A Comparison of the Static and the Dynamic Forms of Interaction within the Atomistic Theory of Matter

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Abstract

The Atomistic Theory of Matter is based on four kinds of point-like stable particles: electrons (e), positrons (p), protons (P) and eltons (E). These carry two kinds of conserved elementary charges, $q_i = \{\pm e\}$ and $g_i = \{\pm g \cdot m_e, \pm g \cdot m_P\}$. This paper discusses approaches which lead to the static and dynamic forms of interaction. The interactions are caused by elementary electric charges, q_i, and by the elementary gravitational charges, g_i and the interactions propagate with a constant speed, c. The propagation speed is independent of the state of the motion of the particles. A comparison is performed between Newton's second law, $F = m^i \cdot a$ (applied to the static gravitation force and the Coulomb force) and the derivation of Maxwell equation, within the atomistic theory of matter. During static force laws describe conservative interactions, Maxwell equation deals with non-conservative interacting fields. Also a comparison to Schrödinger theory of energy quantization of particles is included. The dynamics of particles with interactions is derived with occurrence of Lagrange multipliers, λ_k.

Introduction

The main tasks of physics **[1]** are to determine what matter is and from which constituents matter is composed to ascertain the interactions between those constituents and to deduce the time development of physical systems. The basic principles of established physics are Newton's four laws of classical physics, the hypothesis of the universality of free fall (UFF) and energy conservation. The quantization of energy is connected to energy conservation. The modern theory of gravitation follows from UFF according to the general theory of relativity. The energy-mass-equivalence principle connects energy with mass within the special theory of relativity. Nevertheless, from this cluster of basic principles still doesn't fully address the main tasks of physics, nor is a concept of mass determined which would for instance determine the observed composite particles and their masses.

Therefore, in these paper I do not rely on the basic principles of the established physics, especially not the UFF and energy conservation. Ruther, I have introduced a new physical axiom system which defines the constituents of matter and their interactions:

Four kinds of point-like stable, elementary particles exist: e, p, P and E.

- The elementary particles carry two kind of conversed elementary charges, q_i = $\{- e, + e, + e, - e\}$ *and* $g_i = \{- g{\cdot}m_e, + g{\cdot}m_e, + g{\cdot}m_P, - g{\cdot}m_P\}$, $i = e, p, P, E$.

- The elementary charges cause the interactions between particles. They cause the interaction fields. The masses m_P, m_e *are the elementary masses of proton and electron.*

- The interactions propagate with c and the constant propagation is independent of the state of the motion of particles.

Because of the physical measurements, it should be taken into account that

- measurements with infinite precision cannot be assumed,

- each measurement is performed in finite regions of space and time.

The axiom system is the principle of atomistic theory of matter, based on stable elementary particles which carry two kinds of conserved charges. The axioms incorporate basic assumptions about the constituents of matter and their interactions. The elementary particles are the electrons (e), positrons (p), protons (P) and eltons (E). In conventional physics the eltons are called “anti-protons”. The two kinds of interactions, caused by the elementary charges, are the two known fundamental interactions in physics: electromagnetism and gravitation.

In the following I shall derive within the atomistic theory the static (conservative interaction) and the dynamic forms of interaction (which are principally non-conservative) and compare these with the basic principles of established physics.

The Static Form of the Fundamental Interactions

At first I should state the static form of interactions which are principally conservative. It must only be defined or understood in terms of macroscopic bodies with Newton’s and Coulomb’s static force laws together with Newton’s second, as a result, that the relative positions, $r = |\mathbf{r}_i - \mathbf{r}_j|$ and the relative velocities, $v = |\mathbf{v}_i - \mathbf{v}_j|$, of bodies can be precisely defined. For particles in the microscopic range these quantities cannot be observed. Further considerations are that all relative velocities between two macroscopic bodies are small compared with c, which means that $v/c << 1$, and the propagation velocity of the interactions, c, is neglected. A further approach is also applied, that the motions of the elementary particles within the bodies are neglected. In these approaches, the static forces between two macroscopic bodies are given by the static electric force (Coulomb's law)

$$\mathbf{F}^{(em)}(body_1, body_2) = + Q(body_1)\cdot Q(body_2)\cdot(\mathbf{r_2} - \mathbf{r_1})/4\cdot\pi\cdot|(\mathbf{r_2} - \mathbf{r_1})|^3, \qquad (1)$$

and by Newton's principle for the static gravitational force

$$\mathbf{F}^{(g)}(body_1, body_2) = - G(body_1)\cdot G(body_2)\cdot(\mathbf{r_2} - \mathbf{r_1})/4\cdot\pi\cdot|(\mathbf{r_2} - \mathbf{r_1})|^3. \qquad (2)$$

Newton's famous equation for gravity was originally somewhat simpler

$$\mathbf{F}^{(g)}(body_1, body_2) = - G\cdot m^g(body_1)\cdot m^g(body_2)\cdot(\mathbf{r_2} - \mathbf{r_1})/|(\mathbf{r_2} - \mathbf{r_1})|^3,$$

with the universal gravitational constant $G = g^2/4\cdot\pi$ and with the gravitational masses, $m^g(body_j)$, in Euler's notation. Newton's gravity law used hidden gravitational charges with the same signs. Both static forces depend of the relative distance of the bodies, $\mathbf{r} = (\mathbf{r_2} - \mathbf{r_1})$.

