Atomistic Theory of Matter:
Stable Particles and a Unified Field

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(Dated: April 7, 2015)

The pillars of modern physics stand in stalemate. A revision is needed of the Standard Model of particle physics and the General Theory of Relativity. Undeniable and irreconcilable discrepancies in physics are herein taken as an opportunity to develop an Atomistic Theory of Matter which is intuitively, consistently and mathematically correct. Contradictions appear throughout the history of theoretical physics, and persistently observed deviations from Newton's theory of gravity indicate that a new theory is necessary. This is strengthened by logical deliberations, e.g. the finding that all microscopic objects are invariably smaller than the wave lengths of their radiations. A new set of plausible fundamental physical hypotheses form an innovative view on Nature by solving the Variation Problem in order to derive the equations of motion. In physics a fundamental field (Unified Field - UF) is to be centralized. It consists of the electromagnetic field and the Lorentz covariant gravitational field, generated by four kinds of sources. The sources (or, quanta) of the UF are represented by the four stable particles: electron (e), positron (p), proton (P) and elton (E, negative charged proton) which carry two kinds of Maxwell-charges - the known electrical and an gravitational. The UF is a non-conservative field and propagates with the constant velocity c. The equations of motion for the particles contain some constants: Planck's constant h still describes the atomic shell but at a second basic constant $h^0 = e^2/2c \cdot 1/\sqrt{8} = h/387.7$ can be assigned to describe the nuclei, neutrinos and the unstable particles. The formulation of an Atomistic Theory, in contrast to the Einstein's Energetic Theory, is a successful attempt to clarifying the unsolved questions in physics with a much simpler approach (compared to Quantum and Quark Theories, curved space, String Theory, etc.).

INTRODUCTION

Modern physics faces a problem: both central theories – Einstein's General Theory of Relativity, (which determinate our understanding of gravity and the relativistic theory of energy, [1]), and the Standard Model of particle physics, (which describes the physics of microscopic quantum particles,[2],[3],[4]). cannot consistently explain Nature. Experimental observations reveal a huge diversity of deviations from both theories; this underlines the problems. Fritz Zwicky observed in the 1930s that the galaxies in the Coma Cluster move quicker than Newton's Theory predicts. Astronomer Vera Rubin, in the 1960s, discovered a similar discrepancy when investigating the Andromeda Galaxy and formulated the Galaxy Rotation Problem. The discrepancy could be assigned to the existence of "Dark Matter", which is assumed to account for 95% of all matter and energy in our Universe.

At the scale of our own planetary system, deviations from Newton's Theory can also be identified. First, a minor anomaly is found in the prediction of the Mercury's perihelion, which advances 42.98 arc seconds per century. This specific case is attributed to Einstein's General Relativity. A more significant discrepancy is shown when precisely measured data for the movement of the nine planets (including Pluto), [5], is collected to calculate the "constant" in Kepler's Third Law. Here we find deviations of 0.15%, where we ought to obtain a constant value from the relation R^3/T^2. A simple calculation of this was performed by the author and can be found in [6]. This issue is not discussed in literature and Einstein's Theory of Gravity is unable to explain these rather large deviations in the motions of planets. Also, astrophysicists cannot satisfactorily explain "Black Holes". Our most prominent astrophysicist, Hawking, most recently stated that: "A full explanation of the process would require a theory that successfully merges gravity with the other fundamental forces of nature. But that is a goal that has eluded physicists for nearly a century...", "The correct treatment," he continues, "remains a mystery", [7].

This article hopes to shed light on these discrepancies; it is therefore closely correlated to our understandings of gravity. A fundamental step in this is the melding of gravity with electromagnetism. This is performed by a rather stream-lined Atomistic Theory of Matter based on two kinds of elementary Maxwell-charges of the stable elementary particles. In this theory, well known mathematical concepts such as the Lagrange Formalism, which delivers the equation of motions, were followed to derive a description of Nature within a Unified Field (UF) of both fields – gravitational and electromagnetic. A prerequisite for this theory is a new set of basic hypotheses, each with a reasonable character. These will be presented in the following. Their consequences are far-reaching; they explain the already mentioned astronomic discrepancies and shed light on the microscopic objects: nuclei, neutrinos as bound states and (known) unstable particles. Also, the so called "Dark Matter" is not needed for the

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understanding of the Universe.

ATOMISTIC THEORY OF MATTER

The New Set of Basic Hypotheses on the Atomistic Theory of Matter

1. One fundamental interaction field exists with unified propagation: Only one Lorentz covariant fundamental interaction exists, consisting of the electromagnetic field and the covariant gravitational field in the finite region Ω of the Minkowski space. The field is non-conservative and has finite, constant propagation with the value c, see [8–10]. The isotropic cosmic microwave background radiation (CMBR) is to be taken as frame of reference. This fundamental field is called the Unified Field (UF).

2. The elementary particles (EP): Only four kinds of stable, point-like particles exist, with only two kinds of Maxwell-charges. They are the particles electron (e), positron (p), proton (P) and elton (E). The elementary particles are not composed of smaller, constituent particles (e.g. quarks). These particles quantize the sources of the Unified Field and generate the field.

3. The physical properties of the elementary particles: The elementary particles are unmodifiable objects in space-time – they can be neither annihilated nor created. They are invariant objects in the Minkowski space. The elementary particles have two kinds of elementary charges. The charges cause the electromagnetic and the gravitation field. The elementary electric charges q_i, as well as the elementary gravitational charges g_i, have two signs. The absolute value of the e-charges, e, is the same for all four particles. But the absolute value of the g-charges is only equal for e and p, and respectively for P and E. The amounts of g-charges, g_i of the elementary particles are proportional to the invariant masses (to the rest masses in the isotropic CMBR) m_e or m_P : electron (e): $g_1 = -g \cdot m_e$, positron (p): $g_2 = +g \cdot m_e$, proton (P): $g_3 = +g \cdot m_P$, elton (E): $g_4 = -g \cdot m_P$ and $m_P/m_e = 1,836.152672$. The universal gravitational constant is $\mathbf{G} = g^2/4\pi$, proportional to the square of the specific gravitational charge g of the four elementary particles. This article shall use this index convention of the elementary particles.

4. Basic restrictions on physical descriptions: The physical description of Nature is limited to finite space-time domains, and all physical systems are open systems.

5. The property of the space-time continuum: In finite space-time domains, Ω, space and time are homogeneous, the space is isotropic. There exists a unique Riemann's type metric uniquely determined by the UF propagation, c, in finite domains of the (3, 1) dimensional space-time continuum. Between particles the invariant distances under Lorentz transformation are given by the propagation constant, c, in the Minkowski space. The distance is derived from the expression:

$$(s)^2 = x_\alpha x^\alpha = (x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2 - c^2 \cdot (t_1 - t_2)^2 \quad (1)$$

The invariant infinitesimal distance ds is defined by

$$(ds)^2 = dx_\alpha dx^\alpha = (dx)^2 + (dy)^2 + (dz)^2 - (c \cdot dt)^2 \quad (2)$$

Additional basic assumptions:

6. Uncertainty principle: The position AND velocity of elementary particles are principally indeterminable. This hypothesis is more fundamental and more general than Heisenberg's uncertainty relation with Planck's constant h.

7. Separation principle: A separation principle exists for single elementary particles in very small space time distances and for many particle systems in very large space-time distances. The relative distances are defined via Eq. (1).

Consequences of the Basic Hypotheses

The author discussed the consequences of these hypotheses in [11] (and in detail in, [6], [12], [13], [14], [15], [16]). From these hypotheses originated the Atomistic Theory of Matter based on the four stable elementary particles e, p, P and E; the particles move in the non-conservative Unified Field. Since the self-published work was not widely circulated, this article collects and presents the main findings. The conditions of particle movement are also given in this article, originally omitted in [11].

The masses, m_e and m_P used in these Basic Hypotheses are invariant masses. They are simultaneously the rest mass and the gravitational mass of the elementary particles. We have to distinguish between a particle's inertial mass m^i and the invariant (gravitational) mass m^g. The inertial mass m^i grows if the particles move with velocity near the propagation velocity of the UF. The gravitational mass m^g is connected to the invariant gravitational charges and they do not change in any physical reaction. Therefore, our theory does not support the weak equivalence principle, [17], the equivalence of inertial mass m^i and gravitational mass m^g, nor the equivalence principle of energy and mass, $E = m \cdot c^2$, [4]. The gravitational masses m_e and m_P are not equivalent to energy and the inertial masses of atoms $m^i(A, Z)$ are less than the sum of the masses of the constituents, [18],

[11]. Furthermore, in open, finite regions of space-time Ω, the non-conservative UF does not allow the use of energy conservation as a central principle of a physical system. Therefore we propose the atomistic picture of matter in Nature and not the energetic one.

Since the beginning of the 20^{th} century mainstream physics has operated on an energetic basis [2], [3], [4], [1], [19]. We have also revised Newton's theory of motion in gravity (17^{th} century) to the effect that the inertial mass is unequal to the gravitational mass of macroscopic bodies.

The set of Basic Hypotheses leads to a new model for description of Nature, in which few of the historical collected scientific assumptions of physics are retained. These are:

- Newton's law of static gravitational force,
- the existence of elementary electric charges,
- the propagation of light with c,
- the existence of the stable particles composing atoms and nuclei,

all described by the Maxwell equations. Furthermore, all microscopic objects are essentially smaller than the characteristic wave lengths of their radiation (see Figure 1.). Therefore, the dominance of the wave character of the electromagnetic field has to be accepted in all microscopic processes to describe the phenomenon of light, and not a corpuscular behavior via light quantum [2], [14], [20], [21], [22], [23], [24]. This means that the Maxwell equations for the electromagnetic field remain valid up to all levels of microscopic scale.

An entirely new hypothesis is additional: of the existence of elementary gravitational charges, which is integral part of the Atomistic Theory of Matter. Einstein published an atomistic feature on the molecular-kinetic theory of heat, [25], but he completely changed his theoretical orientation in his other publications, [1–4], in the direction of an energetic one. My Atomistic Theory and Einstein's special and general relativistic are essentially different. They give a very controversial explanation of Nature. A crucial difference also exits between the explanations of the observed gravity generated by the elementary gravitational charges, [12] and the description of gravity within the General Theory of Relativity [1].

The New Theory, based on the seven basic hypotheses, leads to a mathematically correct theory and (I believe) represents the physical laws of Nature. The electromagnetic field is described in Minkowski space with the widely accepted Maxwell equations, in terms of the four-vector potential $A^{(e)\beta}$ of the e-field and the four-vector electric current density $j^{(e)\beta}$; see [26],

$$\partial_\alpha \partial^\alpha A^{(e)\beta} = +j^{(e)\beta}; \tag{3}$$

$A^{(e)\text{ß}} = (\phi^{(e)}/c, \mathbf{A}^{(e)})$, $j^{(e)\beta} = (c\cdot\varrho^{(e)}, \mathbf{j}^{(e)})$ is used with

$$\partial_\beta j^{(e)\beta} = 0, \tag{4}$$

the continuity equation, the conservation of e-charges and

$$\partial_\beta A^{(e)\beta} = 0, \tag{5}$$

the Lorenz gauge, the conservation of the e-field properties. All quantities depend on $x^\alpha = (t, \mathbf{r}) \epsilon\ \Omega$.

The abbreviation, e-field, denotes the electromagnetic field. The equation for the motion of the e-field is a result of the Hamilton principle applied to the Lagrangian of the e-field with the subsidiary condition Eq. (5) in a finite space-time domain, Ω, of the Minkowski space. The Lorenz gauge is to be considered in the variation calculus as a subsidiary condition. The frame of reference is the isotropic CMBR. It is assumed that the Maxwell equations hold in each microscopic region.

