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On Interaction of Motional Masses

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Abstract

This paper supposes an "electrodynamics-like" interaction of motional masses. A development possibility of linear, vector gravitation theory (gravitodynamics) is discussed and the force field (gravito-Lorentz) on this basis is defined. Some direct consequences of the equation of motion are obtained and analyzed in brief and the existence of an important *exp-factor* is mentioned. It is proposed new transformation *χ-factor* which could lead to the more general dynamical picture. The dimensional analysis shows that magnetic-like field vector has frequency dimensions. The proposed wave function describes the state of space around the motional masses. As frequency appears in both quantum and gravitation picture of the substance, the *principle of resonance* arises as a natural, so its possible direct consequence could be the *natural existence of Planck's values* as the main quantums. Finally, this paper also discusses a possible connection between principle of resonance, *creation (origin) of mass* and Heisenberg's principle.

Keywords: gravitodynamics, general relativity, γ-factor, exp-factor, χ-factor, principle of resonance, Planck's values, creation (origin) of mass

Preamble

This paper is just partially altered form of the original written in early 1980s. The *Addendum* is completely new but also represents contemporary author's researches. The original one was directly sent to the Proceeding Royal Society, but rejected (May 1983) as ineligible by referee system regulations. During 1980s the author (then in his early 20s) was independently developing the vector gravity idea (with mass exp-dependency on G-potential, 1980)**, being completely unaware of Heaviside's work as well as of similar efforts. During 1990s, publications of Jefimenko's book as well as of works by different authors, such as Strel'tsov, Potjekhin, de Matos and Tajmar, Vankov and many others (*Add. Ref. Tot.*), brought vitality to this theme, but, in author's humble opinion, its fundamental consequences were not acquired. Since the modern Internet generally opened information flow, including international scientific community being enriched with original and creative ideas, this author, from 1999 on, has been reviving his disrupted researches. He is hoping that discoveries might illuminate misty roads towards highest cognition of gravitational physics as well as to Nature in general.

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** The first version of this work was introduced to J. Brana, Ph.D. (Sarajevo Faculty of Physics). In mid-80's the late professor Dj. Zivanovic (Belgrade Faculty of Physics) was communicating with the author, including correspondence with late B. Lalovic, Ph.D. (Nuclear Institute Vinca, Belgrade) and one long session with M. Blagojevic, Ph.D. (Belgrade Institute of Physics). The end of 1980s was marked with very intensive and fruitful discussions, including written correspondence with R. Ankajcan, M. Sc. in theoretical physics and N. Simonovic, Ph.D. (Belgrade Institute of Physics).

Introduction

If development of the gravitational interaction idea has been followed since the Newton's law in the scalar form (Feynman 1965):

$$F = \frac{Gm_1 m_2}{r^2} \tag{I.1}$$

(with an obvious meaning of G – the Newton's gravitational constant; m_1, m_2 – masses in the interaction and r – a distance between two point-like masses) or more like Faraday's fields-picture (Supek 1980):

$$\begin{aligned} \vec{F} &= m\vec{G} \\ \Delta\phi &= -4\pi G\rho \\ m_i \vec{a} &= -m_g \nabla\phi \end{aligned} \tag{I.2a,b,c}$$

(where $\vec{G}$ is 3-vector of the "gravitostatic" field, $\phi(r) = -GM/r$ is a classical scalar potential of the spherical mass M, m is a gravitational mass, ρ is related mass density and $\vec{a} \equiv \ddot{\vec{r}}$ is 3-acceleration of some point-like particle; (I.2c) is the equation of motion of the test particle; so, system (I.2) is a full description of the "classical field of gravitation", *i.e.* "gravitostatics" in case m = const and $m_i = m_g$) end further, it could be found out that an essentially new and widely accepted matter was given by Einstein only, with his procedure of the general relativity of motion (Born 1948). On the basis of the equivalence principles ($\vec{a} = \vec{G}$) the theory of the gravitational field has been developed consequently. The gravity is connected closely with the space-time metrics here. It has been got to a certain deep equivalence of geometry and gravitation (Einstein 1917, Infeld 1979). As it is known, general theory of relativity (abbr. GTR) inherits a definition of the source from Einstein's special theory of relativity (abbr. STR) energy-impulse concept. The symmetric rank - 2 tensor T_{ik} mostly defines GR's Einstein's choice about final form of the GTR's equations (Einstein 1916):

