4. Principles of Physics

Abstracts: The Standard Model seems to explain nature precisely. However, a fundamental revision is appropriate because neither the accepted assumption of classical physics, the equivalence of inertial mass and gravitational mass, nor the used quantum conditions of microscopic physics appear as valid hypotheses. The fundamental field of nature (UF) consisting of the electromagnetic field and the covariant gravitational field is generated by four types of sources. Each source = quantum of the field, represented through the four stable particles e, p, P and E, has two invariant Maxwell charges. The source quantization leads to variation principles of open physical systems in finite space-time domains and discovers beside the Planck's constant h a second basic constant $h^0 = 1/4\sqrt{2}\, x\, q^2/c$ which is responsible for the neutrinos as bound states. The centralization of the UF and of the four stable particles in physics is resulting in an investigation of two sets of hypotheses, the set of historical gathered assumptions and a set of new fundamental hypotheses which leads to Principles of Physics.
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The Standard Model of Physics seems to explain nature precisely. However, criticism has to be made on the historically gathered hypotheses which are not solely marginal but fundamental. The accepted assumptions were analysed in order to avoid basic discrepancies and impermissible generalizations. First, the usage of the accepted interactions corresponding to different (or not fixed) Riemann's metric was criticized. The result led to the manifest covariant fundamental field (UF) consisting of the electromagnetism and the gravity generated through the four stable particles with two kinds of Maxwell charges. The consequence of the covariant gravitational field causes a violation of the Universality of Free Fall (UFF), Refs. **[1, 2]**. The composition dependent non-equivalence of the inertial and gravitational mass is verified by the author in a fall experiment in Ref. **[12]**. Since all microscopic objects are essentially smaller than the characteristic wave lengths of their radiation, a dominance of the wave character of the electromagnetic field must be assumed in all microscopic processes. The explanation of line spectra is hence connected to the source quantization, to the restrictions of physical descriptions onto finite space-time domains and to the usage of open systems, Refs. **[3, 4]**. The calculus of variation in Ref. **[5]** leads with isoperimetric subsidiary and natural boundary conditions to Lagrange multipliers, corresponding to the Planck's constant h, and to a second fundamental constant h^0. The latter constant is responsible for the neutrinos and for the nuclear forces, Ref. **[3]**. The assumed universality of h and of Heisenberg's uncertainty relation appear as undue generalizations. A set of new basic hypotheses flows in the New Model centralizing the fundamental UF in physics and the four point-like stable elementary particles with two Maxwell charges: the electron (e), positron (p), proton (P) and the negative charged proton with the name elton (E). These particles are the sources of the UF, quantizing it and being able to elucidate many features nowadays unknown. The New Model is an attempt to fix the Principles of Physics.

The historically gathered assumptions in the accepted Standard Model are collected for the analysis in different groups. The summary is in all probability incomplete. Statements quoted with () are either consequences or explanations.

The principal lack of knowledge remaining within and outside the Standard Model is quoted with {}.

Principles on physical descriptions:

No principle restrictions onto finite space-time domains exist.

The usage of closed systems is a fundamental tool in physics.

The accepted interactions with associated properties:

Several {at least four} fundamental interactions exist:

- The electromagnetic field with the propagation c in the Minkowski space,
- The geometrized gravity in a curved space depending on the mass distribution,
- The weak and the strong interactions restricted onto microscopic domains,
- The latter two interactions have intrinsic symmetry properties, no metric defined.

(An attempt exists for a unification of the weak and electromagnetic interaction.)

{The interaction between quarks is essentially unknown. A "fifth" interaction is sought to explain the deviations of the accepted theory of gravity and observations.**}**

The accepted particles and their properties:

Atoms with shell and nucleus do exist. Four stable and a great number of unstable mass particles exist. Each particle has intrinsic properties and its antiparticle. The photon is a mass-less particle. **{**Do the neutrinos have masses or are they mass-less?**}**

Each particle has an electric charge and an intrinsic structure: spin, quantum numbers.