The electric charges $Q(body_1)$, $Q(body_2)$ of the bodies are composed of the elementary charges, q_i, and the gravitational charges, $G(body_1)$, $G(body_2)$, are composed by the elementary gravitational charges, g_i, respectively. Since the elementary particles carry two kinds of charges, the static forces, $\mathbf{F}^{(em)}(body_1, body_2)$ and $\mathbf{F}^{(g)}(body_1, body_2)$, always appear together. However, the electric force is greater than the gravitational force by a factor of ca. 10^{+42}. Furthermore, the extensions of the macroscopic bodies are considered as to be small compared to the relative distance, $r = |\mathbf{r}_1 - \mathbf{r}_2|$. Figuratively speaking, one considers the principle that all elementary particles of two bodies are sitting on the positions $\mathbf{r}_1$ and $\mathbf{r}_2$ with the total charges,

$$Q(body_j) = \Sigma\, q_j,\ G(body_j) = \Sigma\, g_j, \qquad (3)$$

The summation concerns the elementary particles within the $body_j$. In the above mentioned approaches Newton's second law

$$\mathbf{F} = m^i\cdot\mathbf{a} = m^i\cdot d^2\mathbf{r}/dt^2, \qquad (4)$$

"*force = inertial mass · acceleration*", is to be understood with the static electric and the static gravitational forces and with $\mathbf{a}(body_1) = d^2\mathbf{r_1}/dt^2 - d^2\mathbf{r_2}/dt^2$

$$m^i(body_1)\cdot\mathbf{a}(body_1) = \mathbf{F}^{(em)}(body_1, body_2) + \mathbf{F}^{(g)}(body_1, body_2). \qquad (5)$$

In Newton's second law the inertial mass, $m^i(body_1)$, is considered, especially as the inertial rest mass.

Motion in a Static Gravitational Field

Because of the very large difference between the strengths of the electric and gravitational forces, our calculation for motion in gravity only make sense if the Coulomb force does not apply

$$\mathbf{F}^{(em)}(body_1, body_2) = 0. \qquad (6)$$

A necessary condition is that the $body_1$ is electric neutrally, $Q(body_1) = 0$. Furthermore, it is assumed that no outer fields are present. Then the equation of motion of $body_1$ in the gravitational field of a second body is

$$m^i(body_1)\cdot\mathbf{a}(body_1) = \mathbf{F}^{(g)}(body_1, body_2)$$

$$= - G(body_1)\cdot G(body_2)\cdot(\mathbf{r_2} - \mathbf{r_1})/4\cdot\pi\cdot|(\mathbf{r_2} - \mathbf{r_1})|^3. \qquad (7)$$

We shall frequently consider bodies which are composed of electric neutrally atoms or isotopes, which are known as stable entities. In this case, the gravitational charge of a body is the sum of the gravitational charges of electric neutrally isotopes

$$G(body) = \Sigma\, h(A,Z)\cdot g(A,Z\ isotope), \qquad (8)$$

whereby $h(A,Z)$ is the frequency of occurrence for an isotope with mass number A and with nuclear charge Z. If the isotopes do not contain elton particles, the gravitational charges of the isotopes composed by the elementary gravitational charges, $g_i = \{\pm g\cdot m_e, \pm g\cdot m_P\}$, do not depend on Z, but only on A

$$g(A,Z\ isotope) = g(A\ isotope) = + g\cdot A\cdot(m_p - m_e). \qquad (9)$$

The number of positrons, $N_{p,}$ does not appear in this expression because an equal number of electrons neutralize the gravitational charges of the positrons. In this case the gravitational charge of a macroscopic body is simple

$$G(body) = \Sigma\, h(A,Z)\cdot g(A,Z\ isotope) = + g\cdot N\cdot(m_p - m_e), \qquad (10)$$

where N is the number of protons within the body; m_p and m_e are the elementary masses of protons and of electrons. In the case that two bodies are composed of electric neutrally isotopes, which do not contain eltons, the equation of motion of a macroscopic $body_1$ expressed with gravitational charges is

$$m^i(body_1) \cdot \mathbf{a}(body_1) = - G(body_1)\cdot G(body_2)\cdot(\mathbf{r_2} - \mathbf{r_1})/4\cdot\pi\cdot|(\mathbf{r_2} - \mathbf{r_1})|^3$$

$$= - (g\cdot N_1\cdot(m_p - m_e))\cdot(g\cdot N_2\cdot(m_p - m_e))\cdot(\mathbf{r_2} - \mathbf{r_1})/4\cdot\pi\cdot|(\mathbf{r_2} - \mathbf{r_1})|^3$$

$$= - G\cdot m^g{}_1\cdot m^g{}_2\cdot(\mathbf{r_2} - \mathbf{r_1})/|(\mathbf{r_2} - \mathbf{r_1})|^3. \qquad (11)$$

This is to be compared to Newton's $G = g^2/4\cdot\pi$, The gravitational masses are $m^g(body_1) = m^g{}_1 = N_1\cdot(m_p - m_e)$ and $m^g(body_2) = m^g{}_2 = N_2\cdot(m_p - m_e)$. Newton's equation of motion contains the inertial mass $m^i(body_1)$ and the gravitational mass, $m^g(body_1) = m^g{}_1$, of $body_1$. Within the atomistic theory, we see that the gravitational masses, $m^g(body)$, are constant if the numbers of electrons, positrons and protons remain constant within the macroscopic bodies.