$$R_{ik} - g_{ik} R = \frac{8\pi}{G^4} T_{ik} \quad i, k = 0,1,2,3 \tag{I.3}$$

The equation of motion in this theory is strictly defined by metrical tensor g_{ik}, *i.e.*

$$\frac{d^2 x_i}{ds^2} + \Gamma^i_{kl} \frac{dx_k}{ds} \frac{dx_l}{ds} = 0 \tag{I.4}$$

and that is the main reason why one might think of it as a “metrical theory of gravitation”. So, it is obvious that Einstein’s main direction presumed *geometry* over *physics*, which finally led to the *non-linear* theory of gravitation. But at the very beginning of this review, an essential physical problem can be noticed. Before considering “general relativity”, or even before STR itself, *i.e.* already within the framework of the “classical, late XIX century physics”, we have to discuss a question of physical consequences of the relative motion of masses. As for (I.1 and 2) relations, the question could be asked more precisely: Which are dynamical gravitational effects of the motional masses? Its only consequence, in the scope of the Newton’s theory, is the change of the force quantum (I.1), *i.e.* static potential, because of the change of the distance. The change is quantitative only. From a viewpoint of contemporary physics, it seems quite unnatural. A simple fact has dropped out of the sight, considering that the relative motion (and rotation) of masses exerts certain qualitative influence on their interaction (clear electrodynamics analogy). A special interaction close connected with (I.2) could be regarded as new quality, in terms of physics. The concept proposed in this paper elaborates such interaction (*i.e.* gravitodynamics, abbr. GD) and its main qualitative and some quantitative consequences.

1. Force field of motional masses

Since it is expected to have special interaction of motional masses, emphasizing, at the same time, the character of the field, it is naturally for mass (ρ) and currents ($\vec{j}$) densities to be considered as “sources” of the gravity field. An analogy to the electrodynamics can be easily noticed. The following Maxwell-Heaviside’s system could be used as an assumption:

$$\begin{aligned} &\nabla\cdot\vec{G} = -4\pi G\rho \\ &\nabla\cdot\vec{B}_g = 0 \\ &\nabla\times\vec{G} + \frac{\partial\vec{B}_g}{\partial t} = 0 \\ &\nabla\times\vec{B}_g - \frac{H\partial\vec{G}}{G\partial t} = -4\pi H\vec{j} \end{aligned} \qquad (1.1a,b,c,d)$$

with careful sign choice because of the gravity attractive nature. As generally accepted (Purcell 1965), system (1.1) leads to the inhomogeneous wave equations for the “empty space”

$$\nabla^2 \vec{G} - \frac{1}{c_g^{\ 2}} \frac{\partial^2 \vec{G}}{\partial t^2} = 0$$

$$\nabla^2 \vec{B}_g - \frac{1}{c_g^{\ 2}} \frac{\partial^2 \vec{B}_g}{\partial t^2} = 0 \qquad (1.2)$$

The constant H (to the honor of O. Heaviside), which characterizes the gravitomagnetic field, has also very important meaning:

$$H = \frac{G}{c_g^{\ 2}} \qquad (1.4)$$

where c_g would be propagation-speed of the gravity phenomena. The simplest symmetrical idea leads to the identity

$$c_g = c \qquad (1.5)$$

where c is speed of light. This very important conceptual question has to remain opened for the further theoretical and experimental investigations. To complete linear vector-field picture proposed here, we could introduce the gravito-Poynting vector

$$\vec{P}_g = \frac{c^2}{4\pi G} \vec{B}_g \times \vec{G} \qquad (1.6)$$

and also gravito-energy density

$$w_g = -\frac{1}{8\pi G}(\vec{G}^2 + c^2 \vec{B}_g^{\ 2}) \qquad (1.7)$$

The $\vec{B}_g$ (gravitomagnetic, gyro-like) vector is the main characteristic of the force field which influences on a particle with the 3-velocity v. From the main assumption follows:

$$\vec{B}_g = H \frac{\vec{r} \times M\vec{v} + \vec{S}}{r^3}, \quad \vec{r} \perp \vec{S} \qquad (1.8)$$

where $\vec{v}$ is strictly relative, reference frame dependant value, M is a mass and $\vec{S}$ is spin angular momentum of the source. Following electrodynamics analogy the vector potential $\vec{A}_g$ could be introduced here, with

$$\vec{B}_g = \nabla \times \vec{A}_g \qquad (1.9)$$

and

$$\vec{A}_g = -H\frac{M}{r}\vec{v}, \qquad \vec{S} = 0 \qquad (1.10)$$

In complete accordance with a gauge characteristic of the proclaimed potentials, i.e. under the Lorenz gauge condition

$$\nabla\cdot\vec{A}_g + \frac{1}{c^2}\frac{\partial\phi}{\partial t} = 0 \qquad (1.11)$$

system (1.2) could be expressed (for the "empty space") as

$$\begin{aligned} \nabla^2\phi - \frac{1}{c^2}\frac{\partial^2\phi}{\partial t^2} = 0 \\ \nabla^2\vec{A} - \frac{1}{c^2}\frac{\partial^2\vec{A}}{\partial t^2} = 0 \end{aligned} \qquad (1.12)$$

These relations, however, are still of formal nature, though the analogy to the Maxwell's system[1] is very interesting. The point question of the further generalization is referred to the actual nature of the mass (inertion). Its fundamental solution still does not exist (Feynman 1965, Supek 1974)[2]. Therefore, the question is the following: whether this kind of discussions and reconsideration could lead us on the way toward better comprehension of the problem?

2. The gravito-Lorentz force and equation of motion

The total force of the central character which influence on the test particle m can be defined by the relation:

$$\vec{F}_g = m\vec{G} + m\vec{v}\times\vec{B}_g \qquad (2.1)$$

It has to be stressed out that "the right choice of mechanics" on the left side of the relation above, defines deeper meanings and effects of the force field proposed here. But now, we should formulate a more general equation of motion. Even before STR, it could be

$$d\,\vec{p}/dt = m\vec{G} + m\vec{v}\times\vec{B}_g \qquad (2.2)$$

Explicitly, considering (1.8), for a non-rotating ($\vec{S}=0$) spherical symmetric mass M and for test particle $m<<M,$ follows

$$m_i\,d\,\vec{v}/dt + \vec{v}\,dm_i\,/\,dt = -m\frac{GM\vec{r}_0}{r^2}(1-v^2/c^2) \qquad (2.3)$$

[1] All of this could be expressed trough the well-known 4-D vector-tensor formalism of the STR (Add. Ref. Ankajcan 1990, Strel'cov 1999), but our intention is to go behind of any "relativistic theory".
[2] Written during early 80s, but in author's opinion still actual (2000/4)

The above stated relation is very interesting and makes us to face series of open questions. Even for small amounts of velocity and for $\vec{B}_g = 0$, this relation basically *never* turns to the Newton's equation of motion (I.2c) on the base of which Einstein derives the "principle of equivalence" (with a general assumption that the masses of inertia and gravitation are identical). In author's opinion, full meaning of the $\vec{v}\, dm_i / dt$ is crucial for complete understanding of the general dynamics of particles. Classical electrodynamics leads, trough the Lorentz-Poincare-Einstein theory (Einstein 1917), to the well known

$$\vec{p} = m_0 \vec{v} / \sqrt{1-\beta^2} \tag{2.4}$$

where m_0 is a rest (or proper) mass of a particle, and $\beta = v/c$. But the author's simple analysis from early 80s (*Addendum*) of the "relativistic" free fall (Add. Ref. Ankajcan 1988-90, Simonovic1991) clearly introduces one new and, obviously, very interesting fundamental relation

$$m = m_0 \exp(-r_g / r) \tag{2.5}$$

with $r_g = GM / c^2 r$. Considering two last relations, we could here postulate one new and general transformation factor[3]