The fundamental or elementary particles are the various quarks. **{**or strings?**}**

{How are the spins and quantum numbers of particles determined by the quarks?**}**

The accepted properties of the space and time continuum:

At least two different Riemann's type of metric exist, one for the electromagnetism and the other for gravity. (In nature a unique existing metric would be reasonable.)

{The microscopic interactions do not fix a metric in small domains of space and time.**}**

Further accepted assumptions:

In classical physics the Universality of Free Fall (UFF) is valid for each material composition since Philoponus/Galileo Galilei. Kepler's third law R^3/T^2 is exactly valid for all planets.

Newton's law of gravitational force is

$$F = - G m^g M^g / r^2 .$$

In Euler's formulation the Lex Secunda

$$m^i \mathbf{a} = \mathbf{F}$$

describes the motion of a body. The equivalence of inertial mass m^i and gravitational mass m^g (WEP) is valid and define the gravitational constant G.

(With a constant G, WEP is valid only if the UFF is also valid.) From the Equivalence Principle based on WEP follows GTR and the geometrized theory of gravity.

The propagation of the electromagnetic field is finite and has the constant value c.

The energy-mass-equivalence-relation is valid for each mass and also for the rest mass.

According to
$\Delta E = \Delta mc^2$,
each particle can be created and annihilated, see Einstein's derivation in 1946.
The Planck's constant h has a universal character in each microscopic process.
There exist photons with the energy $h\nu$ and the electromagnetic field is quantized.
The canonical coordinates of mass particles fulfil the universal Heisenberg's uncertainty relation with h. All particles have intrinsic angular momenta proportional to h.
Two kinds of statistic exist, the Bose-Einstein and the Fermi (for spin 1/2 particles).
All fields describing interactions between particles are quantized **{**up to the gravity?**}**.
All microscopic interactions **{**up to the gravity**}** are described in this context with creation and annihilation of particles (field quantization and second quantization).
{The metrics defined by microscopic interactions are unknown.
What about the propagation velocity of gravitational field? Is it c or infinite?
The quantization of the gravitational field is unknown. Do gravitons exist?
Beside of some trials, an accepted microscopic theory of gravity does not exist.
The neutrinos and their interactions are not understood. Their number is unknown.
The dark matter is solely assumed in some theories; its properties are unknown.
How many dimensions of space-time (5 or 11) are needed for string theories?
Do string/membrane theories have any relation to physical processes? **}**
In order to avoid discrepancies and none allowed generalizations being inherently in the accepted assumptions and to clear up the principal lack of knowledge, a set of new fundamental hypotheses is formulated. This set contains seven conclusive and most probably complete assumptions with axiomatic character. Statements quoted with () are either explanations or consequences shown by the author in Refs. **[1 - 5, 12]**.

Basic restrictions on the physical descriptions:

1.) *The description of nature is limited only on finite domains of space and time, and all physical systems are open systems***.**
(The general usage of closed systems in a finite domain is an impermissible simplification. The limitation excludes very small and very large distances between events.)

The fundamental interaction field propagates in a unified way:

2.) *Only one frame-invariant fundamental interaction exist consisting of the electro-magnetic field and the covariant gravitational field. The field propagation is finite, constant and has the value c in each frame***.** *This field is the Unified Field (UF)***.**

(This kind of interaction field determines a covariant gravitational field (g-field), which fulfils e.g. Maxwell-like equations as an inseparable part of the fundamental interaction in a finite space-time domain. The g-field can be described with a four-vector potential and a four-vector current as well as with the velocity of propagation $c_g = c$. The existence of the UF is essential. It is designed for the explanations of all the observable interactions. Its sources = quanta are the only elementary particles.)

The elementary particles:

3.) *Only four kinds of point-like and structure-less particles exist with two invariant attributes. The attributes are two kinds of elementary Maxwell charges.*

(The carriers of the two attributes are elementary particles (EP). The four stable particles, the electron, the positron, the proton and the elton = negative charged proton, (e, p, P, E) are the EP. The two kinds of elementary charges, the e-charge and the g-charge, are the sources of the fundamental UF. The EP does not have any other intrinsic property.)