Also, we know phenomenological the inertial masses of the isotopes, m^i(A,Z isotope), from mass-spectrometry, **[2],** and we can therefore phenomenological calculate the inertial mass of each body according to

$$m^i(body) = \Sigma\, h(A,Z)\cdot m^i(A,Z \text{ isotope}). \qquad (12)$$

The acceleration of $body_1$ in the gravitation field of another body is

$$\mathbf{a}(body_1) = - G\cdot m_2{}^g\cdot(\mathbf{r_2} - \mathbf{r_1})/|(\mathbf{r_2} - \mathbf{r_1})|^3\cdot m^g(body_1)/m^i(body_1)$$

$$= - \mathbf{a_0} \cdot m^g(body_1)/m^i(body_1) = - \mathbf{a_0} \cdot (1 + \Delta(body_1). \qquad (13)$$

The expression

$$\mathbf{a_0} = G\cdot m_2{}^g\cdot(\mathbf{r_2} - \mathbf{r_1})/|(\mathbf{r_2} - \mathbf{r_1})|^3 = g^2\cdot m_2{}^g\cdot(\mathbf{r_2} - \mathbf{r_1})/4\cdot\pi\cdot|(\mathbf{r_2} - \mathbf{r_1})|^3, \qquad (14)$$

does not depend on $body_1$. Only the relative mass defect

$$\Delta(body_1) = (m^g(body_1) - m^i(body_1))/m^i(body_1) = m^g(body_1/m^i(body_1) - 1, \qquad (15)$$

depends of property of $body_1$. The relative mass defect, Δ(body), can be phenomenological calculated for each body if we know the isotope composition of the body, because the atomistic theory gives us the gravitational mass, m^g(body). The UFF is not valid then the calculation gives **[3]**

$$- 0.109\% \text{ (hydrogen atom)} < \Delta(body) < + 0.784\% \text{ (}^{56}\text{Fe isotope)}. \qquad (16)$$

In conclusion are the inertial and the gravitational masses of each body different. In established energetic physics the m^g(body) is unknown and it is falsely set

$m(body) = m^i(body) = m^g(body).$ (17)

For the sake of completeness, using the atomistic theory of matter, we can also gain the inertial rest masses of each body, which are composed of N_i elementary particles i = e, p, P and E

$$m^i(body) = (N_P + N_E)\cdot m_P + (N_p + N_e)\cdot m_e - E(binding)/c^2 \geq 0. \quad (18)$$

The energy E(binding) radiates from the body at the binding of the elementary particles. The expression of m^i(body) with m^i(A,Z isotope), Eq. (12), is only an approximation, then the binding energies of the isotopes in body are neglected which are ca. 10^{-6}-times smaller than the average binding energies of particles within the isotopes. The general expression for the gravitational charge connected to the masses is

$$G(body) = \pm\, g\cdot|((N_P - N_E)\cdot m_P + (N_p - N_e)\cdot m_e)|. \quad (19)$$

Gravity can be attractive, repulsive (or zero) depending on the signs of the product $G(body_1)\cdot G(body_2)$.

The approaches of the static interactions are discussed in so far at least for the gravity. Newton's second law describes only dynamics in the statics case. The Newtonian Theory of Gravitation holds only if the signs of the gravitational charges are the same, however, the masses m^i and m^g are different. The matter on Earth is seemingly consisting of components with positive gravitational charges because the mass of proton is 1836 times greater than mass of electron and the gravitational charges of positrons are compensated by the same number of electrons. Further information about the static gravity and the atomistic theory of matter are in **[3]**.

Space is assumed to be Euclidean and time, t, is a separate parameter. The relative positions of two bodies, $\mathbf{r}(t) = \mathbf{r}_1(t) - \mathbf{r}_2(t)$, fulfill the relation for scalar product

$$(\mathbf{r}(t)\cdot\mathbf{r}(t)) = (x_1(t) - x_2(t))^2 + (y_1(t) - y_2(t))^2 + (z_1(t) - z_2(t))^2 > 0.$$

With the relative position vector, $\mathbf{r}(t)$, the relative velocity and relative acceleration are

$$\mathbf{v} = d\mathbf{r}(t)/dt = d\mathbf{r_1}/dt - d\mathbf{r_2}/dt\ ,\ \mathbf{a} = d^2\mathbf{r}(t)/dt^2 = d^2\mathbf{r_1}/dt^2 - d^2\mathbf{r_2}/dt^2. \quad (20)$$

The precise initial conditions $(\mathbf{r}(t_0),\mathbf{p}(t_0))$ are only valid for macroscopic bodies, and cannot be used in microscopic ranges.

Newton's four laws (the inertia, the dynamics, the action-reaction principle and the independence of forces) lead to classical physics, and they can be discussed as approaches to the atomistic theory of matter. The first law, which defines inertial systems, is somewhat specially since it concerns bodies in interaction-free regions. In interaction-free regions the inertial mass, m^i(body), plays no role. In other words, the first Newtonian law cannot invariably apply to the inertial mass of bodies moving in inertial systems. The inertial masses are invariably addressed by the dynamics, principally by Newton's second law.

The Core of Electrodynamics

The dynamics of the electromagnetic field **[4]** was discovered by Maxwell in the 19^{th} century. Maxwell did not have used the Newtonian four laws.

