not fit into the thermoelectric theory, and their reproducibility was low, were attributed to "anomalous." The use of contacts obtained by microelectronics technology, namely, p-n junctions and asymmetric potential barriers, made it possible to obtain high reproducibility of the effects that were identified as thermoelectric. A large series of studies carried out on silicon p-n junctions showed that the EMF arising on the optically and electrically shielded barrier in the initial section is proportional to the magnitude of the heat flux. These thermo-EMFs, commensurate in absolute value with the photo-EMF (without an optical screen at the same p-n junction) but having the opposite sign (on a constant flux) or the opposite phase (at the harmonic one) were described by injection of the main carriers of the hotter p-n junction and were called local thermo-EMF in accordance with the local production of entropy by Ilya Prigogine. The work is aimed at growing artificial structures to create highly efficient thermoelectric converters based on local thermo-EMFs.

Keywords: *thermoelectricity, contact effects, production of local entropy*

GJSFR-A Classification : FOR Code: 020302

ANOMALIESINTHERMOELECTRICITYANDREALITYARELOCALTHERMOEMFS

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Abstract- Discovered at the contacts of the giant thermoelectric power before, because their magnitude did not fit into the thermoelectric theory, and their reproducibility was low, were attributed to "anomalous." The use of contacts obtained by microelectronics technology, namely, p-n junctions and asymmetric potential barriers, made it possible to obtain high reproducibility of the effects that were identified as thermoelectric. A large series of studies carried out on silicon p-n junctions showed that the EMF arising on the optically and electrically shielded barrier in the initial section is proportional to the magnitude of the heat flux. These thermo-EMFs, commensurate in absolute value with the photo-EMF (without an optical screen at the same p-n junction) but having the opposite sign (on a constant flux) or the opposite phase (at the harmonic one) were described by injection of the main carriers of the hotter p-n junction and were called local thermo-EMF in accordance with the local production of entropy by Ilya Prigogine. The work is aimed at growing artificial structures to create highly efficient thermoelectric converters based on local thermo-EMFs.

Keywords: thermoelectricity, contact effects, production of local entropy.

I. The History of "Anomalous"- Contact Thermo-EMFS

The roots of thermoelectric anomalies lie in the history of thermoelectricity itself. The Seebeck effect was discovered in 1821 by T.I.Seebeck. But the question of what they measured at the contacts of the electromotive force: what they are, contact or volumetric, did not initially rise. Everything indicated that this is a three-dimensional property of the material. And they began to consider - on contact thermo-EMF of volume of a material are shown.

The Peltier effect was discovered by J. Peltier in 1834. And initially, beginning with the work of the watchmaker Peltier, who is fond of physics, this reverse thermoelectric effect, due to the fact that it is measured at contacts, was considered to be contact effects.

The Thomson effect was discovered by William Thomson in 1851 and the Benedics phenomenon (in the terminology of Tautz) were recorded as independent (additional), although they are a consequence of previously discovered Seebeck and Peltier effects, but with small concentration corrections in initially homogeneous materials. These effects were considered to be volumetric, although they were also measured at contacts.

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Onsager received a fundamental thermodynamic relationship [1], the principle of symmetry of the kinetic coefficients, directly indicating the volumetric character of the thermoelectric effects being investigated, in this respect, similar electrical conductivity and thermal conductivity. However, in the theory of thermoelectricity for a long time there was a confusion between the contact and volumetric thermoelectric phenomena proper. So there have been attempts to calculate the thermoelectric power from the contact potential difference [2, 3].

These attempts did not bring success. And the analysis of the contact phenomena necessary for the analysis of semiconductor devices was singled out in a separate direction [4], which does not take into account the temperature gradients. And thermoelectricity was isolated in some independent direction [5], in which the difference in temperature at different contacts was considered, and not the temperature difference at the boundary of the same contact. In the pioneering work [6], Professor Anselm considered the limiting case - the separation of the boundaries of one contact by a vacuum gap, in which thermal effects can not be neglected. This pioneering work resulted in a new thermoemission direction, where the thermoelectric effects observed at large temperature gradients were described qualitatively well by the Langmuir and Richardson models.