The property of the space and time continuum:

4.) *In finite domains, space and time is homogeneous, the space is isotropic. There exists a unique Riemann's type metric determined uniquely by the UF in a finite domain of the (3, 1) dimensional space-time continuum.*

(The covariant UF determines with the constant of nature c a unique metric in finite domains of the space-time continuum: in the four-dimensional Minkowski space. The distance of two events, of two particles, is determined uniquely by c being an invariant of the field. Beside of the distance, the path of two particles in the mutual interaction field is also uniquely determined by the UF. But, the assumption of closed paths of particles is not valid. It is only and occasionally a useful approximation.)

Additional fundamental assumptions:

5.) *There exists a separation principle for single elementary particles in very small and for many particle systems in very large space-time distances.*

(The separable elementary particles quantize the sources of the UF. $\rightarrow$ Integral representations in very small distances; variation principles for open systems in finite domains; isoperimetric subsidiary and natural boundary conditions with Lagrange multipliers; strong separation and superposition principle of elementary charges; no particle-wave dualism, generalizations of statistics, entropy, equilibrium and temperature.

From the Eikonal theorem follows: The wave character of the electromagnetic radiation is dominant in each microscopic particle process and not the corpuscular character.)

6.) *The canonical coordinates of elementary particles are principally undeterminable exactly*.

(This hypothesis is more general than Heisenberg's uncertainty relation with h.)

7.) *The two kinds of charges, the e-charges as well as the g-charges, have two signs. The amount of the e-charge, q, is the same for all particles. But the amount of the g-charges is equal only for e and p respectively for P and E. The amount of g-charge g_i is proportional to the rest mass m_e and m_P of an elementary particle.*

So far is the list of the basic restrictions on the physical descriptions.

The gravitational charges (g-charges) g_i define the constant of gravity

$$\boldsymbol{G} = g^2/4\pi$$

with

electron: $g_1 = -gm_e$, positron: $g_2 = +gm_e$, proton: $g_3 = +gm_P$, elton: $g_4 = -gm_P$. (1)

The g-charges are invariants = constants of nature. The equality of g for electron and proton is a further assumption. The motion of bodies in the g-field

$$\frac{d}{dt}(m^i \mathbf{v}) = -\{\boldsymbol{G}\, M^g m^g \mathbf{r}/r^3 + g m^g \mathbf{v}/c \times \mathbf{B}^{(g)}\} = -g m^g (\mathbf{E}^{(g)} + \mathbf{v}/c \times \mathbf{B}^{(g)}\}, \qquad (2)$$

offers a composition dependency because the relation of gravitational mass m^g and inertial mass m^i,

$m^i = m^g(1-\Delta^{MD})$,

is composition dependent. The experimentally observed range is

$1.4x10^{-8} < \Delta^{MD} < 0.78\%$,

emphasized with the mass defect of isotopes. WEP and UFF are invalid assumptions, Refs. **[1,2,12]**. The constant of nature $\boldsymbol{G}$ is ~ 1.5% less than the literature value G^{CODATA} which is an average value. The gravitational mass m^g is constant being proportional to the invariant g-charge. Only the inertial mass changes with the velocity v, ($m^i(v=0) < m^g$ with composed stable particles) according to

$m^i(v) = m^i(v=0)/(1-(v/c)^2)^{1/2}$,

and only the inertial mass changes according to

$\Delta E = \Delta m^i c^2$.

The gravitational Lorentz force for a body with the masses m^g and m^i in the gravitational field of another body with the gravitational mass M^g, Ref. **[3],** is given by Eq. (2). This is analogue to Lorentz force of e-charges in Gaussian units. The second term on the right side arises from the orbit of the body causing a gravito-magnetic field $\mathbf{B}^{(g)}$. The most orbits of planets are approximately circles. Newton's law of gravitational force is a law of static macroscopic g-charges similar to Coulomb law.)

The basic hypotheses 2, 3 and 7 are connected with the unified field and particles. The other hypotheses are general assumptions which must be followed in the treatments of fields and particles. A geometrized theory of gravity based on WEP is not allowed.