The gravitational field is also caused by elementary Maxwell-charges, therefore, in complete analogy to electromagnetism, we can treat the Lorentz covariant gravitational field (g-field) in terms of the four-vector potential $A^{(g)\beta}$ and the four-current density of the g-charges with $j^{(g)\beta}$ on each point of the Minkowski space, in a finite space-time domain, Ω. The equation for the motion of the g-field is, [11],

$$\partial_\alpha \partial^\alpha A^{(g)\beta} = -j^{(g)\beta}; \tag{6}$$

$A^{(g)\text{ß}} = -(\phi^{(g)}/c, \mathbf{A}^{(g)})$, $j^{(g)\beta} = (c\cdot\varrho^{(g)}, \mathbf{j}^{(g)})$ is used with

$$\partial_\beta j^{(g)\beta} = 0, \tag{7}$$

the continuity equation, the conservation of g-charges and

$$\partial_\beta A^{(g)\beta} = 0, \tag{8}$$

the Lorenz gauge, the conservation of the g-field properties. The only difference between Eq.(3) and Eq. (6) is the minus sign.

All equations (3)-(5) and (6)-(7) are written in Lorentz invariant form, i.e. they have definite transformation behavior under Lorentz transformation; they are Lorentz vectors or scalars. With the elementary charges q_i and g_i the charge current densities $j^{(e)\beta}$ and $j^{(g)\beta}$

$j^{(e)\beta} = \sum_{i=1,4} j_i^{(e)\beta}$,

$j^{(g)\beta} = \sum_{i=1,4} j_i^{(g)\beta}$,

and the charge current densities of the particles $j_i^{(e)\beta}$ and $j_i^{(g)\beta}$ can be expressed with the particle current densities $j_i^{(n)\beta}$ of the four particles, $i = 1, 4$;

$$j_i^{(e)\alpha} = q_i \cdot j_i^{(n)\alpha} = q_i \cdot (c \cdot \rho_i^{(n)}, \mathbf{j}_i^{(n)}), \tag{9}$$

and

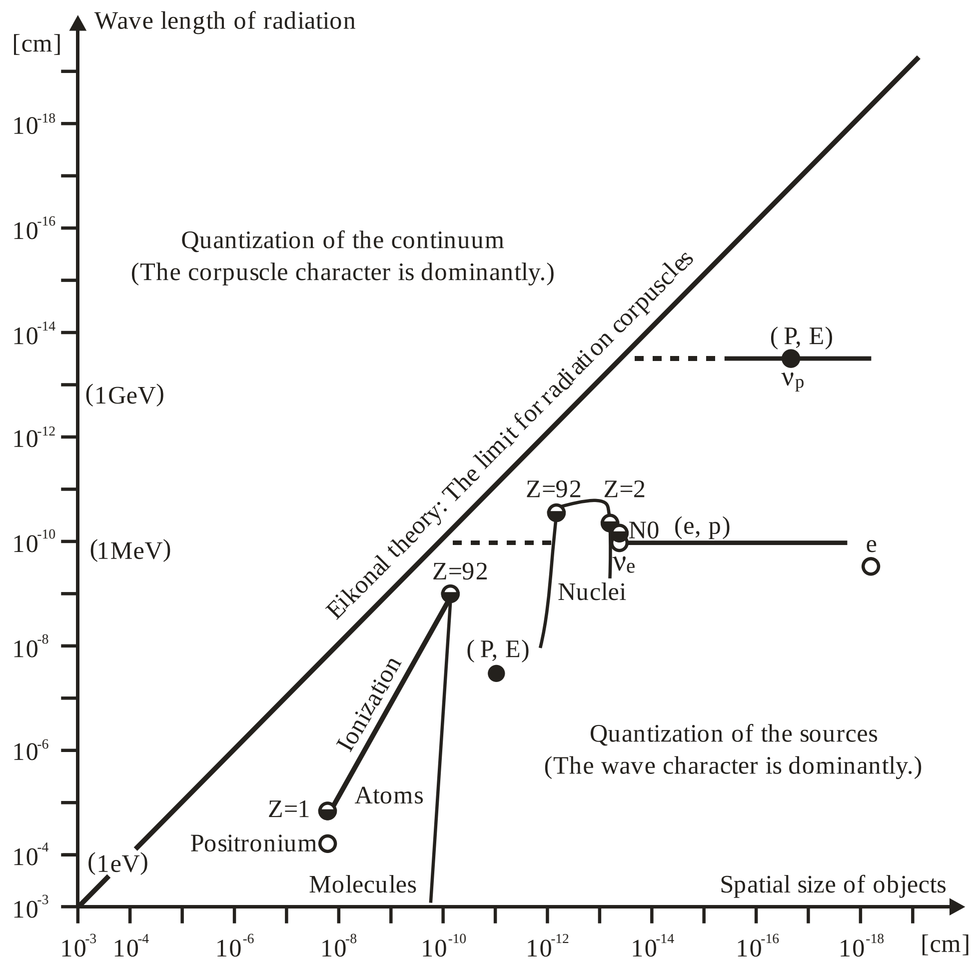

Figure 1. The sizes of microscopic objects with the smallest wave lengths of their electromagnetic radiations. The ionization of an atom means the ionization of the last (Z-1) electron. The sizes of the neutrinos, ν_e= (e,p) and ν_P= (P,E), and of the neutron, $N0 =$ (e,P), are calculated with h^0 . The size of the electron is also drawn at $\sim 10^{-18}$cm, as the limit up to which this particle is considered to be point-like. Hamilton has reconciled the corpuscular theory of light with the Eikonal theory in the geometrical optic with the wave motion, provided that the wave length is smaller than the size of the medium which influence the wave. According to the Eikonal theory, this representation illustrates that the field quantization of the electromagnetic field with photons is prohibited, as used in the accepted Quantum Electrodynamics (QED).

$$j_i^{(g)\alpha} = g_i \cdot j_i^{(n)\alpha} = g_i \cdot (c \cdot \rho_i^{(n)}, \mathbf{j}_i^{(n)}). \tag{10}$$

They are probability densities. The elementary particles are capable of being differentiated by their elementary charges.

According to (3) and (6) all moving bodies described with $j^{(e)\beta}$ and $j^{(g)\beta}$ simultaneously radiate electromagnetic and gravitational rays. The e-field and g-field are connected by the two kinds of invariant Maxwell-charges of the four stable EPs. The propagation of gravity with c is experimentally supported, [8], [9], [10].

The field tensor (the Faraday tensor) of the e-field $F^{(e)\lambda\rho}$ can be expressed with $A^{(e)\beta}$, [26]

$$F^{(e)\lambda\rho} = \partial^\lambda A^{(e)\rho} - \partial^\rho A^{(e)\lambda}. \tag{11}$$

With an analogous technique the field tensor of gravitational field, $F^{(g)\lambda\rho}$ can also be expressed with the vector potential $A^{(g)\beta}$ of the g-field, in [11]

$$F^{(g)\lambda\rho} = \partial^\lambda A^{(g)\rho} - \partial^\rho A^{(g)\lambda}. \tag{12}$$

The gravity part of the Lagrangian can be also constructed in complete analogy to $F^{(e)\lambda\rho}$, $A^{(e)\beta}$ and $j^{(e)\beta}$ with $F^{(g)\lambda\rho}$, $A^{(g)\beta}$ and $j^{(g)\beta}$. As a consequence of the two kinds of elementary Maxwell-charges of the particles the vector field $A^{(e)\beta}$ and $A^{(g)\beta}$ contributions must always be added in the UF Theory.

The elementary charges are defined by the volume integral of the charge densities and Gauss's theorem and deliver the surface integrals of the static e-field $\mathbf{E}_i^{(e)}$ and the static g-field $\mathbf{E}_i^{(g)}$, whereby the closed surface, S, encloses a small finite volume V containing only one EP i, [26]. The two kinds of elementary charges of the four EP are at a time $t = t_0$

$$\int_V \rho_i^{(e)} d^3r = \int_V \nabla \cdot \mathbf{E}_i^{(e)} d^3r = \oint_S \mathbf{E}_i^{(e)} \cdot ds = +q_i, \quad (13)$$

with values
$q_i = -e, +e, +e, -e; i = 1, 4$.

Furthermore, for the electric charge conservation hold the continuity equations with particles of the same kind i

$$-\frac{\partial}{\partial t}\int_V \rho_i^{(e)} d^3r = \oint_S \mathbf{j}_i^{(e)} \cdot d\mathbf{s}, \quad (14)$$

For the gravitational charge conservation apply the equations for one particle i

$$\begin{aligned}\int_V \rho_i^{(g)} d^3r =& -\int_V \nabla \cdot \mathbf{E}_i^{(g)} d^3r \\ =& -\oint_S \mathbf{E}_i^{(g)} \cdot d\mathbf{s} = g_i \end{aligned} \quad (15)$$

with values
$g_i = -g \cdot m_e, +g \cdot m_e, +g \cdot m_P, -g \cdot m_P; i = 1, 4$
and with particles of the same kind i

$$-\frac{\partial}{\partial t}\int_V \rho_i^{(g)} d^3r = \oint_S \mathbf{j}_i^{(g)} \cdot d\mathbf{s}. \quad (16)$$

With Eqs. (13) and (15) follow due to the elementary charges, Eqs. (9) and (10), the continuity equations for the particle current densities

$$-\frac{\partial}{\partial t}\int_V \rho_i^{(n)} d^3r = \oint_S \mathbf{j}_i^{(n)} \cdot d\mathbf{s}, \quad (17)$$

The Eqs. (13) - (17) hold for any time. If the volume V contains at the time $t = t_0$ more elementary particles of the kind i, it then follows that

$$\int_V \rho_i^{(n)} d^3r = +n_i, \quad (18)$$

n_i is the particle number in V of particle kind $i = 1, 4$.

These are the quantum conditions for particle numbers n_i, the fundamental equations of the Atomistic Theory of Matter.

As the Eqs. (13), (14) and (15), (16) due not depend of the surface S, these lead also to natural boundary conditions on the surface of a finite region of Minkowski space Ω. The constant values of the volume integrals q_i and g_i, combined with Eq. (18), give "isoperimetric" subsidiary conditions for particle field variations. The term isoperimetric is used in the Lagrange theory, [27], meaning an integral kind of subsidiary conditions, notably with fixed boundary conditions. For this manner of problem some constants appear in the Euler-Lagrange equation of motion: they are called Lagrange multipliers. In our case the charge conservation also deliver integral subsidiary conditions for particle numbers, Eq. (18), but with natural boundary conditions. It is a free boundary problem with a volume constraint. We do not have a special notation for this situation; therefore we could use the notation "isoperimetric". The values of the integrals Eqs. (13) and (15) do not depend on the closed surface, S, which contains n_i charges, Eq. (18); the values of charges of n_i particles are independent from the boundary. Probably the notation "isopretii" (isopetic = isovalued) would more precise describe the mathematical problem. The Atomistic Theory of Matter produces isopetric problems in the calculus of variation.

In order to fix the signs of the elementary charges and their relations to the fields we use test charges.

A positive sign convention for e-charge and the g-charge of the proton gives, if we use another electric charge q and gravitational charge g, the so called test charges
$\mathbf{E}_i^{(e)} = \mathbf{F}_i^{Coulomb}/q = +q_i \cdot \mathbf{r}/(4\pi r^3)$,
$\mathbf{E}_i^{(g)} = \mathbf{F}_i^{Newton}/g = -g_i \cdot \mathbf{r}/(4\pi r^3)$.
$q_i = +e$; $g_i = +g \cdot m_i$; $i = 3$.

These fix also the signs of all other elementary charges. The gravitational field $\mathbf{E}_i^{(g)}$ and the force $\mathbf{F}_i^{Newton}$ is directed towards the proton with a positive g-charge. That means protons attract each other with their gravitational force. Between particles with opposite sign of the g-charges, such as proton and elton, a repulsive gravitational force exists, between particles with the same sign of g-charges the gravity is attractive. The minus sign in the equation of motion of the g-field, Eq. (6), take care for this circumstance in contrast to the equation of motion of the e-field, Eq, (3) where a plus sign appears.