The static electric force between a test electric charge q_j and a body which is composed of n elementary charges, q_i, is given by the Coulomb's law

$$\mathbf{F}_j^{(em)}(\mathbf{r}_j) = + 1/4\cdot\pi\ \Sigma_i^n\ q_j\cdot q_i\cdot(\mathbf{r}_i - \mathbf{r}_j)/|(\mathbf{r}_i - \mathbf{r}_j)|^3. \qquad (21)$$

The static electric field $\mathbf{E}(\mathbf{r}_j)$ at the position $\mathbf{r}_j$ is

$$\mathbf{E}^{(em)}(\mathbf{r}_j) = + 1/4\cdot\pi\ \Sigma_i^n\ q_i\cdot(\mathbf{r}_i - \mathbf{r}_j)/|(\mathbf{r}_i - \mathbf{r}_j)|^3. \qquad (22)$$

The flux of the vector field $\mathbf{E}^{(em)}$ from the n charges which are located somewhere inside the closed surface S (and act on a single charge, $q_{j,}$ outside S)

$$\text{Flux of } E^{(em)} = + \int^S \mathbf{E}^{(em)}\cdot\mathbf{dS}. \qquad (23)$$

The superposition principle of electric charges gives

$$\int^S \mathbf{E}^{(em)}\cdot\mathbf{dS} = \Sigma_i^n\ q_i = Q(\text{body}). \qquad (24)$$

Since we don't know the location of the charges inside the body (within a volume V), we can express the total charge with the charge density

$$Q(\text{body}) = \int^V \rho^{(em)}\ dV$$

and we have Gauss's law in integrated form

$$Q(\text{body}) = \int^S \mathbf{E}^{(em)}\cdot\mathbf{dS} = \int^V \text{div}\mathbf{E}^{(em)}\ dV = \int^V \rho^{(em)}\ dV. \qquad (25)$$

The differential equation is known as

$$\text{div}\ \mathbf{E}^{(em)} = \rho^{(em)}. \qquad \textbf{Maxwell I} \qquad (26)$$

The magnetic flux through any closed surface, S, is zero

$$\int^{S} \mathbf{B}^{(em)}\cdot\mathbf{dS} = 0, \qquad (27)$$

according to the divergence theorem

$$\mathrm{div}\mathbf{B}^{(em)} = 0. \qquad \textbf{Maxwell II} \qquad (28)$$

The energy gained by charge, q_j, along path C is

$$W^{(em)} = \int_C \mathbf{F}^{(em)}\cdot d\mathbf{l} = q_j \int_C \mathbf{E}^{(em)}\cdot d\mathbf{l} = q_j \int_{r1}^{r2} E^{(em)}\cdot dr \qquad (29)$$

Coulomb's law reveals the conservative property of the electrostatic field

$$\int_C \mathbf{E}^{(em)}\cdot d\mathbf{l} = \int_{r1}^{r2} E^{(em)}(r)\, dr \qquad (30)$$

along any curve between two points r_1 and r_2. It is zero if $r_1 = r_2$. Stock's Theorem gives

$$\mathrm{rot}\, \mathbf{E}^{(em)} = 0. \qquad (31)$$

Because, for a scalar field ϕ yields

$$\mathrm{rot}(\mathrm{grad}\, \phi) = 0, \qquad (32)$$

so the conservative electrostatic field can be written in terms of a potential

$$\mathbf{E}^{(em)} = - \mathrm{grad}\, \phi^{(em)}, \qquad (33)$$

and with the current density $\mathbf{j}$, for the static magnetic field yields

$$\mathrm{rot}\, \mathbf{B}^{(em)} = + \mathbf{j}^{(em)}/c. \qquad (34)$$

$\mathbf{B}^{(em)}$ is non-conservative unless there are no currents.

The conservation of electric charges is expressed by

$$\mathrm{div}\, \rho^{(em)} + \partial \mathbf{j}^{(em)}/\partial t = 0. \qquad (35)$$

If the fields are time dependent it follows then

$$\mathrm{rot}\, \mathbf{E}^{(em)} = - 1/c\cdot\partial \mathbf{B}^{(em)}/\partial t. \qquad \textbf{Maxwell III} \qquad (36)$$

Maxwell III gives the non-conservative part of the electric field if the field is time dependent.

Apart from a term in order of $o((v/c)^2)$ the Lorentz force is

$\mathbf{F}_j^{(em)} = + q_j \cdot (\mathbf{E}^{(em)} + \mathbf{v}/c \; \mathbf{x} \; \mathbf{B}^{(em)})$. (37)

The last equation holds for time-dependent magnetic field, $\mathbf{B}^{(em)}$

$\text{rot}\, \mathbf{B}^{(em)} = \mathbf{j}^{(em)}/c + 1/c \cdot \partial \mathbf{E}^{(em)}/\partial t$. **Maxwell IV** (38)

Instead of $\mathbf{E}^{(em)}$ and $\mathbf{B}^{(em)}$ we can work with a scalar potential $\phi^{(em)}$ and with a vector potential $\mathbf{A}^{(em)}$. Then the fields $\mathbf{E}^{(em)}$ and $\mathbf{B}^{(em)}$ can be written in terms of

$\mathbf{E}^{(em)} = -\, \text{grad}\, \phi^{(em)} - 1/c \cdot \partial \mathbf{A}^{(em)}/\partial t$. (39)

$\mathbf{B}^{(em)} = \text{rot}\, \mathbf{A}^{(em)}$, (40)

However, the new potentials, $\phi^{(em)}$ and $\mathbf{A}^{(em)}$, must fulfill gauge transformations. In the following we shall use the Lorenz gauge

$\text{div}\, \mathbf{A}^{(em)} + 1/c^2 \cdot \partial \phi^{(em)}/\partial t = 0$, (41)

because we want the wave equation to be valid for $\phi^{(em)}$ and $\mathbf{A}^{(em)}$ separately. The Lorenz gauge means the electromagnetic field propagate with c. Up to now, the fields were functions of the position vector **r** and the independent variable t .