Physical Consequences: All of the numerous accepted, but in a number of cases controversial assumptions constitute the so-called Standard Model of Physics. The set of new hypotheses leads to a New Model of nature in which none of the historical gathered assumptions remain valid up to the existence of atoms and elementary electric charges as well as the propagation of light with c. Both models are essentially different and result in a very controversial explanation of nature. The crucial difference is the explanation of the observed gravity generated through the gravitational charges of the four elementary particles with UFF violation, Refs. **[2, 12]**. Is also the hypothesis about the existence of photons not valid as the Eikonal theory offers? If yes, than one has to assume that the New Model is not only a mathematically correct theory based on a few conclusive hypotheses but the laws of nature are represented within it. At the end of this article a short summary demonstrates the new results within the New Model.

The existing gravitational field derived from elementary g-charges is described in terms of the four-vector potential

$A^{(g)\beta} = (\phi^{(g)}/c, \mathbf{A}^{(g)})$

and of the four-current

$j^{(g)\beta} = (\rho^{(g)}, \mathbf{j}^{(g)}/c)$,

according to

$\partial_\alpha \partial^\alpha A^{(g)\beta} = -j^{(g)\beta}$, with $\partial_\beta j^{(g)\beta} = 0$ and $\partial_\beta A^{(g)\beta} = 0$. (3a)

The minus sign is important in the first relation. The theory of covariant gravity is linked with the invariant gravitational charges g_i of the four elementary particles, see Eq. (1). They are defined by static surface integrals

$$\oint_S \mathbf{E}_i^{(g)}.d\mathbf{s} = -\,g_i \text{ with the values } g_i = \{\pm gm_e,\ \pm gm_P\},\quad i=1,4. \qquad (4a)$$

The description of gravity is in complete analogy to the electromagnetic field

$$\partial_\alpha \partial^\alpha A^{(e)\,\beta} = +\,j^{(e)\,\beta} \qquad \text{with } \partial_\beta j^{(e)\,\beta} = 0 \text{ and } \partial_\beta A^{(e)\,\beta} = 0, \qquad (3a)$$

and the electric charges

$$\oint_S \mathbf{E}_i^{(e)}.d\mathbf{s} = q_i \text{ with the values } q_i = \{\pm q\}. \qquad (4b)$$

The stress-energy tensor of the gravitational field, $F^{(g)\,\lambda\rho}$, can be also expressed with the components of the four-vector potential $A^{(g)\,\beta}$ for a Lagrangian. As a consequence of the two kinds of elementary charges, the $A^{(g)\,\beta}$ and $A^{(e)\,\beta}$ must be always added to the UF. But because of the weakness of gravity, the influence of $A^{(g)\,\beta}$ can be experimentally studied only with electric neutral particle systems. Such systems in a finite volume with a surface S are (e,P), (p,E), (e,p) and (P,E). The corresponding net g-charges have the values (e,P)**:** $+g(m_P - m_e)$, (p,E)**:** $-g(m_P - m_e)$, (e,p)**:** zero and (P,E)**:** zero. The gravitational mass of (e,P) and (p,E) is $m_P - m_e$ and of (e,p) and (P,E) is zero. Because of zero gravitational mass, the systems (e,p) and (P,E) are "mass-less" and will be identified with two kinds of neutrinos, the electron-neutrino and proton-neutrino. The consequences of the covariant theory of gravity are studied by the author in Refs. **[1 - 3, 12]**. The unique Riemann's metric corresponding to the UF has a consistent character: Einstein's geometrized theory of gravity, Ref. **[17]**, is invalid with its own metric being different from the metric in the Minkowski space. This theory of gravity corresponds to the geometric properties of the space in the neighbourhood of masses, and does not use the generation of the gravitational field through four elementary gravitational charges.