Neutron, Neutrinos and Electric Neutral Composed Systems

The existence of two kinds of elementary charges explains the microscopic properties of particle systems. N.B. due to the weakness of gravity compared to electromagnetism, the influence of $A^{(g)\beta}$ on the EP can only be experimentally studied with electrically neutral particle systems.

In a small finite volume, V, the forms of electrically neutral two-particle systems are only: (e,P), (p,E), (e,p) and (P,E). Since the static electric force is only attractive between EPs of these two-particle systems, only these basic two-particle systems are able to form bound states. Only these two-particle systems can deliver stationary bound solutions of the Lagrangian in an Atomistic Theory of Matter. The net g-charges of these basic two-particle systems have the values

$g_{(e,P)} = +g \cdot (m_P - m_e)$, $g_{(p,E)} = -g \cdot (m_P - m_e)$,

$g_{(e,p)} = 0, g_{(P,E)} = 0$.

Therefore, the corresponding gravitational masses of these systems are

$m^g = m_P - m_e$, for $N0 =$ (e,P) and $\overline{N0} =$ (p,E);

$m^g = 0$, for $\nu_e =$ (e,p) and $\nu_P =$ (P,E).

The (e,P)-system constructs the hydrogen atom and the stable neutron $N0$; they are special bound states (stationary ground states). The $N0$ exists at a much lower energy as the hydrogen atom. The (p,E)-system constructs also bound states: the elton-hydrogen and the stable elton-neutron, the $\overline{N0}$. In traditional physics the elton-hydrogen is called "anti-hydrogen" and the elton-neutron is called "anti-neutron", but we do not use these notations. Furthermore, nuclear physics has not confirmed stable neutrons $N0$ and stable elton-neutrons $\overline{N0}$. Nuclear physics only recognizes the unstable neutrons which are not elementary particles. The gravitational mass for both systems (e,P) and (p,E) is

$m_P - m_e$,

however, the net gravitational charges for both systems have opposite sings.

In Atomistic Processes the sum of elementary particle masses, from which a particle system is composed, remains constant. The net gravitational charge also remains constant, which is proportional to the gravitational mass of the composed system, as long as all particles remain in a finite small region of the space-time, Ω. Because the gravitational charges of proton and elton have opposite signs, we have to ascertain whether a composed system contains more protons than eltons or vice versa. For simplicity, we now calculate the gravitational mass of a composed systems which don't contain eltons. It is composed of $\mathbf{N}_P$ protons, a particular number of electrons $\mathbf{N}_e$ and positrons $\mathbf{N}_p$. The gravitational mass for this microscopic system is:

$m^g(\mathbf{N}_P, \mathbf{N}_e, \mathbf{N_p}) = \mathbf{N}_P \cdot m_P + \mathbf{N}_p \cdot m_e - \mathbf{N}_e \cdot m_e > 0$.

In electrically neutral composed systems, such as electrically neutral atoms, the number of electrons $\mathbf{N}_e$ must be equal to the sum of the number of protons and positrons $\mathbf{N}_e = \mathbf{N}_P + \mathbf{N}_p$. For electrically neutral atoms the gravitational mass is simple:

$m^g(\mathbf{N}_P) = \mathbf{N}_P \cdot (m_P - m_e)$.

$\mathbf{N}_P$ is the mass number of atom $A = \mathbf{N}_P$ and the number of positrons $\mathbf{N}_p$ disappears.

The number $\mathbf{N}_p$, which is also the number of (e,p) pairs, is the only unknown parameter in the structure of nuclei with a (P,e,p) composition. However, the inertial mass also contains $\mathbf{N}_p$. Generally, in the rest frame, the inertial masses of a composed bound system (such as nuclei, but without elton) are equal to the sum of all elementary masses minus the bound energy, E_{bound}, divided by c^2

$m^i(composed-system) = \sum_{j=1,4} \mathbf{N}_j \cdot m_j - E_{bound}/c^2$.

Einstein also suggested this relation, but the generalization down to $E = m \cdot c^2$ could be argued against, [4]. The number of (e,p) pairs, together with a constant h^0, produce the so called "nuclear forces" (see below). For electrically neutral atoms the two masses $m^g(A)$ and $m^i(A, Z)$ are obviously different. And they differ in the sum of the masses of the composing particles $\sum_{j=1,4} \mathbf{N}_j \cdot m_j$. The bound energy can also be phenomenological calculated with the experimentally observed $m^i(A, Z)$ and with $\sum_{j=1,4} \mathbf{N}_j \cdot m_j$, whereby Z is the nucleus charge.

Since the net gravitational masses of the bound systems (e,p) and (P,E) are zero, they appear as electrically neutral AND "mass-less" (see Pauli's proposal, 1930, on the process of β decay). Aside from the positronium and elton-positronium, special bound states will be identified with two kinds of basic neutrinos, the electron-neutrino at much lower energies

$\nu_e =$ (e,p)

and the proton-neutrino

$\nu_P =$ (P,E).

In the case of neutrinos, the sums of elementary masses are $2 \cdot m_e$ and $2 \cdot m_P$. Assume that the bound energies E_{bound} of the neutrinos are equal to the corresponding value of the sum of elementary masses times c^2. It would then follow that not only the gravitational masses are zero but the inertial masses are ALSO zero. Since the inertial mass cannot be negative, these special bound states are the lowest energetic levels of the (e,p) and (P,E) systems. The energies $2 \cdot m_e \cdot c^2$and $2 \cdot m_P \cdot c^2$ are radiated, but the corresponding two particles remain existent: the elementary particles are invariant objects. Only in these circumstances should we speak about neutrinos ν_e and ν_P. This situation is one of the main difference to Einstein's energetic theory.

From the state of the neutrinos we can derive the value of a second constant, h^0, for the motion of particles in a much smaller space region. This is analogous to the role of Planck's constant, h, for the hydrogen atom, the positronium and the elton-hydrogen. The value h^0 is 387.7 times less than the value of the Planck's constant h and is independent of the elementary masses, as shown below.

It is well known that the value of h can be (approximately) calculated with the bound energy of a hydrogen atom at ground state

$E_{bound} = 13.5984eV$,

and with the reduced mass of the electron-proton system

$m'_{ep} = m_e \cdot m_P/(m_e + m_P)$

to

$$h = e^2/2c \cdot \sqrt{m'_{eP} \cdot c^2/2 \cdot E_{bound}} = e^2/2c \cdot 1/\alpha. \quad (19)$$

This relation was discovered by Arnold Sommerfeld, who interpreted
$\alpha = \sqrt{2 \cdot E_{bound}/m'_{eP} \cdot c^2}$
as the velocity of the electron in the hydrogen atom ground state in units of c. The h describes also the positronium ground state of the electron-positron system, close to energy of $6.8eV$ [28]. Similar to the calculation of h from the energetic lowest ground state of the (e,p) and (P,E)-systems, which are the neutrinos, a second constant h^0 can be calculated. One can define the value of the mass independent constant h^0 with the reduced masses
$m'_{ep} = m_e/2$, and $m'_{PE} = m_P/2$
and the bound energies of ground states
$E_{bound-ep} = 2 \cdot m_e \cdot c^2$ and $E_{bound-PE} = 2 \cdot m_P \cdot c^2$, [13], according the Eq. (19)

$$h^0 = e^2/2c \cdot 1/\sqrt{8}. \quad (20)$$

Analogous to the role of h, the h^0 describes both the neutrinos and the stable neutron $N0$ as ground state of the electron-proton system, respectively. The h^0 also describes $\overline{N0}$, the ground state of positron-elton system. Futhermore, h^0 describes the sizes of the neutrinos and also of $N0$ and $\overline{N0}$. Contrary to traditional physics, the electron and positron do not annihilate each other, nor do the proton and the elton. These particle pairs cannot be generated in the Unified Field. So we do not speak about particles and antiparticles. The h and h^0 will play the role of Lagrange multipliers in the equations for the motion of particles in the Minkowski space as we will show later.

The Planck's constant h determines via the well known relation the distances of particles in the ground state

$$r_{ground-state} = h^2/\pi e^2 m', \quad (21)$$

thus the sizes of the ground states of hydrogen and positronium. With h^0 and with the corresponding reduced masses of the stable neutrons and of the neutrinos the sizes of these objects can be calculate
$r_{N0} = 0.702 \cdot 10^{-13} cm$,
$r_{\overline{N0}} = 0.702 \cdot 10^{-13} cm$,
$r_{\nu_e} = 0.703 \cdot 10^{-13} cm$,
$r_{\nu_P} = 0.383 \cdot 10^{-16} cm$.

Note that the size of $N0$ (this is the diameter) is near the size of the electron-neutrino ν_e[13], (see also Table I.). Both are in the nuclei size range which is somewhat larger than $10^{-13} cm$ and both are observed in nuclei decay experiments alongside protons, electrons and positrons. It is a strong indication that h^0 plays an important role in the processes of the nuclei and that h^0 is responsible for the commonly termed "nuclear forces". The "strong interaction" of the Standard Model is not required as a fundamental interaction in the production of nuclear forces: the electromagnetic force does it with h^0 and with the electron-neutrino ν_e. The Planck's constant h does not play a role in nuclear processes.

According to Eqs. (19) and (20), the calculated bound energy of the neutron in the ground state is
$E_0(N0) = h^2/(h^0)^2 \cdot 13.59eV = 2.04MeV$.

The velocity of the electron in the ground state of an H-atom v/c, in unity of c , is
$\alpha = \sqrt{2 \cdot E_0(hydrogen)/m'_{eP} c^2} = 1/137.036$.

In the stable neutron $N0$ the electron moves in a highly relativistic way
$(v/c)^2/(1-(v/c)^2) = 2 \cdot E_0(N0)/m'_{eP} c^2 = 7.98$,
with the relativistic velocity $v/c = 0.94$, that is 94% of the velocity of light.

The size of the proton-neutrino ν_P is much less than the size of $N0$, ν_e and those of the nuclei, due to the larger mass m_p compared with m_e, see Table I.

The Static Law of Gravity between two Microscopic or Macroscopic Objects

The static electric force $\mathbf{F}^{(e)}(\mathbf{r})$ between two net electric charges q_1 and q_2 is given by Coulomb's law. The static gravitational force $\mathbf{F}^{(g)}(\mathbf{r})$ between two net gravitational charges g_1 and g_2 is defined by Newton's law. For finite relative distances $r = \mid \mathbf{r} \mid$ we have

$$\mathbf{F}^{(e)} = +\frac{q_1 \cdot q_2}{4\pi r^3}\mathbf{r}, \quad (22)$$

$$\mathbf{F}^{(g)} = -\frac{g_1 \cdot g_2}{4\pi r^3}\mathbf{r} = \mp \mathbf{G} \cdot \frac{m_1^g \cdot m_2^g}{r^3}\mathbf{r}, \quad (23)$$

$\mathbf{G} = g^2/4\pi$ is Newton's universal constant of gravity derived from the same specific gravitational charge g of the four stable elementary particles. The sign $\mp$ appears in $\mathbf{F}^{(g)}$ because the gravitational charge has two signs and we will always use gravitational masses with the condition that $m^g \geq 0$. In the Atomistic Theory of Matter, gravity is not universal mass attraction. In the case of an electron, $\mathbf{F}^{(e)}$ is roughly a factor of $\approx 3 \cdot 10^{+42}$ greater than $\mathbf{F}^{(g)}$. In this theory, in the case of a (P,e,p) condensation of matter, for electric neutral atoms with the mass number A and nuclear charge Z, the relative mass defect $\Delta(A,Z)$, can be phenomenological calculated with experimental data $m^i(A,Z)$, [18] and with $m^g(A) = A \cdot (m_P - m_e)$. In Table II. the most frequently occurring isotopes of some chemical elements are listed. One can establish that
$1\% > \Delta(A,Z) = (m^g(A) - m^i(A,Z))/m^i(A) > 0$;
only when hydrogen is $\Delta < 0$.