One can write the electrodynamics in covariant formulation in Minkowski space, $\{x\} \, \varepsilon \, \Omega$. Such a formulation was presented mainly by Lorentz, Poincaré and Minkowski at the beginning of the 20^{th} Century. We write the covariant four-vectors, $x^\nu = (c \cdot t, \mathbf{r})$, $\partial^\nu = \partial/\partial x_\nu = (1/c \cdot \partial/\partial t, -\partial/\partial \mathbf{r})$, the electromagnetic potential and the current density in the Minkowski space as

$A^{(em)\nu}(x) = (\phi^{(em)}(\mathbf{r},t)/c, \mathbf{A}^{(em)}(\mathbf{r},t))$, with $\nu = 0, 1, 2, 3$ and (42)

$j^{(em)\nu}(x) = (c \cdot \rho^{(em)}(\mathbf{r},t), \mathbf{j}^{(em)}(\mathbf{r},t)$. (43)

With the electric charge conservation

$\partial_\nu j^{(em)\nu}(x) = 0$,

and with the Lorenz gauge (double occurring indexes are sums over 0, 1, 2, 3)

$\partial_\nu A^{(em)\nu}(x) = 0$, (44)

we have the Maxwell equation in a compact, covariant form

$\partial_\mu \partial^\mu A^{(em)\nu}(x) = + j^{(em)\nu}(x)$. (45)

It can be assumed **[5]** that one could also perform the same procedure also for the gravitational field, which is caused by the elementary gravitational charges,

g_i. One need only replace the label $^{(em)}$ with $^{(g)}$ in the formalism and one take into account that instead of the Coulomb's law the Newtonian law gives the connections between the charges and the force, $\mathbf{F}_j^{(g)}(\mathbf{r_j})$, with a minus sign,

$$\mathbf{F}_j^{(g)}(\mathbf{r_j}) = - 1/4\cdot\pi\ \Sigma_i^n\ g_j\cdot g_i\cdot(\mathbf{r}_i - \mathbf{r}_j)/|(\mathbf{r}_i - \mathbf{r}_j)|^3 = - g_j\cdot\mathbf{E}^{(g)}(\mathbf{r_j}). = - g_j\cdot\int^V \rho^{(g)}\ dV. \qquad (46)$$

The appearing minus sign in the force means that we must also replace $\mathbf{j}^{(em)}$ with - $\mathbf{j}^{(g)}$ in connection to the field. We write explicitly only the most important equations for gravity. For the equation of the static gravito-magnetic fields holds

$$\text{rot}\ \mathbf{B}^{(g)} = - \mathbf{j}^{(g)}/c. \qquad (47)$$

The continuity equation of gravitational charges is

$$\text{div}\ \rho^{(g)} + \partial\mathbf{j}^{(g)}/\partial t = 0, \qquad (48)$$

and Lorentz force for the gravitation is up to a term of the order of $o((v/c)^2)$

$$\mathbf{F}_j^{(g)} = - g_j\cdot(\mathbf{E}^{(g)} + \mathbf{v}/c\ \mathbf{x}\ \mathbf{B}^{(g)}). \qquad (49)$$

In the invariant notation the Lorenz gauge remains the same for the gravitation

$$\partial_{\mathbf{v}}\, A^{(g)v}(x) = 0. \qquad (50)$$

The corresponding covariant wave equation for the gravitational field will be

$$\partial_{\boldsymbol{\mu}}\, \partial^{\boldsymbol{\mu}}\, A^{(g)v}(x) = - j^{(g)v}(x). \qquad (51)$$

In must be emphasized that $j^{(em)v}(x)$ and $j^{(g)v}(x)$ are probability density covariant four vector-functions. In the following we shall derive the covariant equations of motion for the fields and particles within the Lagrange formalism (in finite ranges of Minkowski space $\{x\}\ \varepsilon\ \Omega$). A crucial point is the formulation of the invariant, non-conservative interactions between the charge probability density functions and the fields. We attain an elegant formulation of covariant dynamics, but it can be seen that the energy is neither conserved, nor quantized.

The Dynamic Form of Electromagnetic and Gravitational Interactions

For the formulation of dynamics, Lagrange, Euler and Hamilton gave a generalized description. They created the Lagrange formalism. The equations of motion can be derived and according to the Hamilton principle. This allowed using a more general form of interactions. Nevertheless, Lagrange, Euler and Hamilton did not have use the most general description for physics. They used, for instance, that the positions and velocities (impulses) of bodies, ($\mathbf{r}_i(t)$, $\mathbf{p}_i(t)$), can be determined at every time, t, precisely. At least, they assumed that the precise initial conditions, ($\mathbf{r}_i(t_0)$, $\mathbf{p}_i(t_0)$), can be assumed at some time, $t = t_0$. In the following, I shall give up this assumption.