The radiation in microscopic processes is joined to the second fundamental objection to the accepted Standard Model. It has arisen from the empirical fact that all microscopic objects are essentially smaller than the wavelengths of their characteristic electromagnetic radiation as emphasized by Szász in Ref. **[4]**. For instance, in case of the hydrogen atom, the 1 Angström atomic size is to be compared with the wave lengths of radiation > 927 Angström. Therefore, using the Eikonal theory, in all known microscopic processes the wave character of radiation is dominant and not the corpuscular character. Consequently, the Eikonal theory prohibits the corpuscular picture of the wave motions of the electromagnetic field in all microscopic processes. Therefore, the existence of a light corpuscle is excluded in all emission and absorption processes of light through microscopic particle systems. But how can the line spectra be understood in absence of photons? Within the New Model**,** the explanation of microscopic radiation processes is essentially fixed with the sources quantization of the UF instead of the quantization of the field itself**,** as shown by Szász in Refs. **[3, 4, 5]**. Within the source quantization, we are dealing with variation principles of the covariant Lagrange functions (action integral, cf. Hamilton principle)

$$I(\eta_\rho) = \int_\Omega (dx^4)\, L(\eta_\rho(x^\mu),\ \eta_{\rho,\nu}(x^\mu),\ x^\mu),\ \mu,\nu = 1,4,\quad \rho = 1,12, \qquad (5)$$

where dx^4 is the invariant volume element, η_ρ are the field quantities describing the electromagnetic field, the gravitational field and the four kinds of elementary particles and $\eta_{\rho,\nu}$ their derivatives. The integration has to be carried out in finite space-time domains Ω. The source quantization, the quantum condition within the New Model, leads to isoperimetric subsidiary conditions generally written as

$$G(\eta_\rho) = \int_\Omega (dx^4)\, G(\eta_\rho(x^\mu),\ \eta_{\rho,\nu}(x^\mu),\ x^\mu) = \text{const.},\ \rho = 1,4. \qquad (6)$$

The isoperimetric problem with natural boundary conditions is mathematically well defined and leads to Lagrange multipliers λ; see e.g. in Ref. **[14],** in the calculus of variation and the Lagrange formalism**.** The Lagrange multipliers λ_i,

$$\delta I(\eta_\rho, \varphi_q) + \lambda_i\, \delta G(\eta_\rho, \varphi_q) = 0 \text{ for } \rho = 1,4 \text{ all and } \varphi_q \qquad (7)$$

are eigenvalues of an open physical system. The differences $\lambda_j - \lambda_i$ determine the frequencies of the observed line spectra. But in this context, the eigenvalues λ_j are not the energies of the particle systems considered as parts of open physical systems. The quantum conditions, Eq. (6), are to be applying only on the sources = quanta of the UF, on the field quantities of the four elementary particles η_ρ with ρ = 1,4. The Eq. (7) delivers than a covariant eigenvalue problem within the New Model. But the energies of bound particle systems are neither constant nor quantized with Eq. (7).

Variation problems defined by the Eqs. (5) to (7) build only a subclass of a great manifold of variation principles which occur in nature. A second class of variation principles arises if instead of a natural boundary condition, a steady current of particles or of a field, is flowing across the surface S containing a definite number of some kinds of elementary particles. In this case, Eq. (6) remains only valid for these particles; e.g. only the number of protons can be holding constant in the inner region of S. If the condition in Eq. (6) is valid for all types of the four particles, the steady currents flowing through S can be only the electromagnetic or the gravitational field. In the case of laser, there is only an electromagnetic wave to be considered with a definite frequency flowing through the surface S. Another specific kind of problem is given at the equilibrium of bound (e, p, P) systems with the electromagnetic field residing outside the surface. This problem contains also statistics and corresponds to the black body radiation at which Planck's constant h was found in 1900.

The unstable particles and the stable and decaying nuclei will be discussed in Refs. **[3, 5]** within the concept of open systems as stationary states of variation problems according to Eqs. (5) to (7).

The 6th hypothesis states the principal undeterminably canonical coordinates of particles which is more general than Heisenberg's uncertainty relation. Planck's constant h corresponding to Lagrange multipliers loses its role of universality considering all microscopic processes, as discussed by Szász in Ref. **[3 - 5]**.