$\Delta(A,Z) \neq 0$, thus the relative mass defect is not zero and dependent on A and Z. The discrepancy between

Table I. Collection of the Values of Constants in Universe

Velocity of light and gravity	c	$2.99 \times 10^{10} cm\, s^{-1}$
Elementary electric charge	e	$1.703 \times 10^{-9} g^{1/2} cm^{3/2} s^{-1}$
Electron mass	m_e	$9.11 \times 10^{-28} g$
Proton mass	m_p	$1.67 \times 10^{-24} g$
The ration of elementary masses	m_p/m_e	1836.152
Gravitational constant [2]	G	$6.57 \times 10^{-8} g^{-1} cm^3 s^{-2}$
Specific gravitational charge	g	$0.908 \times 10^{-3} g^{-1/2} cm^{3/2} s^{-1}$
Elementary gravitational charge of proton	$g \cdot m_p$	$1.52 \times 10^{-27} g^{1/2} cm^{3/2} s^{-1}$
The rations of electric and gravity force	$e^2/g^2 m_p^2$	1.255×10^{36}
Planck's constant	h	$6.62 \times 10^{-27} g\, cm^2 s^{-1}$
The second constant	h_0	$1.71 \times 10^{-29} g\, cm^2 s^{-1}$
Minimal wavelength, hydrogen radiation	$\lambda_{cutoff} (\lambda_{H-Atom} > \lambda_{cutoff})$	$0.912 \times 10^{-5} cm$
Bohr 's radius of hydrogen atom	r_H	$0.529 \times 10^{-8} cm$
Size of stable neutron (diameter)	r_{N0}	$0.702 \times 10^{-13} cm$
Size of electron-neutrino	r_{ν_e}	$0.703 \times 10^{-13} cm$
Size of proton-neutrino	r_{ν_p}	$0.383 \times 10^{-16} cm$
Maximal mass density $m_p/(10^{-13} cm^3)$	$\rho_{max} (\rho_{Neutronstar} < \rho_{max})$	$1.67 \times 10^{15} g\, cm^{-3}$
Minimal time distance	r_{ν_P}/c	$1.27 \times 10^{-27} s$
Maximal detectable distance	R_Ω	10^{10} light year $\approx 10^{30} cm$
Loschmidt number	N_L	$2.686 \times 10^{19} cm^{-3}$
Boltzmann constant	k	$1.380 \times 10^{-14} g\, cm^2 s^{-2} K^{-1}$
Temperature of background radiation	T_{CMBR} calculated with h	$2.725 K$
Absolute zero temperature	$0K$	$-273.15°C$

inertial and gravitational mass in atoms transfers these properties to macroscopic bodies with differing compositions of chemical elements. Therefore, the equation of motion for macroscopic bodies with the inertial mass $m^i(body)$ and gravitational mass $m^g(body)$ in the gravitational field of a second body with the gravitational mass M^g, if the g-charges of both bodies have the same sign

$$m^i(body) \cdot \mathbf{a}(body) = \mathbf{F}^{(g)} = -\mathbf{G} \cdot \frac{M^g \cdot m^g(body)}{r^3} \mathbf{r} \quad (24)$$

offers a composition dependent relative acceleration $\mathbf{a}(body)$ with $\mathbf{a}_0 = -\mathbf{G} \cdot \frac{M^g}{r^3} \mathbf{r}$

$$\mathbf{a}(body) = \mathbf{a}_0 \cdot m^g(body)/m^i(body) = \mathbf{a}_0/(1 - \triangle(body)) \approx \mathbf{a}_0 \cdot (1 + \triangle(body)) \quad (25)$$

The Atomistic Theory of Matter modifies Newton's 2nd law with the static gravitational force and is able to explain the 0.15% deviation of Kepler's "constant" in the orbits of planets that are principally composed of very different materials [12]. Within a gravitational field iron has the largest acceleration and hydrogen the smallest. The acceleration difference between these materials is almost 1%. It should be noted that, the inner planets are Fe/Ni-planets; the outer gas-planets contain much hydrogen. The deviation of the value of the ration R^3/T^2 between Mars and Uranus is 0.15% [6]. On the other hand, the minor anomaly in the movement of the Mercury's perihelion ought to be explained with the "gravity Lorentz force", similar to the Lorentz force on the movement of electric charges [11] but we are still waiting on a concrete calculation.

A violation of the Universality of Free Fall (UFF) was identified by the author by means of a fall experiment in a vacuum tube from a height of 110 m using different chemical elements, [16]. This study could be extended, provided access is granted to the drop tower at the University of Bremen. On the other hand, Einstein's Theory of Gravity can neither explain the deviations of Kepler's "constant", nor abnormal galactic rotation. The Eq. (25) with

$\triangle(body) < 1\%$,

holds so long as the velocities of the bodies are much less than the propagation of the UF c and that the retarded effect of the field does not play a role over the relative distances between bodies. Over small distances disturbances of the e-field also play a role (Eötvös experiment, see below).

Einstein's Theory of Gravity is based on the equivalence of inertial and gravitational mass, which seems to be confirmed by torsion balance measurements. Consequently Einstein eliminated the gravitational mass from physics. At the beginning of the 20th century the experiments of Loránd Eötvös seem to measure the equality

Table II. Mass Defect of Isotopes

Composition of the Nuclei	Gravitational Mass [amu]	Isotope Mass [amu]	Name	Relative Mass Defect [%]	Mass Nr.
$[1P + 1e$	1.006727885	1.00782443	${}^{1}_{1}H$	−0.109	1]
$2P + 2N$	4.026911540	4.002603250	${}^{4}_{2}He$	0.607	4
$3P + 4N$	7.047095195	7.016004049	${}^{7}_{3}Li$	0.441	7
$4P + 5N$	9.060550965	9.012182135	${}^{9}_{4}Be$	0.534	9
$5P + 6N$	11.074006735	11.009305466	${}^{11}_{5}B$	0.584	11
$6P + 6N$	12.080734620	12.000000000	${}^{12}_{6}C$	0.668	12
$7P + 7N$	14.094190390	14.003074005	${}^{14}_{7}N$	0.647	14
$8P + 8N$	16.107646160	15.994914622	${}^{16}_{8}O$	0.700	16
$9P + 10N$	19.127829815	18.998403205	${}^{19}_{9}F$	0.677	19
$10P + 10N$	20.134557700	19.992440176	${}^{20}_{10}Ne$	0.706	20
$11P + 12N$	23.154741355	22.989769675	${}^{23}_{11}Na$	0.713	23
$12P + 12N$	24.161469240	23.985041898	${}^{24}_{12}Mg$	0.730	24
$13P + 14N$	27.181652895	26.981538441	${}^{27}_{13}Al$	0.736	27
$14P + 14N$	28.188380780	27.976926533	${}^{28}_{14}Si$	0.750	28
$15P + 16N$	31.208564435	30.973761512	${}^{31}_{15}P$	0.752	31
$16P + 16N$	32.215292320	31.972070690	${}^{32}_{16}S$	0.755	32
$17P + 18N$	35.235475975	34.968852707	${}^{35}_{17}Cl$	0.757	35
$18P + 22N$	40.269115400	39.962383123	${}^{40}_{18}Ar$	0.762	40
$19P + 20N$	39.262387515	38.963706861	${}^{39}_{19}K$	0.761	39
$20P + 20N$	40.269115400	39.962591155	${}^{40}_{20}Ca$	0.761	40
$21P + 24N$	45.302754825	44.955910243	${}^{45}_{21}Sc$	0.767	45
$26P + 30N$	56.376761560	55.934843937	${}^{56}_{26}Fe$	0.784	56
$79P + 118N$	198.325393346	196.96655131	${}^{197}_{79}Au$	0.685	197
$80P + 122N$	203.359032770	201.97062560	${}^{202}_{80}Hg$	0.683	202
$82P + 208N$	209.399400080	207.97663590	${}^{208}_{82}Pb$	0.679	208
$92P + 146N$	239.601236630	238.05078258	${}^{238}_{146}U$	0.647	238

of $m^g(body)$ and $m^i(body)$, confirmed the parity with an uncertainty of $5 \cdot 10^{-9}$, taking the composition of the bodies into account. Since that time more accurate Eötvös-experiments have been performed, [17]. All of them seemed to confirm the weak equivalence principle. However, when the Newtonian universal constant of gravity **G** is measured with the same experimental arrangements a much larger uncertainty is rendered (1998 CODATA sets the uncertainty at 0.15%). The gravity physicists are aware of this problem, but in spite of questioning the experimental confirmation of the weak equivalence principle they seem to accept the uncertainty. The physicists do not take into account the electromagnetic disturbance of the surrounding matter in the Eötvös-experiments, they do not analyzed the discrepancy in the measurement of **G** and those of $m^g(body)/m^i(body)$. In [11], the problem is examined from a number of considerations. Further fall experiments from a great height using different materials (which are very rarely performed) will clarify the correctness or the violation of the weak equivalence principle in Nature. Further such experiments have been scheduled by the author and the results will be published.

In the Atomistic Theory two kinds of relative mass defect can be defined. The first concerns gravitational mass; this definition $\triangle(body)$ is used in the afore mentioned equation of motion. The second mass defect is calculated respective to the sum of masses of the constituting particles. In nuclear physics, $\triangle^{nuclear-physics}(atom)$, this second kind is used

$m^i(atom) = \sum \mathbf{N}_i \cdot m_i - E_{bound}/c^2$.

In nuclear physics the relative mass defect is used relative to the mass number A with the result

$\triangle^{nucler-physics}(atom) = \left\{\sum \mathbf{N}_i \cdot m_i - m^i(atom)\right\}/A$
$= E_{bound}/c^2 A < 9MeV/c^2$.

However, the neutron, when part of a nucleus, is considered in nuclear physics as an elementary particle and for its mass the inertial mass of the unstable neutron, $m^i(N)$, is incorporated in the calculation. But the unstable neutron N consists of four elementary particles: of one proton, two electrons and one positron. The weak decay of neutron is

$N=$ (P,e,p,e) $\rightarrow$ P + e + (e,p)-neutrino = P + e + υ_e.

The inertial mass is $m^i(N) = 939.5653MeV/c^2 = m_p + 3 \cdot m_e - E_{bound}(N)$. The inertial mass of N is greater than the proton mass $m_P = 938.2720MeV/c^2$.

The gravitational mass of N is the same as that of $N0$: $m^g(N) = m_P - m_e = 937.72321 MeV/c^2$. The inverse beta decay may also sometimes refer to the process e + P→ N +υ_e can never occur in Nature. The phenomenological calculation of the relative mass defect of nuclei as used in nuclear physics is inadmissible.

The static law of gravity can also be considered at each electric neutral two-particle system. Only the (e,P) and (p,E)-systems have non-zero static gravitational forces $\mathbf{F}^{(g)}$ to each other:

$$\mathbf{F}^{(g)}_{(e,p),(e,P)} = \mathbf{F}^{(g)}_{(p,E),(p,E)} = -\mathbf{G}\cdot\frac{(m_P - m_e)^2}{r^3}\mathbf{r}, \quad (26)$$

$$\mathbf{F}^{(g)}_{(e,P),(p,E)} = +\mathbf{G}\cdot\frac{(m_P - m_e)^2}{r^3}\mathbf{r}, \quad (27)$$

Between the (e,P)- and (p,E)-systems the gravitational field produces a repulsive static gravitational force, thus the Newtonian force between an (e,P)- and a (p,E)-system is repulsive. It should be noted that: the singularity in Eq. (26) and (27) at $r \to 0$ cannot appear in the interactions: The h^0 prohibits distances between (e,P), (p,E) and (e,p) smaller than $0.702 \cdot 10^{-13} cm$ and between (P,E) distances less than $0.383 \cdot 10^{-16} cm$ (see also the "separation principle of particles" in the basic assumptions).