However, these models did not even provide a qualitative description of the spurious thermoelectric power observed sporadically at the contacts and gave negligible currents. Therefore, they were attributed to the anomalous [7]. And although the "vacuum" semiconductor model was useful for small volume thermoelectric power [8], attempts by Mahan and his followers to optimize many contact-multilayer barrier structures in these representations [9, 10, 11] did not bring much success, the base of Richardson's formula was given by negligibly small currents.

Thus, historical confusion in the definitions of thermoelectric parameters and the inability of the theory to describe contact thermoelectric effects and sent them to the category of anomalies.

II. Experimental Observation of Thermoelectric "Anomalies"

The difference between the experimental results of thermoelectric power measurements and the predictions of the simplest, but traditionally used in thermoelectric production, is cautiously pointed out long ago. Thus, according to the data of [12], at low temperatures, with an increase in the mean free path of electrons, a change in the thermoelectric power is observed with a change in the geometry of even homogeneous, pure samples (Fig. 1) and, correspondingly, the density of heat flux through it.

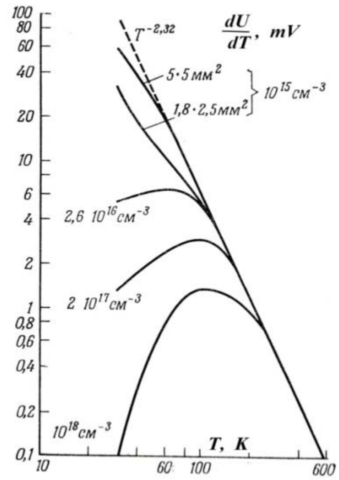

Fig.1: The change in the temperature dependence of the thermopower of weakly doped silicon with a change in the cross section of the sample.

But the electrical engineer, with incomplete higher education, but who knows mathematics well and personally launched the production of the first point-turn Ge-transistors at the same time as Bell (for which he was immediately awarded the title of Doctor of Technical Sciences, and later - the title of professor at the American University) Jan Tautz, not could be limited to the simplest thermoelectric models when designing their transistors. And in his classic book for photo-energetics [7], the results of his own measurements of anomalous, which depend on the method of measuring the thermoelectric power (Fig. 2), are presented and various variants of their description are considered.

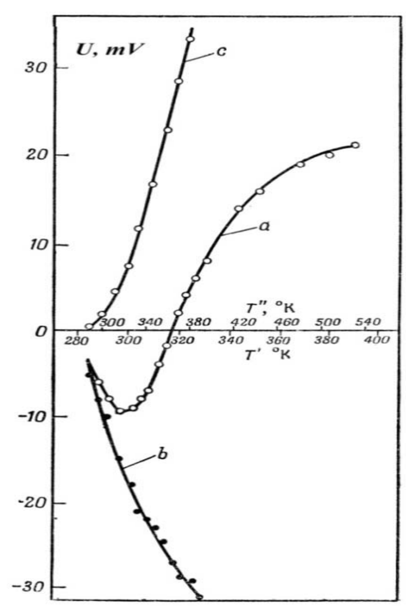

Fig.2: Measurement of anomalous thermoelectric power in germanium soldered to a radiator with a temperature T ': a - a point contact is used at the temperature T ", b - a plane contact is used at the temperature T", a is the difference between the curves a and b. It follows from [7].

So, the giant thermoelectric power observed later occasionally at the contacts was attributed to the anomalous yet by Tauz during the investigation of the first p-n junctions formed by him. And for correct explanation of these anomalous thermoelectric power it was necessary to return again to p-n junctions, in which Tauz found them, but which until recently were not found in strict explanation and, as a consequence, were not taken into account either in transistors or photodiodes. While the unobscured Tautz, even in the first experiments, their influence on the properties of semiconductor devices was noted and tried to give them a rigorous mathematical description.

Qualitatively, the appearance of significant temperature drops at micron potential barriers is knitted with the absorption and release of a giant energy of the order of the height of the potential energy barrier per electron. Taking into account the difference in temperature on the p-n junction plates, precision measurements showed a displacement of current-voltage characteristics, similar to their displacement in the photoelectric effect, but in a diametrically opposite quadrant (Fig. 3).