$$\chi = 1 / \sqrt{\exp(2r_g / r) - \beta^2} \tag{2.6}$$

which should lead us to the completely new area of one general theory, *i.e.* electro-gravitodynamics (abbr. Electro-GD)[4]. In the case that $v \approx c$, and considering (2.6) or (2.4 and 5), equation of motion obviously leads to the qualitatively and quantitatively new dynamical effects. For example, rotation of a both source and test particle influences to their moving. In some cases, comparing classical and gravitodynamical picture, one could say that "rotation causes anti-gravitation". It is also evident that the discussed effects are very slight. They are more apparent in the "relativistic" cases only. And just here they are expected to be checked experimentally. Although the question of the three well-known GTR classical tests is very important, its full analysis remains out of the scope of this conceptual review. However, briefly, it is quite clear that (2.3) leads to:

1) Planet's perihelia precession, which is a very complex issue of celestial mechanics, is far away from simplifications given by standard GTR reviews. It is also rather

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[3] As this author believes, that would be his first appearance

[4] If we accept this proposal seriously, we can see that so-called STR limitations are wrong *per se*. For instance, because of $\exp(2r_g / r) \geq 1$, a conclusion could be that speed of light is not any kind of barrier at all.

obvious that all gravitomagnetic effects, such as Lenz-Thirring's, are inclusive (Braginski and Polnarev 1985).

2) (2.5), according to the author, explains gravitational redshift, or, vice versa, the shift proofs "interaction of all masses" (including photon's) in G-field (recalling Mach's old idea but now completely implemented in physical reality, in the paradoxically opposing mode of "mass exhausting"), and lastly
3) Opened issue of gravitation caused light beam deflection. A possible explanation of the above mentioned phenomenon should be both of crucial importance for our picture of world and of practical difference between theoretical concepts of gravitation. Above proposed χ -factor could be of the crucial importance because of a clear possibility that c is not speed barrier at all, *i.e.* a photon could possess a rest mass!

Vector GD is absolutely irreducible either to Newton's classical theory, or Einstein's kinematic-geometrical GTR conception. Therefore, the above stated concept is fully competitive gravitation theory, i.e. a reliable part of one wider dynamical picture.

3. The nature of B_g – field

In order to understand better the nature of the field in question, a dimensional analysis of the (1.8) relation should be performed. The conclusion follows:

$$\left[\vec{B}_g\right] = T^{-1} \tag{3.1}$$

The $\vec{B}_g$ - vector has dimensions of frequency. That fact is very interesting, first of all, because of the natural way of introducing of the vector. From the system (1.1c,d) standpoint it is, in a certain way, justified mathematically, too. The curl of the $\vec{G}$ - vector is just a differential quotient of a vector with dimensions of frequency. So, each space point around the motional mass is characterized by certain frequency. In a certain way, each point of the surrounding space vibrates. A description of that phenomenon of vibration could be given by the equation:

$$f = A\cos 2\pi B_g t \tag{3.2}$$

The equation represents sort of harmonic oscillator and it is valid for the point around a source mass M determined by the $\vec{r}$. We are interested in the physical meaning of the f elongation which is here a measure of deviation of the radius-vector from a definite position at a definite time. The definite position is that one, which a point (or r) could get in the (v

$= 0$) case. A mathematically more universal relation could be derivated, if a complex form of the (3.2) relation is found out. From the Euler's formula follows directly the wave function (Crawford 1968):

$$\Psi_g = A\exp(2\pi i B_g t) \tag{3.3}$$

This, or a similar approach, the author marks as an entrance to, up to the time, not researched field of gravitational, say G - wave mechanics. In a similar way, following (3.1) and harmonic oscillator equations (3.2 or 3), we could expect a deeper connection between two until now completely separate worlds – Quantum and Gravity.