Remaining Role of "Dark Matter"

In Nature two kinds of matter condensation seem to exist. The first is only formed with the particles (P,e,p); this is "our world", a proton based world. The second would be (E,p,e), an "elton based world". In traditional physics the second kind of matter is called antimatter, but we do not use this notation. Between bodies of these two kinds of condensed matter, a repulsive gravitational force would exist. This explains why the co called "antimatter" is so rarely encountered in our planetary system and most probably in our galaxy. Perhaps our next galaxy, the Andromeda, is an elton based galaxy. A condensation of matter formed of all four EP seems not to exist. Nevertheless, there are also composed particle systems, classified as "neutrino-like aggregates", which do contain all four EPs.

The two mass-less neutrinos υ_e and υ_P exert neither a static electric nor a static gravitational influence on each other or to all other EP-systems. A notation "Dark Matter" allows the descriptions for the deviation of observed phenomena from Newton's theory of gravity based on the two signs of gravitational charges. In the Atomistic Theory the "Dark Matter" could constitute free flying neutrino-like aggregates which can only build small particle aggregates, for instant a υ_{eP} = (P,e,p,E)-system. But the neutrino-like aggregates cannot form condensed matter. The electric-charged elementary particles split the neutrino-like aggregates. Even the composite-neutrino υ_{eP}, can be splitted into the two basic neutrinos, (see the decay of charged unstable myons,) [13],

μ^- =(e, υ_{eP}) →e + ν_e+ν_P ,

μ^+ =(p, υ_{eP}) →p + ν_e+ν_P.

The observed decays of unstable particles seem to confirm the situation that the structures of the composite unstable particles contain more electrically and gravitational neutral particle systems, existing in the form [13]

$(\mathbf{n}\cdot(e,p), \mathbf{m}\cdot(p,E))$, with $\mathbf{n}+\mathbf{m} \geq 1$.

Generally, the gravitational mass and inertial mass of a composed stable or unstable particle system with proton excess $\mathbf{N}_P > \mathbf{N}_E$ can be calculated as

$m^i = (\mathbf{N}_P - \mathbf{N}_E)\cdot m_P + (\mathbf{N}_p - \mathbf{N}_e)\cdot m_e$,

$m^i = \sum \mathbf{N}_i \cdot m_i - E_{bound}/c^2$.

The gravitational mass for a particle system with elton excess, $\mathbf{N}_E > \mathbf{N_P}$ is

$m^g = (\mathbf{N}_E - \mathbf{N}_P)\cdot m_P + (\mathbf{N}_p - \mathbf{N}_e)\cdot m_e$.

As the variation principle of particle systems is to be set up in finite regions of the Minkowski space with non-conservative fields, the Lagrange formalism also has quasi-stationary solutions for unstable particle systems with complex values $E - i\Gamma$; with $E \geq \Gamma > 0$ (see the earlier investigation of the author in [20] - [24] and [29]). The $\mathit{\Gamma}$ defines the life-time of the unstable state, i.e. for the unstable neutron or for the charged myons. Decaying unstable particles are not elementary particles.

For neutrino-like aggregates $\mathbf{N}_P = \mathbf{N}_E$ and $\mathbf{N}_p = \mathbf{N}_e$, the gravitational mass is zero

$m^g(neutrino-like) = 0$.

The inertial mass of these aggregates is $m^i(neutrino-like) \geq 0$ (and it might be also zero).

"Dark Matter", in these terms, is composed of all these tiny, electric and gravitational neutral particle systems in the sub-nuclear range. The stable neutrons $N0$ and $\overline{N0}$ with their very low reactions rate could be also counted to "Dark Matter". "Dark Matter" is present throughout Nature, and even pervade our experimental equipment. This implies that even the best physical vacuum in laboratories would always contain "Dark Matter", composed of neutrino-like aggregates. This all-pervasive nature of "Dark Matter" should therefore always be taking in account when interpreting scattering experiments at energies greater than approximately $1MeV$, i.e. above the separation energy of the electron-neutrinos.

Experiments on the decay of nuclei have only shown the elementary particles: electrons, positrons and protons as decay products. The ν_e = (e, p) neutrinos are also present in the β decay and also the unstable neutron. But according to literature, elton (E), elton-neutron $\overline{N0}$ = (p,E), the proton-neutrino ν_P = (P,E) as well as the unstable elton-neutron (p,e,p,E), are not referred to as products of nuclear decay in experimental nuclear physics (or at least, have not been, to date). Of course, the interaction of our proton based nuclei with eltons, contained in the composite neutrino-like aggregates of "Dark Matter" cannot be excluded. And if they were to interact, the results would theoretically be the creation of short-lived unstable nuclei containing eltons. It would be worthwhile to investigate these phenomena theoretically and experimentally.

Interim Summary

The Atomistic Theory of Matter explains deviations from Newton's gravitation, so the notation "Dark Matter" is so far unnecessary. We also do not need hypothetical particles characterized by incredibly short life-times and huge energies as predicted by the relativistic field theories of the Standard Model (e.g. the Higgs-Boson) to explain the origin of masses of stable/unstable composite particles. The masses are determined by the invariant masses of the constituent parts and by their bound energies. The problem of quantum gravity is also resolved: gravity is caused by elementary (quantized) gravitational charges and not by gravitons. The Big Bang would also be unnecessary for the global generation of the cosmos; the four kinds of stable particles were always there. The Atomistic Theory of Matter also incorporates gravity in fundamental microscopic processes. It does not require string theories and 11-dimensional space-time constructions to reconcile the inconsistent pillars of modern physics when describing physical processes at the scale of less than 10^{-30} centimeters. The Atomistic Theory of Matter can explain many of the inconsistencies of mainstream energetic based physics.

VARIATION FORMULATION OF THE UF AND PARTICLES IN A FINITE SPACE-TIME DOMAIN Ω

Now, we have outlined all the required conditions and properties of the components of the variation. The Lorentz invariant Lagrange density for the non-conservative interaction can be established. The invariant $(dx)^4$ can also be defined as invariant infinitesimal element with the metric of the Minkowski space. In the Lagrange Formalism, arranged in finite domains of the Minkowski space, the Euler-Lagrange equations provide the equations of motion for the described system. In the Atomistic Theory of Matter the Lagrange Formalism is accomplished by natural (free) boundary conditions and by an isopetric subsidiary condition for the particles.

The Hamilton's Eikonal theory prohibits light corpuscles in each microscopic process, see Figure 1. Therefore in the Lagrange Formalism the classically understood electromagnetic field is to be accepted in all elementary processes. Thus we adopt the quantization of the source of the UF instead of the quantization of the field itself, with virtual field particles [13], [30].

The quantum condition of the four EPs in a finite volume V is derived from the charge conservation originated from the charge densities of the particles $i = 1, 4$

$$j_i^{(e)\alpha}(x) = q_i \cdot j_i^{(n)\alpha}(x) = q_i \cdot (c \cdot \rho_i^{(n)}(x), \mathbf{j}_i^{(n)}(x)), \quad (28)$$

and

$$j_i^{(g)\alpha}(x) = g_i \cdot j_i^{(n)\alpha}(x) = g_i \cdot (c \cdot \rho_i^{(n)}(x), \mathbf{j}_i^{(n)}(x)), \quad (29)$$

whereby $j_i^{(n)\alpha}$ is the four-vector particle current densities of particles of kind i which fulfill the continuity equations. The continuity equations

$$-\frac{\partial}{\partial t}\int_V \rho_i^{(n)}(\mathbf{r}, t) d^3r = \oint_S \mathbf{j}_i^{(n)}(\mathbf{r}, t) \cdot d\mathbf{s}, \qquad (30)$$

lead to the quantum conditions of particle numbers in the Atomistic Theory of Matter

$$\int_V \rho_i^{(n)}(\mathbf{r}, t) d^3r = +n_i, \qquad (31)$$

n_i is the number of particles i in V, $i = 1, 4$ at a time $t = t_0$. The Eqs. (31) are the isopetric subsidiary conditions for the variation of the particle fields.

Over time the decline of particle i in finite volume V is given by the flow of particles i through the surface, S, enclosing the finite volume, V. From the Eq. (30), multiplied with the invariant mass of the particle i, we obtain the equations of motion. For this we must take into account that we only know that the particle i was in volume V, and that we neither know the precise location, nor the precise velocity of the particle. The integrals in Eq. (31) deliver the subsidiary conditions for the variation of the Lagrangian, in order yield the Euler-Lagrange equations of the particles, i.e. to derive the equations of particle motion. These conditions are called "isopetric" conditions, and cause the appearance of some additional constants: the Lagrange multipliers, see [27]. The continuity equations Eqs. (4) and (7) with Eq. (17) connect the subsidiary conditions with the natural (free) boundary conditions for each kind of particles i in a finite domain of the Minkowski space Ω. The conservation of both Maxwell-charges and the conservation of the particle numbers are equivalent statements.

The natural boundary conditions mean that the boundary does not influence the physical statements, whatever the surface in Ω is. These boundary conditions also reflect the fact that the interaction between particles is performed via elementary Maxwell-charges, Eqs. (13) and (15). With forms of inter-particle interactions other than the Maxwell-charges, the independence of physics from the boundary would generally not be valid.

The action integral I, for interacting particles with two kinds of elementary Maxwell-charges, which generate the Unified Field (UF), is to be established by the Lorentz-scalar Lagrange density

$$\begin{aligned} L(x) =& L^T(x) - L^{UF}(x) \\ &= L^T(x) - L^0(x) - L^{Int}(x). \end{aligned} \qquad (32)$$

The Lagrange density consists of a kinetic part for particles $L^T(x)$ and the part of the Unified Field $L^{UF}(x)$. $L^{UF}(x)$ contains the source free part $L^0(x)$ and the interaction part between field and particles $L^{Int}(x)$. The $L^{UF}(x)$ depends on $A^{(e)\alpha}(x)$ and $A^{(g)\alpha}(x)$, and $L^{Int}(x)$ additionally on the charge current densities $j^{(e)\alpha}(x)$ and $j^{(e)\alpha}(x)$

$$I = \int_\Omega (dx)^4 \{L^T(x) - L^0(A^{(e)\alpha}(x), A^{(g)\alpha}(x)) - L^{Int}(A^{(e)\alpha}(x), A^{(g)\alpha}(x), j^{(e)\alpha}(x), j^{(g)\alpha}(x))\} \quad (33)$$

in a finite space-time domain Ω. The integration only runs for time-like distances. To simplify the written expression, we neglect x sometimes as argument; we know that each field quantity depends on x.

The source free part $L^0(x)$ of the Lagrange density can be represented as
$L^0(A^{(e)}(x), A^{(g)}(x)) =$
$-F^{(e)}_{\lambda\rho}(x)F^{(e)\lambda\rho}(x)/4 - F^{(g)}_{\lambda\rho}(x)/F^{(g)\lambda\rho}(x)/4$
$= L^0(A^{(e)}(x)) + L^0(A^g(x))$,
by the Faraday tensors. The $L^{Int}(x)$ can be expressed by $A^{(e)\alpha}(x)$, $A^{(g)\alpha}(x)$ and by $j^{(e)\alpha}(x)$, $j^{(g)\alpha}(x)$. Further, the both current densities can be expressed by the two kinds of elementary charges q_i and g_i and by the particle current densities $j_i^{(n)\alpha}(x)$ of the four kinds of particles,
$j^{(e)\alpha}(x) = \sum_{i=1,4} q_i \cdot j_i^{(n)\alpha}(x)$,
$j^{(g)\alpha}(x) = \sum_{i=1,4} g_i \cdot j_i^{(n)\alpha}(x)$.
The interaction of the particles and the fields is described by the couplings of the particle current densities via the elementary charges q_i and g_i and the particle current densities $j_i^{(n)\alpha}(x)$ to the corresponding vector fields $A^{(e)\alpha}(x)$ and $A^{(g)\alpha}(x)$

$$I = \int_\Omega (dx)^4 \{L^T(x) - L^0(A^{(e)\alpha}(x)) - L^{(0)}(A^{(g)\alpha}(x)) - \sum_{i=1,4} (q_i \cdot A^{(e)}_\alpha(x) - g_i \cdot A^{(g)}_\alpha(x)) \cdot j_i^{(n)\alpha}(x)\} \quad (34)$$

In Eq. (34) all terms of the Lagrange density are Lorentz scalars. The Lorentz scalar $L^T(x)$ will be given later at the variation of the particle fields. Please note that with Eq. (34) we do not follow Einstein [3], who described (in a very simplified way) the electrodynamics motion of a charged electron. In the traditional Relativistic Quantum Field Theory the Sommerfeld's fine structure constant α is considered to be the coupling constant of the electromagnetic interaction, which determines "the strength of the electromagnetic force" on the electron!