A second basic constant h^0 is appearing in the theory of the (e,p) and (P,E)-systems and determining two kinds of neutrinos as bound states ν_e = (e,p) and ν_p = (P,E), Ref. **[3]**. In this context, the neutron n = (e,P) is also a bound two particle system and not "the second state of a nucleon" as was postulated by Heisenberg. The unstable free neutron is a four particle system consisting of e, P

and of an electron-neutrino ν_e = (e,p). The neutrinos ν_e = (e,p) and ν_p = (P,E) are as well electric as in respect to the gravitational charge neutral. Because of the zero g-charge, the neutrinos appear as "mass-less" particles. Such "uncharged particles" have interaction spheres comparable with their sizes. The calculated size of the electron-neutrino ν_e is with 7.03×10^{-14} cm solely somewhat smaller than the sizes of nuclei. The size of the proton-neutrino ν_p is with

$r = 3.82 \times 10^{-17}$ cm,

by a factor

$m_e/m_P = 1/1836$

smaller than the size of ν_e.

The small sizes of the neutrinos cause, as bound states and because of their total neutrality, a short interaction range of neutrinos with all other bound particle systems. The size of ν_e with h^0 allows the assumption that ν_e = (e,p) is responsible for the nuclear forces. The much smaller ν_p = (P;E) cannot take place in the building of nuclei under normal conditions. The observed unstable free neutron is an unstable state of an (e,P)-neutron with an additional electron-neutrino ν_e = (e,p), as mentioned above. A second kind of neutron, a (p,E)-neutron, exists also, and two kinds of matter condensation follows. The ν_p and the unbounded ν_e build the so called dark matter. Because of their properties, the neutrinos do not have an ability to build large condensed formations. The overall presence of free flying ν_e and ν_p neutrinos causes occasionally the "creation" of a separated (e+p) or (P+E) pair, if the radiation field has sufficient high frequency or if the energy is high enough in collisions with other particles. In the New Model, the "creation of particle pairs" is solely the separation of the constituents of bound states. Furthermore, the neutrinos have an ability to build bound states with each other. With charged particles, they build short living ($\leq 10^{-6}$ s) charged composition systems. Such systems are the observed unstable particles.

The source quantization of the UF has also a far reaching consequence for the context of interactions, because the creation and annihilation of elementary particles with invariant properties is prohibited, as investigated by Szász in Refs. **[3, 5]**. The numbers of e, p, P and E are conserved in each frame as well as in each microscopic process. These four particles are stable as observed in nature. A creation and annihilation of these particles cannot arise in the context of the UF within the New Model.

The spontaneous beta decay of a nuclei, the emission of an electron or positron with an additional electron-neutrino ν_e = (e,p), has to be understood as an unstable state of nuclei and can be calculated with variation principles of the New Model. This kind of

decay corresponds to the s. c. weak interaction within the accepted Standard Model.

As mentioned, the observed unstable particles appear as temporary condensation of neutrinos ν_e = (e,p) and ν_p = (P,E) on elementary particles. The condensation with a participation of more than one proton-neutrino ν_p could

e.g. produce the so called strong interaction of particles, Ref**. [3]**. Consequently, there is no need for the introduction of any additional fundamental microscopic interactions within the New Model. Since the four stable particles are the sources = quanta of UF, according to 2nd and 3rd hypotheses, and the UF is the only interacting field, other particles do not exist in nature. There is also no need for the introduction of any other fundamental particles than the four elementary particles e, p, P and E. Thus, there is no need for the introduction of quarks, strings or anything else as fundamental particles in physics.

Furthermore, since Planck's constant corresponds to a Lagrange multiplier of an extended many-particle system, e.g. of an (e, p, P) system, the constant h cannot be simultaneously connected to an intrinsic property of the four elementary particles. Conclusively, the four elementary particles cannot have an intrinsic angular momentum (spin 1/2) and a corresponding magnetic momentum proportional to h. The observed splitting of spectral lines appears through the presence of the magnetic field caused by the motion of electric charges during the resonance process of emission/absorption, Refs. **[4, 5]**. Therefore, Pauli's exclusion principle with spin 1/2 particles and the Fermi statistic do not have a right of existence within the New Model.