4. Principle of Resonance

Knowing from the above general assumption that the masses motion causes in principle a new quality, the result is that the quality has its own wave (oscillation) characteristic – frequency. The situation is to some extent analogue to De Broglie's postulate of the wave aspect of the substance (de Broglie 1954, Shpolskiy 1984). That aspect was already formulated clearly in main relations for frequency:

$$\nu = \frac{E}{h} \tag{4.1}$$

and for wave length:

$$\lambda = \frac{h}{p} \tag{4.2}$$

where h – Planck's constant . The frequency naturally appeared in the area of quantum and gravitation. This fact seems to be quite fundamental. A principle of resonance could be postulated rightfully:

$$\nu = B_g \tag{4.3}$$

which means a direct natural connection between the quantum and gravitation characteristics of the substance. If a substitution from the (1.8) and (4.1) relations into (4.3) one is made, than it is (in general case of two different particles):

$$\frac{mc^2}{h} = \gamma\frac{\vec{r} \times M\vec{v} + \vec{S}}{r^3} \tag{4.4}$$

If $S = 0$, when settled by the r, it follows:

$$r = \left(\frac{GhMv}{c^4 m}\right)^{1/2} \tag{4.5}$$

where negative root is skipped. The distance *r* is realistic and maximal when $v \approx c$ and $M >> m$. That case is just interesting for us and it means the greatest distance from the center of the mass M, where de Broglie's frequency of the test particle can not be differed from the extern B_g any more. Obviously, it is impossible for any smaller distances. If $S \neq 0$ and $v = 0$ then (in a simplified scalar form)

$$r = \left(\frac{GhS}{c^4 m}\right)^{1/3} \qquad (4.6)$$

So the places of the "total resonance" of the particles are determined by the (4.5 and 6) relations. It is obvious that it leads to the strong GD area. Very important special case of (4.5) is $v = c$ and $M = m$. Within the STR, this is the case of photon or generally all particles without rest mass. However, according to the author, GD (2.5) leads to the deeper revision of the mass concept as well as whole mechanics. Nevertheless, from (4.5) directly follows fundamental length

$$r = \left(\frac{Gh}{c^3}\right)^{1/2} \qquad (4.7)$$

which makes sense of deep quantum level of reality. First of all, *r* (4.7) is Planck's length r_P, if we use reduced $\hbar$ instead of *h*. Thus, in a certain way, this length is represented as basic length quantum. Whole picture of "resonance" might be seen from the viewpoint of a single body (particle). In that case, a particle does not need to relatively move ($v=0$) at all but to rotate only ($S>0$). For radius, it is identical as (4.6), just *S* and *m* are now "eigenvalues". According to the author's understanding of the quantum objects world, Planck's constant has clear physical meaning of angular momentum quantum. In other words, *h* (*i.e.* $\hbar$) could be regarded as pseudo-vector, *i.e.* as a source of B_g field.

From (4.4) or (4.6) then follows:

$$r = \left(\frac{Gh^2}{2\pi c^4 m}\right)^{1/3} \qquad (4.8)$$

Determining *r* in this way, it represents the position of a particle's resonance and its B_g vortex. For instance, electron (the smallest known mass) has $r \approx 10^{-28}\, m$. If we rise a question for which mass the resonance radius is equal to Planck's length, then directly follows

$$m_P = \left(\frac{c\hbar}{G}\right)^{1/2} \quad (4.9)$$

which is Planck's mass. For all masses over the m_P, resonance would be produced in cases of radius being below r_P, so that it is legitimate to ask if it is certain distance limit. Therefore, there is one more reason to regard herein-postulated resonance principle as deeply natural, opening the next theme of this review.

5. Resonance (4.3) and rest mass

The (4.4) relation is allowed by the above mentioned explanation to be reinterpreted. To be clearer, it can be transformed into the following form:

$$m = Gh\frac{\vec{r} \times M\vec{v} + \vec{S}}{c^4 r^3} \quad (5.1)$$

where *m* now is the "mass of resonance". For simplification $S = 0$, and after substitute (2.5) into (5.1) follows:

$$m_0 = \frac{GhMv}{c^4 r^2}\exp(-r_g / r) \quad (5.2)$$

And once again, it is obvious that (5.1) and (5.2) lead to the strong GD area. According to the known value ranges of the three fundamental constants, these relations are valid for $r = r_g$ and $v=c$ only. Hence,