The well-known variations, respectively the field quantities $A^{(e)}(x)$ and $A^{(g)}(x)$ separately, lead to the (Maxwell) equation of motion of the fields with the source free part $L^0(x)$ and the interaction part of the Lagrange density $L^{Int}(x)$, including both electromagnetic and gravitational fields. The $L^T(x)$ does not depend on $A^{(e)}(x)$ and $A^{(g)}(x)$. The variation of both fundamental fields can be performed separately, as the electromagnetic and gravitational field do not influence each other.

$$\delta \mid_{A^{(e)}} = \int_\Omega (dx)^4 \left\{L^{UF}(A^{(e)\alpha}(x), j^{(e)\alpha}(x))\right\}, \quad (35)$$

$$\delta \mid_{A^{(g)}} = \int_\Omega (dx)^4 \left\{L^{UF}(A^{(g)\alpha}(x), j^{(g)\alpha}(x))\right\}, \quad (36)$$

The variations in Eqs. (35), (36) give the equations of motion for both fields; for the electromagnetic (3) and the gravitational (6) fields according to the Hamiltonian principle. For the variation both field quantities $A^{(e)}(x)$ and $A^{(g)}(x)$ must additionally fulfill the subsidiary conditions: the Lorenz gauge in Eqs. (5) and (8). If I can presume to answer the Hawking quote in the Introduction: the merging of gravity with the other fundamental force, the electromagnetic force, is not a mystery.

In our Atomistic Theory of Matter the motion of the gravitational field caused by the elementary gravitational charges Eq. (10) is described with Eqs. (6) - (8) in Minkowski space. This has not been considered previously. The consequence is, that we do not follow Einstein's weak equivalence principle to the extent that ascribing electromagnetism to a curvature of space-time would be required [1]. Furthermore, Black Holes lack proof or basis. These are only consequences of Einstein's theory of gravity and are purely theoretical constructs. In postulations the fundamental fields $A^{(e)}(x)$ and $A^{(g)}(x)$ do not influence each other. The symmetry properties of the action integral can be also studied with Eq. (34), with simultaneous exchange of both elementary charges q_i, g_i in $L^{Int}(x)$ and masses m_i in $L^T(x)$ of all the particles pairs.

Variation Formulation for the Particle Fields

The particle fields appear only in the kinetic part $L^T(x)$ and in the interacting part $L^{Int}(x)$ of the Lorentz scalar Lagrange density. We set up the kinetic part as

$$L^T(j_i^{(n)\alpha}x) = \sum_{i=1,4} m_i \cdot c \cdot \partial_\alpha j_i^{(n)\alpha}(x). \quad (37)$$

It is a Lorentz scalar and we have multiplied by factors $m_i \cdot c$ in order to put $L^T(x)$ in the Lagrange density in Eq. (32). Furthermore, we construct the particle fields with the elementary charges and the particle current densities $j_i^{(n)\alpha}(x)$ according to the Eqs. (28), (29) with suitable Minkowski space objects, with the four component spinors $\Psi_i(x)$. To describe relativistic moving particles, we use the covariant $\Psi_i(x)$ and the four component adjoint spinors $\overline{\Psi_i(x)} = \Psi_i^*(x)\gamma^0$ as Dirac spinors of the Dirac algebra with the (4x4)-matrices γ^α for the construction of the particle current densities $j_i^{(n)\alpha}$, [19], [30]

$$j_i^{(n)\alpha}(x) = c \cdot \overline{\Psi_i(x)}\gamma^\alpha \Psi_i(x). \quad (38)$$

Note: our motivation to use the spinors for the description of particle i is neither to linearize the expression

$E^2 = m_i^2 \cdot c^4 + \mathbf{p}^2 \cdot c^2$

nor to describe spin $\frac{1}{2}$ particles. Crucially when choosing spinors $\Psi_i(x)$ for each particle kind i they should have the same dimensions as Minkowski space (namely 4) and are so constructed that the current densities $j_i^{(n)\alpha}$, Eq. (38), fulfill the continuity equations of particle numbers in the Minkowski space

$\partial_\alpha j_i^{(n)\alpha}(x) = 0, i = 1, 4.$

The factor c is in Eq. (38) explicitly included because the definition of $j_i^{(n)\alpha}(x)$ with the spinors

$j_i^{(n)\alpha}(x) = (c \cdot \rho_i^{(n)}(x), \mathbf{j}_i^{(n)}(x)) = c \cdot \overline{\Psi_i(x)}\gamma^\alpha \Psi_i(x)$

and we want to describe with $\overline{\Psi_i(x)}\gamma^0 \Psi_i(x)$ the particles number density $\rho^{(n)}(x)$. The 0 component of the particle current density can be normalized

$j_i^{(n)0}(x)/c = \overline{\Psi_i(x)}\gamma^0 \Psi_i(x) = \sum_{k=0,3} \Psi_{i,k}^*(x) \cdot \Psi_{i,k}(x) > 0$, i = 1,4,

in order to use at some time $t = t_0$

$$\int_V d^3r j_i^{(n)0}(\mathbf{r})/c = \int_V d^3r \overline{\Psi_i}(\mathbf{r})\gamma^0 \Psi_i(\mathbf{r}) = \int_V d^3r \sum_{k=0,3} \Psi_{i,k}^*(\mathbf{r})\Psi_{i,k}(\mathbf{r}) = n_i, \quad (39)$$

for $n_i \geq 1$ particles i residing in V. The spinors represent the particles i by four complex functions $\Psi_{i,k}(x)$, $k = 0, 3$ which can be used to describe probabilities of point like particles at location x of the Minkowski space, under the condition that NETHER the location NOR the velocity of the particles are exactly known. It is worth noting that the same kinds of particles are repulsive to each other, because their electric charges are the same. Such particles do not remain very close to each other in the Minkowski space.

For all four kinds of particles, we can construct the Lagrange density $L(x)$ expressed by the particle current densities with spinors in a Lorentz scalar form which is invariant under Lorentz transformation. Now, we are able to write down the kinetic part of the Lagrange density $L^T(x)$ at each location x in expressed with spinors

$$L^T(x) = \sum_{i=1,4} m_i \cdot c \cdot \partial_\alpha j_i^{(n)\alpha}(x) = \sum_{i=1,4} m_i \cdot c^2 \left\{\partial_\alpha(\overline{\Psi_i}(x))\gamma^\alpha \Psi_i(x) + \overline{\Psi_i}(x)\gamma^\alpha \partial_\alpha(\Psi_i(x))\right\}. \quad (40)$$

Since the term $L^0(x)$ corresponds to the particle free part of the fields, at the variation for the particle fields this term can be omitted. For variation of the particle fields only the following expression can be considered

$$I = \int_\Omega (dx)^4 \{\sum_{i=1,4} m_i \cdot c \cdot \partial_\alpha j_i^{(n)\alpha}(x) - \sum_{i=1,4} (q_i \cdot A_\alpha^{(e)}(x) - g_i \cdot A_\alpha^{(g)}(x)) \cdot j_i^{(n)\alpha}(x)\}. \quad (41)$$

Finally we obtain the action integral for the particle fields containing the parts $L^T(x)$ and $L^{Int}(x)$ which are expressed with the spinors $\Psi_i(x)$ and which depend on $x = (t, \mathbf{r}) \,\epsilon\, \Omega$

$$I = \int_\Omega (dx)^4 \{\sum_{i=1,4} m_i \cdot c^2 \cdot \partial_\alpha(\overline{\Psi_i(x)}\gamma^\alpha \Psi_i(x)) - \sum_{i=1,4} (q_i \cdot A_\alpha^{(e)}(x) - g_i \cdot A_\alpha^{(g)}(x)) \cdot c \cdot \overline{\Psi_i(x)}\gamma^\alpha \Psi_i(x)\}. \quad (42)$$

In a good approximation the gravity part of the interaction proportional to g_i can be neglected for microscopic systems, but we cannot neglect the conservation of the gravitational charges

$$I = \int_\Omega (dx)^4 \{\sum_{i=1,4} (m_i \cdot c^2 \cdot (\partial_\alpha(\overline{\Psi_i(x)})\gamma^\alpha \Psi_i(x) + \overline{\Psi_i(x)}\gamma^\alpha \partial_\alpha(\Psi_i(x)) - q_i \cdot c \cdot A_\alpha^{(e)}(x)\overline{\Psi_i(x)}\gamma^\alpha \Psi_i(x))\}. \quad (43)$$

Furthermore, since only the dual-particle systems (e,P), (p,E), (e,p) and (P,E) – i.e. the combinations $(i = 1, j = 3)$, $(i = 2, j = 4)$, $(i = 1, j = 2)$ and $(i = 3, j = 4)$ - can deliver bound states if at any time $t = t_0$, both particles i and j are present in a finite small volume V. Only these basic two-particle systems

- are electric neutral,
- have particles whose electric forces attracte each other, and
- only for these systems stationary bound solutions of the variation are expected.

Now we will only consider these cases. We express this with the conditions

$$\int_V d^3r \overline{\Psi_i(\mathbf{r})}\gamma^0 \Psi_i(\mathbf{r}) = 1; \int_V d^3r \overline{\Psi_j(\mathbf{r})}\gamma^0 \Psi_j(\mathbf{r}) = 1, (44)$$

at the same time $t = t_0$ which are the subsidiary conditions of the action integral within the Lagrange Formalism. Furthermore, the action integral does not depend on the volume V and on the surface of V , S, as long as both conditions in Eqs. (44) hold. Finally we have to consider the variation of the action integral in respect to $\Psi_i(x)$, $\overline{\Psi_i(x)}$, $\Psi_j(x)$ and $\overline{\Psi_j(x)}$ for two particles i and j

$$I = \int_{\Omega}(dx)^4\{\sum_{l=i,,j}(m_l \cdot c^2 \cdot (\partial_\alpha(\overline{\Psi_l(x)})\gamma^\alpha\Psi_l(x) + \overline{\Psi_l(x)}\gamma^\alpha\partial_\alpha(\Psi_l(x))) - q_l \cdot c \cdot A_\alpha^{(e)}(x)\overline{\Psi_l(x)}\gamma^\alpha\Psi_l(x))\}. \tag{45}$$

with the subsidiary conditions Eq. (44) and the free (independence) condition of the surface S of volume V, respectively of the closed surface in Ω.

Lagrange Multipliers h and h^0

In our representation of the action integral only $L^T(x)$ contains the first derivatives of the covariant and adjoint spinors (with respect to the four coordinate of the Minkowski space as required in variations of a Lagrangian). Furthermore, we have isopetric subsidiary conditions, Eq. (44), and free boundary conditions of the particle fields $\Psi_i(x)$, $\overline{\Psi_i(x)}$, $\Psi_j(x)$ and $\overline{\Psi_j(x)}$. Therefore, and in accordance to the Hamilton principle, at the variation separately performed with $\Psi_i(x)$, $\overline{\Psi_i(x)}$, $\Psi_j(x)$ and $\overline{\Psi_j(x)}$ the Euler equations for Eq. (45) shall contain some constants, called the Lagrange multipliers (see [27], page 90 ff.) which make the variation stationary. Thus, these constants will appear in equations of motion of the particle fields. We identify the Lagrange multipliers with the Planck's constant h and with h^0. The Euler equation of the particles with the constants h and with h^0 are fulfilled on Ω. The Lagrange multiplier h appears linear and not quadratic as in the time dependent Schrödinger's equation (see below). Further, we shall give a physical interpretation of the appearance of the additional constants in the particle motion equations.