Because the interactions are assumed to propagate with the constant speed c, space and time are connected. I shall describe the dynamics in finite ranges of Minkowski space, Ω. In Minkowski space the distance between two points $a_1^\nu = (c\cdot t_1, \mathbf{r}_1)$ and $a_2^\nu = (c\cdot t_2, \mathbf{r}_2)$ is defined with an invariant expression

$$\Delta(a_1,a_2) = a_{1\nu}\, a_2^\nu = c^2\cdot(t_1 - t_2)^2 - ((x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2). \quad (52)$$

This expression is not positive definite. Individual particles can only move on paths connecting points with $\Delta(a_1,a_2) > 0$. The interactions propagate on a four dimensional surface with $\Delta(a_1,a_2) = 0$. The distances $\Delta(a_1,a_2) < 0$ correspond to different individual particles. Furthermore, $\partial^\nu = \partial/\partial x_\nu = (1/c\cdot\partial/\partial t, -\partial/\partial\mathbf{r})$.

The following does not use the condition that the knowledge of precise positions, $\mathbf{r}_i(t)$, and velocities (impulses, $\mathbf{p}_i(t)$) of particles/bodies are known. Furthermore, I formulate each expression in Lorentz covariant forms in order to be sure that they are valid in each coordinate system of Minkowski space Ω.

Therefore, I write for each kinds of particle, i, instead of ($\mathbf{r}_i(t)$,$\mathbf{p}_i(t)$), the Lorentz covariant probability current densities, $j_i^{(n)\nu}(x) = (c\cdot\rho^{(n)}(\mathbf{r},t),\mathbf{j}^{(n)}(\mathbf{r},t))$, ν = 0,1,2,3, $\{x\}\varepsilon\ \Omega$. Any particles of the same kind are indistinguishable from each other. Therefore, the electric current density (expressed by elementary electric charges, q_i,) is given by

$$j^{(em)\nu}(x) = \Sigma_{i=e,p,P,E}\ q_i\cdot j_i^{(n)\nu}(x). \quad (53)$$

For the current density of gravitational charges, g_i, we use a similar expression

$$j^{(g)\nu}(x) = \Sigma_{i=e,p,P,E}\ g_i\cdot j_i^{(n)\nu}(x). \quad (54)$$

Since the elementary charges cause the fields, the interaction between charges probability current densities and the field can be written in the following Lorentz invariant form for electromagnetism

$$+ j^{(em)}{}_\nu(x)/c\ A^{(em)\nu}(x) = + \Sigma_{i=e,p,P,E}\ q_i\cdot j_i^{(n)}{}_\nu(x)\cdot A^{(em)\nu}(x), \quad (55)$$

and for gravitation

$$- j^{(g)}{}_\nu(x)/c\ A^{(g)\nu}(x) = - \Sigma_{i=e,p,P,E}\ g_i\cdot j_i^{(n)}{}_\nu(x)\cdot A^{(g)\nu}(x). \quad (56)$$

One sees that the fields must be four vector fields, $A^{(em)\nu}(x)$ amd $A^{(g)\nu}(x)$, in order to get a Lorentz invariant interaction term. Since the fields propagate with the constant speed, c, the four vector fields must fulfill the subsidiary conditions (the Lorenz conditions)

$$\partial_\nu A^{(em)\nu}(x) = 0 \text{ and } \partial_\nu A^{(g)\nu}(x) = 0. \quad (57)$$

The action integral is constructed with a Lorentz invariant Lagrange density, **[6]**

$$I = \int^{\Omega} (dx)^4 \{\Sigma_{i=e,p,P,E}\, m_i \cdot c \cdot \partial_\nu j_i^{(n)\nu}(x) - (F^{(em)}{}_{\mu\nu}(x) \cdot F^{(em)\mu\nu}(x) + F^{(g)}{}_{\mu\nu}(x) \cdot F^{(g)\mu\nu}(x))/4$$

$$- \Sigma_{i=e,p,P,E}\, q_i \cdot j_i^{(n)}{}_\nu(x) \cdot A^{(em)\nu}(x) + \Sigma_{i=e,p,P,E}\, g_i \cdot j_i^{(n)}{}_\nu(x) \cdot A^{(g)\nu}(x)\}, \quad (58)$$

with the help of the Faraday tensors

$$F^{(em)\mu\nu}(x) = \partial^\mu A^{(em)\nu}(x) - \partial^\nu A^{(em)\mu}(x), \quad (59)$$

$$F^{(g)\mu\nu}(x) = \partial^\mu A^{(g)\nu}(x) - \partial^\nu A^{(g)\mu}(x). \quad (60)$$

The action integral is a Lorentz scalar. It is a probability density functional and it is constructed in order to derive the dynamics of the fields and the particles in a most general form. But the action functional, I, is not an expression for energy.

With the Hamilton principle, treating $A^{(em)\nu}(x)$ and $A^{(g)\nu}(x)$ as independent generalized variables and applying the Lorenz conditions as subsidiary conditions, the dynamics of the fields could be derived in the usual way within Ω. The covariant dynamics of the fields are given by the equations

$$\partial^\mu \partial_\mu A^{(em)\nu}(x) = + j^{(em)\nu}(x) = + \Sigma_{i=e,p,P,E}\, q_i \cdot j_i^{(n)\nu}(x), \quad (61)$$

$$\partial^\mu \partial_\mu A^{(g)\nu}(x) = - j^{(g)\nu}(x) = - \Sigma_{i=e,p,P,E}\, g_i \cdot j_i^{(n)\nu}(x). \quad (62)$$

The first equation is the well known Maxwell equation. The second equation is a new wave equation for the motion of the covariant gravitational field, $A^{(g)\nu}(x)$. Both equations are wave equation with the propagation speed c.