Neglecting the contribution of the magnetic field, the motion of a particle with an elementary e-charge can be described with a Schrödinger's like differential equation in a central potential V(**r**) in a non-relativistic approach as a static problem within the New Model too, Refs. **[4]**. But the eigenvalue problem, due to the variation formulation of an open system with an isoperimetric subsidiary and a natural boundary condition in a finite space region, is not equivalent to a quantization of the system energy. But it gives reason for the appearance of line spectra, and the spectral lines are split if the contribution of the magnetic field is considered, too. Within the New Model**,** the split of spectral lines and the usage of the stationary Schrödinger equation in a finite domain appear in a complete new context. A numerical calculation of the eigenvalues λ_i in Eq. (7) can be performed with a technique used earlier by Szász in Ref. **[5],** and by V. Marigliano Ramaglia and G. P. Zucchelli in Ref**. [19]**. This mathematical technique must be developed further for general usage, however.

A summary of observations, consequences and discoveries is collected and based on the New Model:

- The constant of nature $\boldsymbol{G}$ is defined with invariant properties of the four elementary particles e, p, P and E., The value
  $\boldsymbol{G} = g^2/4\pi$ is determined in Ref. **[2],**
  $\boldsymbol{G} = 6.576(6)\text{x}10^{-11}\ \text{m}^3\,\text{kg}^{-1}\,\text{s}^{-2}$,
  and the literature value
  $G^{CODATA} = 6.673(10)\ \text{x}10^{-11}\ \text{m}^3\,\text{kg}^{-1}\,\text{s}^{-2}$,
  is only an average value with different test materials.
- As the precision of measurements increased, an experimental evidence of a ~0.7% time variation of G was observed by Karagioz et al, Ref. **[7]** and an orientation dependency of G about 0.054% was measured by Gershteyn et al, Ref. **[8]**. These observations correspond to the large uncertainty of G^{CODATA}, see also Ref. **[18]**.
- The composition dependent
  $G = \boldsymbol{G}\text{x}(m_1^g/m_1^i)(m_2^g/m_2^i)$,

is calculated with $\boldsymbol{G}$ and with the known relative mass defect of bodies Δ^{MD}, Refs. **[2, 9]**

- The gravitation mass and the inertial mass of composite bodies are fundamentally different. Their relation is determined by
  $m^i = m^g(1-\Delta^{MD})$.
  The gravitational mass m^g is constant being proportional to an invariant quantity. The inertial mass changes according to
  $m^i = m^g/(1-(v/c)^2)^{1/2}$,
  and
  $\Delta E^{bound} = (m^g - m^i)c^2$.
- The UFF is violated and
  $|\Delta a|/a \approx |\Delta^{MD}_B - \Delta^{MD}_A|$,
  is between $1.4\text{x}10^{-8}$ and $0.78\text{x}10^{-2}$ with different chemical elements A and B from hydrogen to iron, Ref. **[12].**
- The inner planets, Mercury, Venus, Earth and Mars, with similar Fe/Ni kernel and the outer ice, rock, gaseous planets, Uranus, Neptune and Pluto, offer differences

  $$1.3\text{x}10^{-6} < \Delta(R^3/T'^2)/(R^3_E/T'^2_E) < 1.5\text{x}10^{-3},$$

  with

  $$T'^2 = T^2(1+M^i_{planet}/M^i_{sun}),$$

  Ref. **[1]**. Only if all nine planets fulfil the relation

  $$R^3/T'^2 = \text{const},$$

  a composition independent gravity follows with WEP and UFF. Only in this case would a basic arise for Equivalence Principle, the GTR and the geometrized theory of gravity.
- The gravitational field is a covariant field, see Eq. (3). The gravitational field fulfils the Maxwell equations with a negative sign of $\rho^{(g)}$ and $\mathbf{j}^{(g)}$, Ref. **[3]**.
- The g-charges are Maxwell charges, the g-radiation exists and the gravito-magnetic field causes a Lorentz force. The velocity of gravity is $c_g = c$, Ref. **[15]**.
- All particles/bodies radiate in the fundamental field UF. The zero component of the field equation Eq. (3) corresponds to static law of gravitational force.
- Within the Newtonian gravity, all elliptic orbits with the same energy have the same probability of occurrence. But the orbits of planets, except for those of Mercury and Pluto, have a small eccentricity, they are nearly circles. This means that an effect of the gravito-magnetism must be present in the motion of planets, Eq. (2).
- The orbits of planets and of solar-like systems are not arbitrary. The mean orbital distances of satellites from the central object are "anyhow quantized", Ref. **[20]**.
- The sources of the fundamental field are quantized and not the field itself. The sources are represented by the four particles e, p, P and E which are elementary.
- Microscopic processes are determined with variation principles within a covariant Lagrange formalism for open systems conditioned with various

subsidiary and boundary conditions in a finite space-time domain, Refs. **[3, 4]**.