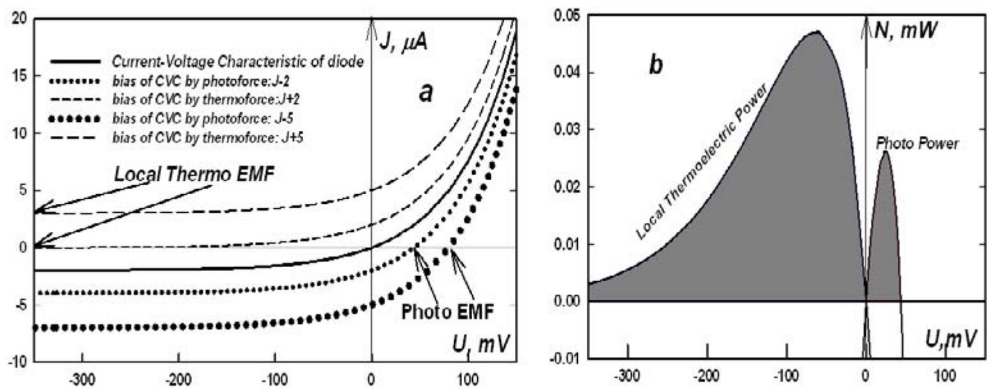

Fig.3: The bias CVCof the ideal diode by the photo-force and the thermal force in diametrically opposite quadrants (a) and generated in quadrants, where the current and voltage are opposite to the phase, the power (filled in gray in figure b). From the paper [13].

III. Theoretical Descriptions of Thermoelectric "Anomalies".

In fact, even Tautz, in an attempt to explain the thermoelectric "anomalies", introduced a model of barrier thermoelectricity [7], in parallel with Andrei IvanovichAnsel'm [7], and a model of concentration thermoelectricity (using previously recorded effects of Thomson and Benedict). But neither the predecessors of Tautz, nor himself, nor numerous followers / developers of his models, did not take into account two principal points (noted and taken into account in my last works).

First, the fact that barrier effects and concentration effects are phenomenologically related and can not be correctly described separately.

And secondly, in the framework of the traditional phenomenology of thermoelectricity, which is limited to the consideration of two equations of coupling between two thermodynamic forces and two flows: electrical and thermal, the concentration force and flux are, in the first approximation, thrown out of consideration - there is only one independent, by the Onsager symmetry principle , cross-ratio/effect Seebeck/Peltier.

And, as a consequence of these two reasons, all previously used models for describing "anomalous" thermo-emfs, in principle, are applicable only to the description of small corrections, but not as for giant deviations in the first approximation from the traditional thermoelectric effects of Seebeck / Peltier. In order to describe giant local thermo-emfs in the first approximation, and not as corrections (small) to diffuse thermoelectricity, the initial account of the concentration force [13] and the expansion of phenomenology [14] (Figure 4).

$$
\left.\begin{aligned}
J_E &= L_{EE}\cdot F_E + L_{ET}\cdot F_T + L_{EN}\cdot F_N\\
J_T &= L_{ET}\cdot F_E + L_{TT}\cdot F_T + L_{NT}\cdot F_N\\
J_N &= L_{EN}\cdot F_E + L_{NT}\cdot F_T + L_{NN}\cdot F_N
\end{aligned}\right\}
$$

Fig.4: A complete system of phenomenological equations in the canonical form: the yellow thermoelectric system of equations is highlighted in yellow, all the members of the equations (effects) ejected in the first approximation by traditional thermoelectric phenomenology are emitted.

This theoretical "anomaly" also imposed an anomaly on giant local (in particular contact) thermo-EMFs, whose existence was actually "solved" by Ilya Prigogine, introducing the concept of local entropy production [15].

A calculation of the probability of a spatial transition showed (Fig. 5),

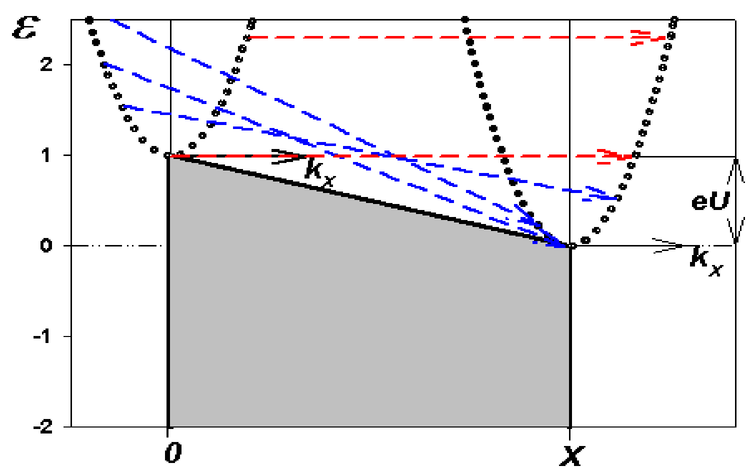

Fig.5: Consideration of spatial electronic transitions (marked by arrows) under the action of an electric field within the framework of the standard law of dispersion of free electrons.