The Dynamics of Particle Systems

The particles also have subsidiary conditions which are given by the conservation of particle numbers, $\partial_\nu j_i^{(n)\nu}(x) = 0$, i = e,p,P,E. within Ω. I call the subsidiary conditions of particles as isopretic subsidiary conditions because the numbers of particles are conserved in Ω and these are integral conditions. Such subsidiary conditions must be treated as Lagrange multipliers, λ_i, at the variation, **[7]**

$$\delta I + \delta \Sigma_k \lambda_k/c\cdot(\Sigma_i \int^{\Omega} (dx)^4 \partial_\nu j_i^{(n)\nu}(x)) = 0. \quad (63)$$

The subsidiary conditions for particles are never used in the established physics. Furthermore, the probability current densities must be written in a bilinear form

$$j_i^{(n)\nu}(x) = (c\cdot\rho_i(\mathbf{r},t),\mathbf{j}_i(\mathbf{r},t)) = c\cdot\underline{\psi_i}(x)\gamma^\nu\psi_i(x),\ \nu = 0,1,2,3 \text{ and } i = e,p,P,E, \quad (64)$$

and must be inserted in I, in order to perform the variation. It is important to notice, that the four components Dirac spinors $\psi_i(x)$, the adjoin spinors $\underline{\psi_i}(x) = \psi_i(x)^{T*}\cdot\gamma^0$ and the γ^ν matrixes come into the theory because neither the positions, nor the velocities (impulses) of the particles are precisely known. Per construction the $\underline{\psi_i}(x)\gamma^\nu\psi_i(x)$ are covariant four-vectors and fulfill the continuity equations $\partial_\nu(\underline{\psi_i}(x)\gamma^\nu\psi_i(x)) = 0$, i = e,p,P,E. At the variation then the spinors and adjoint spinors, $\psi_i(x)$, $\underline{\psi_i}(x)$, i = e,p,P,E, must be treated as independent generalized variables. The derived equation of particle motion is

$$(m_i\cdot c^2 - \Sigma_k \lambda_k\cdot\partial_\nu\gamma^\nu)\, \psi_i(x) + q_i\cdot A^{(em)}{}_\nu(x)\gamma^\nu\psi_i(x) - g_i\cdot A^{(g)}{}_\nu(x)\gamma^\nu\psi_i(x) = 0,$$

$$i=e,p,P,E. \quad (65)$$

The variation of Eq. (58) is stationary in Ω, if all the spinors, $\psi_i(x)$, fulfill these equations and if the fields fulfill the covariant wave equations Eqs. (61), (62).

But, that the variation is stationary is another problem, because we are seeking the time stationary in order to render conserved energies for exceptional particle states in Ω. For time stationary of solutions one must consider the equations

$$(m_i\cdot c^2 - i\cdot\Sigma_k \lambda_k'/2\pi\cdot\partial'_\nu\gamma^\nu)\psi_i'(x') + q_i\cdot A^{(em)\prime}{}_\nu(x')\gamma^\nu\psi_i'(x') - g_i\cdot A^{(g)\prime}{}_\nu(x')\gamma^\nu\psi_i'(x') = 0,$$

$$\text{for } i = e, p, P, E. \quad (66)$$

The mutual fields of a composite particle systems, $A^{(em)\prime\nu}(x')$and $A^{(g)\prime\nu}(x')$, must also be time stationary in the center of mass (COM) of the particles and $\psi_i'(x')$ are relative spinors. The coordinate, x’, is to be taken according to COM system. Regardless, the Lagrange multipliers, λ_k, λ_k', only occur in the equations of particle motion because the particle numbers conservations. Such stationary states are independent of the boundary conditions of the surface of finite volumes V [**10]**.

A Comparison with the Schrödinger Formalism

The Eq. (66) is the correct "relativistic generalization" of the Schrödinger formalism [**8**]. For the microscopically motion of particles, this formalism starts with the corresponding principle (an ad hoc transformation)

$$E \rightarrow +i\cdot h/2\cdot\pi\cdot\partial/\partial t, \tag{67}$$

$$\mathbf{p} \rightarrow -i\cdot h/2\cdot\pi\cdot\partial/\partial\mathbf{r}, \tag{68}$$

and applied on the energy expression (with conservation of energy)

$$E = \mathbf{p}^2/2\cdot m' + V(\mathbf{r}),\ \ m' \text{ is the reduced mass.} \tag{69}$$

Schrödinger has taken complex valued wave functions, $\psi(\mathbf{r},t)$, resulting in

$$+i\cdot h/2\pi\cdot\partial\psi(\mathbf{r},t)/\partial\, t = -\,(h/2\cdot\pi)^2/2\cdot m'\cdot\Delta\psi(\mathbf{r},t) + V(\mathbf{r})\cdot\psi(\mathbf{r},t). \tag{70}$$