- The microscopic electromagnetic radiation is a resonance process determined by h, but without photons. The four elementary particles do not have spin 1/2.
- Beside the Planck's constant h, a second basic constant
  $h^0 = 1/4\sqrt{2}\, x q^2/c$,
  exists.
- The neutrinos ν_e and ν_p are bound states of the (e,p), (P,E) systems determined by h^0. Their sizes are calculated and their properties are determined, Ref. **[4]**.
- The nuclear force is determined by the presence of electron-neutrinos ν_e = (e,p) in the nuclei and by h^0. The eltons and ν_p are not present in the known nuclei.
- The interaction between particles is solely caused by the fundamental field UF, and is not to be treated in the context of particle creation and annihilation process.
- There is no need for any further fundamental microscopic interaction.
- All particle systems are built up with the four elementary particles e, p, P and E. A proposal for the actual constituents of the most unstable particles is made, Ref. **[3]**.
- Two kinds of matter condensations exist in nature as (e,p,P) and (e,p,E) systems.
- The two kinds of matter exert a repulsive gravitational force against each other.
- The shift of spectral lines of stars gives information about both kinds of matter.
- The dark matter consists of both kinds of neutrinos in a non-condensed formation. The free flying neutrinos are present always and everywhere in universe.

The mentioned "irregular effects in observations" up to $\sim 10^{-2}$ regarding the accepted gravity are in strict contradiction to the numerous Equivalence-Principle (E.P.) test results with an apparent confirmation of about 10^{-13}, see Ref. **[10]**. The planed tests, STEP, "GALILEO GALILEI" (GG), MICROSCOPE, etc., Ref. **[11]**, have the goal of testing the E.P. up to 10^{-18}. In particular, UFF test are very rare. The recent test of Szász, Ref. **[12],** contradicts the results of Niebauer et al, Kuroda et al and Su et al, Ref. **[13]**, who saw a $5x10^{-12}$ apparent confirmation of UFF. The other apparent proofs of Einstein's geometrized gravity, the rotation of Mercury's perihelion, the red shift of spectral line in strong gravitational fields and the propagation of light along a curved space trajectory are explanations of very small effects. They must be reinvestigated in the context of the covariant theory of gravity, too. Einstein's theory of gravity, based on the invalid assumption $m^g = m^i$, is not designed to describe the composition dependent motion of bodies in the gravitational field.

The clarification of the second of the two fundamental interactions, of the gravity, by Szász has brought the strongest input to the new insight in the laws of nature. The variation principles of open systems complete the formalism within the Principles of Physics.

Newton stated in the 17th century: "Nature does nothing in vain, and more is in vain, when less will serve; for nature is pleased with simplicity and affects not the pomp of superfluous causes."

A consequence of the very large factor ~ 10^{42} between the Coulomb and the Newtonian forces is that gravity can be only studied with electric neutral particle systems. The amount of the e-charge is known with a relative uncertainty of 8.5×10^{-8} only. The amount of the g-charge is much less precise known 9×10^{-4}. The value distribution of elementary charges in Eq. (4) and the equivalence of the velocity of light and of gravity $c = c_g$ is solely axiomatically assumed.

A next step of further simplification in basic physics could be an understanding the UF without the separation in an e-field and the g-field with two different types of charges then this is somewhat artificial: Therefore, we must never rest with the verification of an apparently successful fundament. A possible falsification may be hiding behind it. But at the moment, we are occupied with the development of consequences from the New Model in comparison with the predictions of the old model. At first, the inner connection of the different Lagrange multipliers, e.g. of h_0 and h, have to be understood.

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