That the electron flux over the potential barrier is concentrated at the lower energy level nearest the barrier ceiling [16] (Fig. 6).

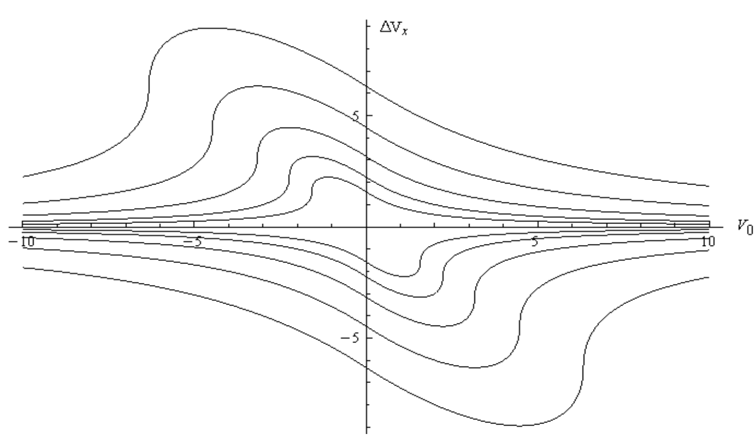

Fig.6: Dependence of the electron velocity increment on their initial thermal velocity. The potential difference for adjacent curves differs by a factor of 2.

It is this "electronic condensate", which gives currents several orders of magnitude greater than the currents of Richardson, and has translated "anomalies" into actually observed local thermo-emfs. This result not only completely closed the question of the measurability of local thermo-emfs, but also showed a higher efficiency of devices based on them than on traditional diffuse thermoelectricity, which reached its theoretical limit [13].

An investigation of micro-structured materials up to nano-level has shown that without directional anisotropy of the medium, both micro- and nano-structuring gives simply a new efficient macroscopic medium [18] all with the same macroscopic limitations of the efficiency of thermoelectric energy conversion. While a correct separation of the bulk and thermo-electrical properties of the material itself [19, 20], it was possible to construct a fundamentally new thermoelectric medium [21]. Traditional theoretical macroscopic prohibitions on the existence of a thermoelectric power in the proper contact region were removed in the works of Ilya Prigogine on the production of local entropy [15].

IV. Longitudinal Thermoelectric Effect Across the Film

A longitudinal thermoelectric effect along thin films has been used for a long time, in particular, for some detectors. However, the small diffuse effects of Seebeck and Peltier were rightly thrown out of consideration when constructing the elements of electronics. In addition, the skeptical attitude of specialists in the field of traditional thermoelectricity to measurements of the thermoelectric power across the film is also based on the concepts of volume kinetic coefficients, on the formal representation of an infinitesimal temperature drop on the semiconductor structure itself and, consequently, on the negligibly small integral thermal-EMF of the film. With this traditional approach, the formation of potential barriers at the film boundary is thrown out of consideration, which in itself gives other thermo-EMFs, and no less important, giant thermal effects at the film boundaries, in order of magnitude, corresponding to energies per electron of the order of height of the potential barrier.

However, the conducted cycle of studies of contact thermo-EMF [21, 22, 23], named according to Prigogine's representations by local thermo-emfs, confirmed both the high-voltage character of the thermoelectric power at the micron scale and the high efficiency of energy conversion on the basis of local thermo-EMFs [24].

Moreover, even the simplest energy diagram of the film device, even without taking into account the barrier effects at the semiconductor / metal boundaries, indicates the determining contribution of contact thermo-EMFs whose model based on the contact potential difference has long been described [3]. But for a correct description of the operation of the device element on the basis of "anomalous" thermo-EMFs, it is necessary to calculate the magnitude of potential barriers both at the metal-semiconductor interface and at the boundaries within the semiconductor structure and take into account the ballistic contribution to the formation of local thermo-EMFs.