For microscopic states the Heisenberg Uncertainty Relation (constructed with the help of $h/2\pi$) must be fulfilled. The timely stationary of a state is given if

$$\psi(\mathbf{r},t) = \exp(-i\cdot E\cdot t/h/2\cdot\pi)\cdot\psi(\mathbf{r},0), \tag{71}$$

and if $\psi(\mathbf{r},0)$ fulfills the eigenvalue equation within a variation principle getting

$$E\cdot\psi(\mathbf{r},0) = -\,(h/2\cdot\pi)^2/2\cdot m'\cdot\Delta\psi(\mathbf{r},0) + V(\mathbf{r})\cdot\psi(\mathbf{r},0)\ \ \text{for} \int|\,\psi(\mathbf{r},0)|^2\, dV = 1. \tag{72}$$

Quantum mechanics assumed that the initial states, $\psi(\mathbf{r},t)$ for $t = t_0$, can be always precisely known. An ad hoc constant $h/2\cdot\pi$ was needed for the quantization of energy and h is the Planck constant. Schrödinger's concept did neither contain the magnetic field, nor the propagation of interactions with c and it tried to describe microscopic atomic states within energy conservation.

In the atomistic theory of matter, neither the precise knowledge of the initial states, nor energy conservation is required. The additional constants are appearing in the theory of particle motions as Lagrange multipliers, λ_k'. Depending on surface conditions of Ω, the theory is also able to describe stable or unstable states of composed particle **[1]**, **[9]** and **[10**] simultaneously with energies and lifetimes.

In the atomistic theory of matter (ATOM), the timely stationary of states gives only energy conservation for exceptional states with some Lagrange multipliers in Ω. With time-dependent fields, $A^{(em)\nu}(x)$ and $A^{(g)\nu}(x)$, energy conservation cannot be understood as a general principle in physics. But, in the established physics energy conservation is considered as the most important fundamental basics. Such a principle does not exist generally in Nature. The atomistic theory of matter is a relativistic quantum field theory, but neither energy quantization, nor the $E = m^{*}\cdot c^{2}$ principle are needed. In a following paper **[11]**, the prognoses of ATOM will be discussed in comparison with observed composite particles, in particular with neutrinos and neutrino-like particles which have gravitational charges and gravitational masses zero.

Conclusion

The Atomistic Theory of Matter (ATOM), defined by a new physical axiom system, is a relativistic quantum field theory where only the charges of the elementary particles are quantized. The elementary charges are conserved. The Planck constant, h, introduced 1900 by Max Planck, plays indeed the role of a Lagrange multiplier and it occurs only in the equations of particle motion. In the ATOM (based on the four kinds of stable elementary particles) the electromagnetism and the gravitation are formulated in a unified manner with the same space-time metric and this theory describes a completely different kind of physics than the established energetic physics. Furthermore, the gravitation is also built into the particle physics as interaction. In contrast to the established gravitation theory derived from the general theory of relativity, gravitation does not incorporate singularity in space and time. The elementary particles cannot approach each other closer than 10^{-17} cm; a maximum matter density is given to be ca. 10^{+24} g/cm^{3}, [6]. The special and the generally relativity theories are not used in ATOM. In the atomistic theory of matter only the relativity of motions between particles and relative to c are needed. The energy-mass-equivalence, $E = m^{*}\cdot c^{2}$, is not valid because the elementary masses of proton and electron, m_{P} and $m_{e,}$ are not equivalent to energy. Conservation of Energy and UFF, basic principles of the established physics, are indeed not present in Nature. The laws of Nature are non-deterministic, however causal.

References

[1] Gy. I. Szász, *Physics of Elementary Processes; Basic Approach in Physics and Astronomy*, Cerberus, Budapest, (2005), ISBN: 963 219 791 7 and

Gy. I. Szász, *Why is a New Beginning in Physics Necessary?* Infinite Energy Magazine, **129**, 4, (2016)

[2] G. Audi, A. H. Wapstra, Nuclear Physics, **A595,** 409, (1995)

[3] Gy. I. Szász, *Was verursacht die Gravitation? An Atomistic Theory of Matter*, Lecture, (2014), https://www.youtube.com/watch?v=WsyJjxC7SRc

[4] S. C. Chapman, *Core Electrodynamics*, Taylor & Francis, London, (2000), First Edition, ISBN: 0-7484-0623-9

[5] Gy. I. Szász, *Atomistic Theory of Matter: Stable Particles and a Unified Field* (2015) http://atomsz.com/theory/stable-particles-and-a-unified-field-eng/

[6] Gy. I. Szász, *The Covariant Theory for the Fields and the Particles*, (2017) http://atomsz.com/covariant-theory/, see also home page www.atomsz.com

[7] M. Giaquinta, S. Hildebrand, *Calculus of Variation I: The Lagrange Formalism, Chapter 2.* Springer, Berlin-Heidelberg-New York, (2004), ISBN: 3-540-50625-X

[8] E. Schrödinger, *Quantisierung als Eigenwertproblem*, Ann. d. Phys. **79**, S. 361, 489, 734, (1926)

[9] Gy. I. Szász, Zeitschr. für Phys., **A275**, 403, (1975), Zeitschr. für Phys., **A278**, 165, (1976), Fortschr. der Phys., **24**, 405 (1976),

[10] Gy. I. Szász, Phys. Lett., **A55**, 327, (1976), Phys. Lett., **A62**, 327, (1977), M. Ramaglia, G. P. Zucchelli, Phys. Lett., **A67,** 9, (1978)

[11] Gy. I. Szász, *Prognosis of Atomistic Theory of Matter and Observed Particles*, to be published (2017)

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