$$m_0 \approx \frac{ch}{GM} \quad (5.3)$$

The question could be, *e.g.*, what value must M be to generate, at a distance of its r_g, mass equal to an electron's mass. This, applied to (5.3), follows to

$$M_e \approx \frac{ch}{Gm_e} \quad (5.4)$$

where is, according to the value of the natural constants, $M_e \approx 3.27\times 10^{15}\, kg$. Also, it could be marked that the gravitational radius r_g of the M_e is identical to the electron's Compton-wavelength

$$r_g = \lambda_e = \frac{h}{m_e c} \quad (5.5)$$

Following same direction, it is possible to conclude that the smallest mass which can generate some other mass (or better say, *auto create* itself) is Plank's mass, *i.e.* from (5.3), if $M = m_P$, follows $m_0 \approx m_P$. It is obvious that gravitational (or resonance) radius in this case must be Planck's length.

It seems that through GD, Nature guides to significant direction: the Resonance phenomenon (4.3) is profoundly associated to mass generation. Substantial issue is whether mass is outer or inner body feature. The exp-factor (2.5) seems to mainly support the inner one. Other very significant issue includes the existence of rest mass for relativistic borderline of $v=c$. It is generally accepted that such bodies (particles) do not have rest mass, being determined by Lorentz's γ - factor. According to the author's opinion, specially in the light of (2.6) *i.e.* χ - factor, all of that is an ultimate simplification of the real world. The future author's works will prove that all the restrictions of the STR are the consequence of limited scopes instead much wider dynamical one. This wider scope leads to the direction completely opposite to the established GTR paradigm, *i.e.* opposite to any a priori *geometrisation*.

So, to comprehend conditions and circumstances referring to the resonance (4.3), means to be able to understand the appearance of the rest (proper) mass. The problem requires deeper insight into connection of all interaction dynamics.

6. Principle of Indetermination and Resonance (4.3)

Certainly it is of a great interest to discuss the Heisenberg's principle of indetermination in light of herein-proposed resonance. Possible quantum character of the space (and time) will naturally exert influence on some of main physical laws. Now it is clear that the minimal time interval, within which we can still have an information about the examined system should be

$$t_P = \frac{r_P}{c} \tag{6.1}$$

So, from the principle of indetermination point of view, it is the least time indetermination, or, in principle, the greatest possible precision of measurement. According to the Heisenberg's relation (Landau and Lifshitz 1966, Shpolskiy 1984), the greatest possible energy fluctuation during that time (maximal indetermination) is:

$$E_p = \frac{h}{t_p} \tag{6.2}$$

On the basis of the m_P mass, the impulse ("a photon case") could be expressed as

$$p_P = m_P c \tag{6.3}$$

and according to Einstein's STR, the energy:

$$E_P = m_P c^2 \tag{6.4}$$

The p_P and E_p constants are on the "upper limitation" of the indetermination principles. At the same time, the constants denote direct problem solution, referring to indefinite values of the mass and energy of quantum electrodynamics (Feynman 1965, Supek 1974). The insert of the virtual photon in the electron mass-energy can not be greater than m_P.

So, the limitation of the space-time continuity is considered to be the cause of indetermination limiting of the main system characteristics (m_P, p_P, E_p). It is not only a description, but also a fundamental principle of their behaviour. Accordingly, the r_P and t_p constants should take a special role in more comprehensive physical picture of the world.

Conclusion

The main intention of this conceptual survey is to point out the necessity to change paradigm related, first of all, to the gravitation phenomenon. By temporary usage of the late 19th century concepts, the author searched for the basis to return to the natural way of development of physics. In a simple manner,