Thus, it is precisely on the thin films used across the heat flux that the contact potential difference works, whereas on thick films the large contribution of the bulk diffuse thermoelectric power is determined. On the basis of this technology, it will be possible to create a higher-voltage and more efficient energy converter than suggested, for example, in [25], and possibly more efficient than real photo-detectors [26].

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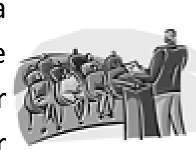

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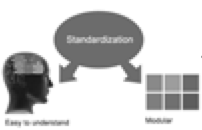

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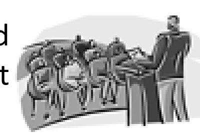

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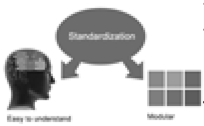

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- In case of "Difference of Opinion [if any]" among the Board members, our decision will be final and binding to everyone.

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1. General,

2. Ethical Guidelines,

3. Submission of Manuscripts,

4. Manuscript’s Category,

5. Structure and Format of Manuscript,

6. After Acceptance.

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The **Introduction** should "introduce" the manuscript. The reviewer should be presented with sufficient background information to be capable to comprehend and calculate the purpose of your study without having to submit to other works. The basis for the study should be offered. Give most important references but shun difficult to make a comprehensive appraisal of the topic. In the introduction, describe the problem visibly. If the problem is not acknowledged in a logical, reasonable way, the reviewer will have no attention in your result. Speak in common terms about techniques used to explain the problem, if needed, but do not present any particulars about the protocols here. Following approach can create a valuable beginning:

- Explain the value (significance) of the study
- Shield the model - why did you employ this particular system or method? What is its compensation? You strength remark on its appropriateness from a abstract point of vision as well as point out sensible reasons for using it.
- Present a justification. Status your particular theory (es) or aim(s), and describe the logic that led you to choose them.
- Very for a short time explain the tentative propose and how it skilled the declared objectives.

Approach:

- Use past tense except for when referring to recognized facts. After all, the manuscript will be submitted after the entire job is done.
- Sort out your thoughts; manufacture one key point with every section. If you make the four points listed above, you will need a least of four paragraphs.

- Present surroundings information only as desirable in order hold up a situation. The reviewer does not desire to read the whole thing you know about a topic.
- Shape the theory/purpose specifically - do not take a broad view.
- As always, give awareness to spelling, simplicity and correctness of sentences and phrases.

Procedures (Methods and Materials):

This part is supposed to be the easiest to carve if you have good skills. A sound written Procedures segment allows a capable scientist to replacement your results. Present precise information about your supplies. The suppliers and clarity of reagents can be helpful bits of information. Present methods in sequential order but linked methodologies can be grouped as a segment. Be concise when relating the protocols. Attempt for the least amount of information that would permit another capable scientist to spare your outcome but be cautious that vital information is integrated. The use of subheadings is suggested and ought to be synchronized with the results section. When a technique is used that has been well described in another object, mention the specific item describing a way but draw the basic principle while stating the situation. The purpose is to text all particular resources and broad procedures, so that another person may use some or all of the methods in one more study or referee the scientific value of your work. It is not to be a step by step report of the whole thing you did, nor is a methods section a set of orders.

Materials:

- Explain materials individually only if the study is so complex that it saves liberty this way.
- Embrace particular materials, and any tools or provisions that are not frequently found in laboratories.
- Do not take in frequently found.
- If use of a definite type of tools.
- Materials may be reported in a part section or else they may be recognized along with your measures.

Methods:

- Report the method (not particulars of each process that engaged the same methodology)
- Describe the method entirely
- To be succinct, present methods under headings dedicated to specific dealings or groups of measures
- Simplify - details how procedures were completed not how they were exclusively performed on a particular day.
- If well known procedures were used, account the procedure by name, possibly with reference, and that's all.

Approach:

- It is embarrassed or not possible to use vigorous voice when documenting methods with no using first person, which would focus the reviewer's interest on the researcher rather than the job. As a result when script up the methods most authors use third person passive voice.
- Use standard style in this and in every other part of the paper - avoid familiar lists, and use full sentences.

What to keep away from

- Resources and methods are not a set of information.
- Skip all descriptive information and surroundings - save it for the argument.
- Leave out information that is immaterial to a third party.