The independence of physics from the boundary in the course of Maxwell-charges is a powerful feature. For instance, we are able to reduce the variation problem of the particles i and j in the Minkowski space to a variation in the 3-dimensional space in the case of stationary bound solutions Ψ_i(x) of particle i if it is in the neighborhood of particle j, $\Psi_j(x)$, by an appropriate chosen constant for the time behavior. This independence of the boundary connects:

- the time variation and space variation for the bound stationary solution on Ω with
- a constant λ and i with $i^2 = -1$ in the exponential function

$$\Psi_i(\mathbf{r},t) = \Psi_i(\mathbf{r}) \cdot exp(-iEt/\lambda); \quad \Psi_j(\mathbf{r},t) = \Psi_j(\mathbf{r}) \cdot exp(-iEt/\lambda), \tag{46}$$

The particle fields Ψ_i(x) and $\Psi_j(x)$ with the phase

$$exp(+i(\mathbf{p}\cdot\mathbf{r} - Et)/\lambda) \tag{47}$$

fulfills the free boundary conditions for Eq. (45) with $\mathbf{p} = \mathbf{p}(E)$ and it is also temporal stationary.

As already mentioned, the same particle kinds repulse to each other, because their electric charges are the same. They do not tolerate the proximity of others in Minkowski space. It should be noted, the bound stationary systems (e,P), (p,E) have outside of V, respectably outside Ω, the magnetic fields corresponding to the magnetic dipole moments of the bound particle systems. These two-particle systems also have gravitational force outside of V where both fields are competitive.

A Comparison with the Traditional Quantum Mechanics

At this point, we compare traditional quantum mechanics and the correspondence principle to our theory. In traditional quantum mechanics this is succinctly described with the "switch-over", with a heuristic instruction, [31],[32], [33],[34]

$$E \to +i\hbar\partial/\partial t \tag{48}$$

$$\mathbf{p} \to -i\hbar\partial/\partial\mathbf{r} \tag{49}$$

Officially, the Schrödinger equation in the space representation arises within the correspondence principle (Niels Bohr) from the Hamiltonian (an expression for the energy) of the considered problem where $r =\mid \mathbf{r} \mid$ is the relative electron-proton distance

$$E = \mathbf{p}^2/2 \cdot m_{eP}^{'} + V(r) \tag{50}$$

with subsequent application of the "switch-over", Eq. (48), (49), (50), on the wave function $\psi = \psi(\mathbf{r},t)$ of an electron in the electric field of proton $V(r)$ to produce the time dependent Schrödinger equation

$$i\hbar\frac{\partial}{\partial t}\psi(\mathbf{r},t) = -\frac{\hbar^2}{2m_{eP}^{'}}\triangle\psi(\mathbf{r},t) + V(r)\Psi(\mathbf{r},t) \tag{51}$$

The wave function $\psi(\mathbf{r},t)$ is a scalar function in the 3-dimensional Euclidean space and depends on $\mathbf{r}$ and on the time t. With Eq. (46) and $\lambda = \hbar = h/2\pi$ we get the time independent Schrödinger equation

$$E\psi(\mathbf{r}) = -\frac{\hbar^2}{2m_{eP}^{'}}\triangle\psi(\mathbf{r}) + V(r)\Psi(\mathbf{r}). \tag{52}$$

Moreover, the subsidiary condition
$\int d^3r \mid \psi(\mathbf{r},t) \mid^2 = \int d^3r \mid \psi(\mathbf{r}) \mid^2 = 1$,
is used and the integration runs over the 3-dimensional space. The interpretation is: since the precise location of the electron is not known, the probability to find it anywhere is 1. But, what is about the velocity of the electron in the ground state of the hydrogen atom? Fortunately, Sommerfeld discovered the relation Eq. (19) with

$$h = e^2/2c \cdot 1/\alpha; \alpha = \sqrt{2 \cdot E_{bound}/m'_{eP}c^2}, \qquad (53)$$

between the natural constants e, c, m_e, m_P and the ground state energy E_{bound}. The interpretation of α is the relative velocity of the electron in the hydrogen atom ground state divided by c. It is essential in quantum mechanics. However, nobody knows why the dimensionless Sommerfeld's fine structure constant has the value $\alpha = 1/137.036$. Furthermore, theoretical scientists cannot explain why the "switch-over", Eqs. (48) –(52), with the given value of h, Eq. (53), produces the developed quantum theory for the electron in a hydrogen atom.

Furthermore, as we have seen, h is not a universal constant describing all the microscopic processes. Beside h there is a second constant

$$h^0 = e^2/2c \cdot 1/\sqrt{8}; = h/387.7, \qquad (54)$$

in the electron-proton system.

Contrary to conventional quantum mechanics in our theory the h does not quantize the energy. The h appears at the variation principle for stationary bound solutions of particle fields with quantized charges and quantized particle numbers, Eq. (39), as a Lagrange multiplier. Please note that, we do not imagine the quantity E as energy and $\mathbf{p}(E)$ in Eq. (47) as generalized impulse of a particle in our Atomistic Theory. We are dealing with the Lagrange formalism in the Minkowski space. The Lagrangian is independent of the natural boundary on each surface of Ω. The boundary conditions are incorporated in the space-time behavior of the spinors $\Psi_i(x)$ and $\Psi_j(x)$ on the surface of Ω described with h, respectively h^0, and is independent of the surface of Ω. If we constructed the particle current densities and the continuity equations (4) and (7) with the spinors for stationary bound solutions, the particle current densities $j_i^{(n)\alpha}(x)$ and $j_j^{(n)\alpha}(x)$ would be time independent. That means there is no radiation in the movement of charges and so Eqs. (44) give the quantum conditions of the particle numbers in interior of V. This quantum condition of the sources has nothing to do with the quantization of energy. At this point, we finish the comparison of traditional quantum mechanics and correspondence principle and continue our investigation with the conditions of variation of the Lagrangian in the Minkowski space for the particles.

Relativity, Frame of Reference and Mutual Interactions

Now, we turn to the last problem, to the problem of relativity in this context. In inertial systems contemporaneous equal distances along the spatial scale are used as coordinate scale. This description of inertial system is also used as frame of reference by Einstein [3]. For the more generalized description of nature that we use, in the Minkowski space, inertial systems make no sense as frame of references. Moreover, we cannot realize inertial coordinate systems with physical objects: Point-like stable elementary particles would be the best microscopic objects to mark the equal distance scale in space, but according to our uncertainty principle (in the sixth basic hypothesis), we cannot physically construct inertial systems with these particles, because their locations AND velocities are not precisely known. The invariant relative distance in our formalism is defined by Eq. (1). The frame of reference is the isotropic cosmic microwave background (CMBR) which is universally present. If an object moves in some direction, then the observed maximum of CMBR is blue shifted in the direction of the motion. In the opposite direction it is red shifted. In conclusion, we can define the velocity of particles in respect to the CMBR. This is as a frame of reference, which is a frame in respect to the velocity of light c.

In traditional physics, the principle of relativity requires that "the equations describing the laws of physics have the same form in all admissible frames of reference." As an example, does "... in the framework of special relativity, the Maxwell equation have the same form in all inertial frames of reference". From our findings we question the expression "in all admissible frames of reference" - it is of much more important to introduce the principle of relativity correctly with the use of Lorentz transformations, also with respect to c. Then the construction of inertial systems with equal space distances at the same time $t = t_0$ which are "admissible frames of reference" is impossible. Another aspect of relativity lies in trying to define relative distances between particles for the mutual interactions. They are important if external fields are also considered. They appear in the Zeeman Effect and Stark Effect in shifting and splitting the spectral lines and in the Mößbauer spectroscopy in external gravitational field. However, investigations of these effects lie beyond the scope of this article.

The mutual interactions of particles depend on relative distances, Eq. (1), on the velocities of the particles relative to each other and on the relative orientation of the spinors (that means the relative directions of velocities). Please recall, the interaction propagates with c and that moving charged particles create magnetic fields, so that the motion of the other particle is also affected via Lorentz force, depending on its velocity. We can define the motion of center of mass (COM) with the sum of the elementary masses minus the E_{bound}/c^2. The relative motion of particles is defined by the reduced masses in a frame of reference connected to the COM. But the motion in and relative to the COM is not a Lorentz invariant motion. With Eq. (46) the time dependency would be ruled out and we need only to consider a space action integral for variation with the conditions Eq. (44). For the relativity of particles in the mutual interaction fields we assume that the COM is at rest. If the COM is in rest, then the condition of stationary bound states for the two-particle systems with net electric charge zero means, NO electromagnetic radiation leaves AND the particle current densities vanish on the surface of Ω. This means, we are looking in the relative coordinate system between particle i and j for such constants λ for which the action integral vanishes

$$I = \int_{\Omega} (dx)^4 \{ \sum_{l=i,j} ((-i\lambda) \cdot m_l \cdot c^2 \cdot (\partial_\alpha (\overline{\Psi_l(x)}) \gamma^\alpha \Psi_l(x) + \overline{\Psi_l(x)} \gamma^\alpha \partial_\alpha (\Psi_l(x))) - q_l \cdot c \cdot A_\alpha^{(e)}(x) \overline{\Psi_l(x)} \gamma^\alpha \Psi_l(x)) \} |_{COM} \tag{55}$$

whereby λ multiplied with the imaginary unit i. Obviously, if we choose

$$\lambda = \hbar, \tag{56}$$

we get similar equations to the "switch-over" of the traditional quantum mechanics in Eqs. (50) - (52), but with a completely different Lagrange density resulted in the equation of motion in Eqs. (51) and (52) for the description of atomic shells.

If we choose

$$\lambda = \hbar^0 = \hbar/387.7, \tag{57}$$

we get the description of neutrinos, the neutron and the nuclei in a much narrower region of space and time, [11]. From Eq. (55) and with use of $\hbar$ and $\hbar^0$ respectively we introduce additional constants that give rise to stationary bound solutions in the variation principle for the relative motion of particles. This results in steady stationary bound states of the particle motions if the COM is in rest.

If the velocity of COM is much less than c, the Lagrangian splits off in the movement of the COM with the sum of the masses of constituents and in the movement with the reduced mass. For two-particle systems with zero net electric charge this means the COM moves with the inertial mass m^i, which is the sum of masses, minus the bound energy divided by c^2

$m^i = m_i + m_j - E_{bound}/c^2$,

and in a movement in the COM with the reduced mass of particles i and j

$m_{ij}' = m_i \cdot m_j/(m_i + m_j)$,

at relative distances r_{ij} defined in Eq. (1). The bound energy E_{bound} is radiated from the particle system at the binding. The movement in the COM has to be described with relative particle current densities $j_{ij}(r_{ij})$ and the derivatives are constructed in respect to the relative coordinates r_{ij}. Also the positions of the spinors relative to each other and to the relative particle current densities give contributions. The relative particle current density $j_{ij}(r_{ij})$ is a conditional probability. In the interaction term develops the mutual vector potential and the whole interaction expression, derived from Eq. (55), would be time independent in the case of temporal stationary solutions.

The action integral Eq. (34) is very general and does not depend of the surface of Ω. In the combination with $L^0(x)$, Eqs. (37) and (39), it describes the plasma state and all possible states of matter described by the Lagrange multiples h and h^0. However, the conservation of particle numbers has to be fulfilled.