FIELD LAWS (PHYSICS) $\longrightarrow$ *TRANSFORMATIONS (GEOMETRY)*

This could be understood as a goal of the development of herein proposed gravitodynamics. The exp-factor existence in mass expression and above proposed transformation factor $\chi = \left(\exp(2r_g / r) - \beta^2\right)^{-1/2}$, seems to guide to this direction. GD is regarded to be completely competitive theory, opened to all kinds of researches. It represents a comeback to dynamical concepts that have always been the basis of real breakthroughs into new fields. The author has made an effort to find and point out to the workable connection with other significant fields of physics. In that sense, the resonance of gravitomagnetic field and De Broglie's wave naturally arises. Although this might look like speculation, the author is deeply convinced that the above mentioned concept proposal returns physics to itself. It seems that a natural appearance of the Planck's values strongly supports herein-explained concept. Therefore, the place could be made for a completely original G - wave mechanics as a complementary to quantum mechanics (*i.e.* h-wave mechanics). Speaking of crucial experiment, before all, examination equation of motion for strong fields (or rehabilitating of range Φ^2) should be of ultimate benefit.

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[5] The reference herein proposed and used mainly represents the literature available to the author during the early 80s. The list could be significantly extended, but it does not have basic influence on the methods of key insights.

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Addendum

If we observe a free point-like test particle of a mass *m* in a spherical symmetric gravitational field produced by a solid spherical mass $M >> m$ then, considering famous $E = mc^2$ and gravitational energy $E_{pot} = -G\frac{Mm}{r}$, and respecting energy conservation law, follows

$$c^2 dm = GMd\left(\frac{m}{r}\right) \tag{A.1}$$

After differentiation and because of $G\frac{M\,dm}{r} \approx 0$, we obtain

$$c^2 dm = G\frac{Mmdr}{r^2} \tag{A.2}$$

Rearranging and integrating under the limits $m \to m_0$ and $r \to \infty$, *i. e.*

$$\int_{m_0}^{m} \frac{dm}{m} = G\frac{M}{c^2}\int_{\infty}^{r} \frac{dr}{r^2} \tag{A.3}$$

we get very important

$$m = m_0 \exp(-r_g / r) \tag{A.4}$$

where $r_g = GM / c^2 r$. Well, Relativistic Dynamics leads to the conclusion that all masses are under the clear mutual influence, but just opposite to the famous Mach's idea and later Einstein's expectations. Exactly the same result could be derived if, as a starting point, we use equation of motion (2.2 or 3) but for the one-dimensional case *r* only. Then would be $dA = \vec{F} d\vec{r}$, where $\vec{F} = GMm / r^2$ and because of $c^2 dm = dA$, which leads to the above (A.4). Once the rest (proper) mass variation is taken into account, a gravitostatic force is

$$F_G = \frac{GMm_0}{r^2}\exp(-r_g / r) \tag{A.5}$$

Static potential in this picture could be introduced (Add. Ref. Simonovic 1991) as

$$V_r = c^2\left(\exp(-r_g / r) - 1\right) \tag{A.6}$$

which should lead us to the very interesting new gravitokinematics. Namely, it is not so complicated from the above to get next relations (for the same one-dimensional case of free test point-like particle) for the "limit velocity" and acceleration, respectively:

$$v = c\sqrt{1 - \exp(-2r_g / r)} \quad (A.7)$$

$$a = G\frac{M}{r^2}\exp(-2r_g / r) \quad (A.8)$$

It is obvious that in the weak field limit *i.e.* $\exp(-2r_g / r) \approx 1 - 2r_g / r$, (A.7) leads to the Newton's classical picture. But (A.8) remains out of it. It is important to emphasize that GTR and herein-expressed concept are different in principle. Under weak field conditions it is hard to distinguish between them, but not impossible in the scope of modern technology. In the strong field area, herein-proposed gravitodynamics and deeper consequences, like eventual general Electro-GD or some sort of G - wave mechanics, should prevail.

Once again, the author repeats that all of these are his own researches from the last two decades (Preambul, Add. Ref. Ankajcan 1988-90, Simonovic1991). But as far as author's present knowledge concerned, one who first published (A.4) was Nordström (Add. Ref. Brans 1997, Vankov 2003). His efforts were strictly rejected by Einstein and others, and finally by Nordström himself. Of course, it was in favour of GTR tensor-source concept and further *geometrisation*. During recent period of time, from different reasons and in a different manner, few authors introduced or analysed the same as (A.4), see (Add. Ref. Hatch 2000, Kiesslinger 2000, Richterek and Majernik 1999, Vankov 2003).

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