Results:

The principle of a results segment is to present and demonstrate your conclusion. Create this part a entirely objective details of the outcome, and save all understanding for the discussion.

The page length of this segment is set by the sum and types of data to be reported. Carry on to be to the point, by means of statistics and tables, if suitable, to present consequences most efficiently.You must obviously differentiate material that would usually be incorporated in a study editorial from any unprocessed data or additional appendix matter that would not be available. In fact, such matter should not be submitted at all except requested by the instructor.

Content

- Sum up your conclusion in text and demonstrate them, if suitable, with figures and tables.
- In manuscript, explain each of your consequences, point the reader to remarks that are most appropriate.
- Present a background, such as by describing the question that was addressed by creation an exacting study.
- Explain results of control experiments and comprise remarks that are not accessible in a prescribed figure or table, if appropriate.
- Examine your data, then prepare the analyzed (transformed) data in the form of a figure (graph), table, or in manuscript form.

What to stay away from

- Do not discuss or infer your outcome, report surroundings information, or try to explain anything.
- Not at all, take in raw data or intermediate calculations in a research manuscript.
- Do not present the similar data more than once.
- Manuscript should complement any figures or tables, not duplicate the identical information.
- Never confuse figures with tables - there is a difference.

Approach

- As forever, use past tense when you submit to your results, and put the whole thing in a reasonable order.
- Put figures and tables, appropriately numbered, in order at the end of the report
- If you desire, you may place your figures and tables properly within the text of your results part.

Figures and tables

- If you put figures and tables at the end of the details, make certain that they are visibly distinguished from any attach appendix materials, such as raw facts
- Despite of position, each figure must be numbered one after the other and complete with subtitle
- In spite of position, each table must be titled, numbered one after the other and complete with heading
- All figure and table must be adequately complete that it could situate on its own, divide from text

Discussion:

The Discussion is expected the trickiest segment to write and describe. A lot of papers submitted for journal are discarded based on problems with the Discussion. There is no head of state for how long a argument should be. Position your understanding of the outcome visibly to lead the reviewer through your conclusions, and then finish the paper with a summing up of the implication of the study. The purpose here is to offer an understanding of your results and hold up for all of your conclusions, using facts from your research and generally accepted information, if suitable. The implication of result should be visibly described. Infer your data in the conversation in suitable depth. This means that when you clarify an observable fact you must explain mechanisms that may account for the observation. If your results vary from your prospect, make clear why that may have happened. If your results agree, then explain the theory that the proof supported. It is never suitable to just state that the data approved with prospect, and let it drop at that.

- Make a decision if each premise is supported, discarded, or if you cannot make a conclusion with assurance. Do not just dismiss a study or part of a study as "uncertain."
- Research papers are not acknowledged if the work is imperfect. Draw what conclusions you can based upon the results that you have, and take care of the study as a finished work
- You may propose future guidelines, such as how the experiment might be personalized to accomplish a new idea.
- Give details all of your remarks as much as possible, focus on mechanisms.
- Make a decision if the tentative design sufficiently addressed the theory, and whether or not it was correctly restricted.
- Try to present substitute explanations if sensible alternatives be present.
- One research will not counter an overall question, so maintain the large picture in mind, where do you go next? The best studies unlock new avenues of study. What questions remain?
- Recommendations for detailed papers will offer supplementary suggestions.

Approach:

- When you refer to information, differentiate data generated by your own studies from available information
- Submit to work done by specific persons (including you) in past tense.
- Submit to generally acknowledged facts and main beliefs in present tense.

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Methods and Procedures	Clear and to the point with well arranged paragraph, precision and accuracy of facts and figures, well organized subheads	Difficult to comprehend with embarrassed text, too much explanation but completed	Incorrect and unorganized structure with hazy meaning
Result	Well organized, Clear and specific, Correct units with precision, correct data, well structuring of paragraph, no grammar and spelling mistake	Complete and embarrassed text, difficult to comprehend	Irregular format with wrong facts and figures
Discussion	Well organized, meaningful specification, sound conclusion, logical and concise explanation, highly structured paragraph reference cited	Wordy, unclear conclusion, spurious	Conclusion is not cited, unorganized, difficult to comprehend
References	Complete and correct format, well organized	Beside the point, Incomplete	Wrong format and structuring

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