Excitation and Radiation

The real occurrences of the transition from an unbound state of two particles to a stationary bound state are a non-conservative process: Over time, particles lose their energies - they radiate energy in the form of an electromagnetic (and of course gravitational) waves. The total radiated energy is equal to E_{bound}. The time evaluation, given by time dependent Schrödinger equation Eq. (51) is not able to describe this transition process with radiation. Also, the generalized description with a Hamilton operator for microscopic systems is not able to characterize the non-conservative transition process of radiation. The commonly understood image, of electrons jumping from one excited state to a less exited state and emitting discrete energy packages quantized with $E_{kl} = h\nu_{kl}$, as Quantum Theory would suggest, is incapable of describing this transition processes.

A bound electron carries the electric charge e and it moves in the electromagnetic field of the proton. Moving electric charges always radiates energy. So how do we explain the fact that the bound electron in a hydrogen atom does not radiate? The explanation is, if the electron is correctly described in the Minkowski space with an appropriate chosen spinor, the bound electron only in the ground state does not radiate. The excited state is the superposition of the ground state and the other stationary bound solutions of the variation principle. Thus the charge density of the excited state is time dependent. Time dependent charge densities of the excited states cause the radiation of electromagnetic waves with discrete frequencies υ_{kl}. However, the system does not emit quantized photons, the energy of the excited states lose smoothly the energy. The transition should rather be described with a superposition of stationary bound states $\eta_{i,,j}(k;\mathbf{r},t)$, with different values of E_k and an oscillating charge density of the excited state, resulting in

$$\rho_{i,j}^{(e)}(\mathbf{r},t) = q_i \sum_{k,l} a_k^* a_l \eta_{i,j}^*(k;\mathbf{r},t) \cdot \eta_{i,j}(l;\mathbf{r},t) = q_i \sum_{k,l} a_k^* a_l \eta_{i,j}^*(k;\mathbf{r}) \eta_{i,j}(l;\mathbf{r}) \cdot exp(-i(E_l - E_k)t/\hbar). \tag{58}$$

The electric charge density $\rho_{i,j}^{(e)}(\mathbf{r},t)$ oscillates in V with the frequencies

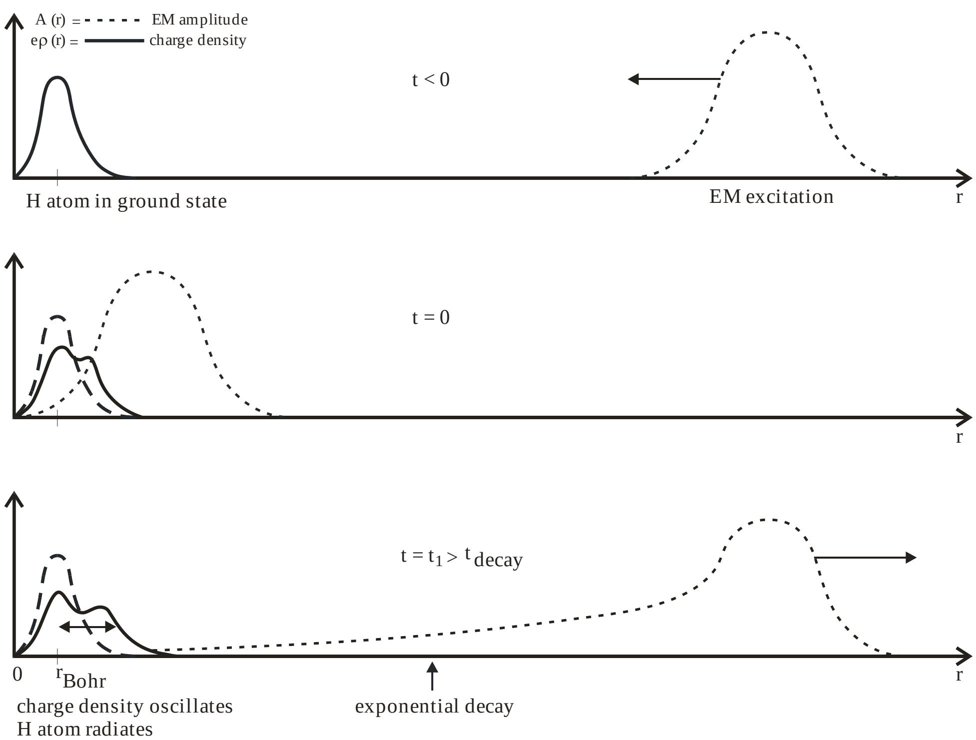

Figure 2. The figure schematically shows the hydrogen atom excitation process before (t $<$ 0) during (t $=$ 0) and after (t $>$ 0).The excitation, where ρ(r) is the electron location probability in relative distance to the proton. A(r) is the amplitude of the classical electromagnetic field. After the excitation, the charge density $e\rho(r,t)$ of the excited H atom oscillates and emits waves with discrete frequencies on the rear flank (in a finite space-time region) of the excitation wave package. In this region, marked with $\uparrow$, the exponential behavior of the emitted wave appears: The limited radius of V for a variation principle of the particles should be selected in this region.

$$\nu_{kl} = (E_k - E_l)/h; E_k > E_l, \tag{59}$$

which radiates electromagnetic waves with these frequencies, see Figure 2. The energy of the excited state declines smoothly during the radiation until the ground state energy is reached: Again, we do not need jumps/sudden excitation of electrons between energies E_k of the excited system as the traditional quantum mechanics assume.

The excited atom is a damped resonating system with the decay time $t_{decay} \gg 1/\upsilon_{kl}$. However, the Eq. (58) does not contain the damping factor.

On the wave-particle dualism: The electromagnetic radiation has unambiguous wave character and the particles are particles. But because of $\hbar$ the probabilities of particle densities of excited states behave in a similar manner to how they would if they were waves, as in Eq. (58) is shown. I do not follow Einstein's description of quantized photon, [2]. The Hamilton's Eikonal theory prohibits corpuscular light quanta. The emission of light by atoms is a wave phenomenon and not a corpuscular one. Double slit experiments have to be discussed within this context. Schrödinger, [31], disregarded the natural boundary condition on the surface S of the enclosed volume V and he set up integrals defined in the whole 3-dimensional space. A second difference is the quadratic appearance of $\hbar$ in Eq. (52) as a consequence of "switch-over" Eq. (48)-(52). In our Eq. (55) the $\lambda = \hbar$ is linear. Later on, relativistic corrections on the "non-relativistic" theory of H-atom were proposed, particularly in the frame of Quantum Electrodynamics (QED). And yet, one ought to question the QED since nobody remarked or criticized that the corresponding wave lengths λ_{ik} to ν_{ik} are essentially larger than the size of the excited states themselves!

Also the role of Planck's constant remains inexact in the transition of the traditional non-relativistic to the relativistic theory. It is unsurprising that Schrödinger did not find a relativistic description of a hydrogen atom. The reason is that $\hbar$ in the QED has a completely different meaning than in the relativistic field theory for mass particles, e.g. in the Dirac equation. In Feynman graphs the fine structure constant α is used as a coupling constant. The Feynman graphs deconstruct the relativistic phenomenon and the infinite sum of graphs lead to infinite terms which have to be renormalized. For instance, expressions for charges (and masses) are infinite terms and finite physical values of charges are only a consequence of renormalization. We consider $\hbar$ and $\hbar^0$ in our relativistic Atomistic Theory of Matter as Lagrange multipliers, based on the particle numbers conservation and the elementary charges q_i and g_i are the coupling constants between the fields and the particle densities.

Physical Interpretation of the Lagrange Multipliers h and h_0

In the electron-proton system both Lagrange multipliers h and h^0 appear together. h describes the atomic shells and explains the steady ground states and excited states. The lowest stable energy state of the hydrogen atom is at $\sim 13.6eV$. Meanwhile, the description of the stable neutron by h^0 leads to an even lower stable bound energy of the (e,P)-system at $2.04MeV$ [13]. We identified this lowest energy ground state as the stable neutron $N0$ and discussed this at an earlier point. However, the energy gap between these two ground states determined by h and h^0 is very large and the spatial distribution is so different that a spontaneous transition occurs very rarely. The transition from hydrogen ground state to stable neutron is neither described in literature nor directly observed. Still, we propose that an outer perturbation can reinforce the transition. Indirectly, phenomena such as the burning of a $2:1$ hydrogen oxygen mix (Oxyhydrogen) [35] might give important indications for this transition.

Another interesting two-particle system to investigate is the bound (e,p) system, known as positronium. The energy of the positronium ground state is nearly at $6.8eV$, half that of the hydrogen ground state energy. This is because the reduced mass is $m' = m_e/2$. Consequently the energy $E_{bound} = e^4 m_e/16h^2$. Since different decays of the initial para-positronium and ortho-positonium can be experimentally observed [28] this is a good occasion to examine the above mentioned non-conservative transition process from positronium to electron-neutrino ν_e. The preferred decay of a positronium is into an electron-neutrino and two radiations with an approximate energy of $0.511MeV$. It should be remembered that the electron and positron pair do not annihilate each other after the radiation; instead they form the electron-neutrino. In traditional relativistic quantum field theories the interactions are presented with annihilation and the creation of field particles. The Atomistic Theory does not agree with this formalism.

The relations between h, h^0, the sizes of objects in the ground states Eqs. (21) and the natural constants e, c, the reduced masses m' as well as the bound energies E_{bound} all are, to some extent, approximations, but they are very useful and plausible relations. In a forthcoming article the author will treat the variation problem of the relative motion of particles in the case of stationary solutions in detail and explain these relations, i.e. determine the conditions for the calculation of the bound energies with Eq. (55). The form of the Atomistic Theory of Matter presented here sets physics at ease: electromagnetic and gravitational interactions are well accepted for all physical processes in Nature. However, these interactions are non-conservative and precise inertial conditions, the dominant characteristics of classical physics, are missed. Furthermore, the central principle of physics, that of the energy conservation, has to be replaced with conservation of Maxwell-charges and, consequentially, with the conservation of particle numbers.

CONCLUSION

A relativistic description of particles and fields in a finite range of the Minkowski space was developed in the framework of an Atomistic Theory of Matter. The theory model was achieved with a new assumption: Gravity is caused by elementary gravitational charges $g_i = \pm g \cdot m_i$; a second kind of charge alongside the elementary electric charges $q_i = \pm e$ of the stable elementary particles. Charge conservation is an equivalent statement to the conservation of particle numbers n_i. The inertial mass and the gravitational mass of composite particle systems are different even in the rest frame of reference. Accordingly, Newton's classical law of motion in gravity has to be modified. Due to the isopetric subsidiary condition the equations for the motion of particle systems contain some additional constants, producing the radiation of electromagnetic rays with discrete frequencies. We have compared this new theory to traditional Quantum Mechanics based on the Schrödinger theory. In this comparison the Planck's constant h (Max Planck, 1900) plays an entirely different role. The constant h is neither a quantum of action nor of energy; h appears as a Lagrange multiplier in the Minkowski space for particle systems corresponding to the isopetric subsidiary conditions. The Bohr-Heisenberg Corresponding Principle has covered the inconsistency of the Quantum Theory. The new theory does not use energy expressions for the descriptions of time development. Nor does it agree with the quantization of the interacting field in which virtual particles cause the interactions. Generally, quanta are not needed in physics beside the four stable elementary particles. The theory uses a second constant, h^0 to describe the nuclei, neutrinos and unstable particles. The Atomistic Theory of Matter is an axiomatic, self-consistent theory and is able to explain the discrepancies of the two pillars of modern physics, since both those theories are based on invalid fundamental assumptions. The Atomistic Theory can replace the Energetic Theory to deliver a comprehensive physical description of Nature. It then follows that Nature is not based on energy conservation, but rather on charge conservation and, from that, the conservation of particle numbers. The physical laws of Nature are non-deterministic, however causal.

ACKNOWLEDGMENTS

I would like to thank Julian Szász for his support in the preparation of this article.

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