Prognoses of Atomistic Theory of Matter and Observed Particles

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Abstract

The prognoses of Atomistic Theory of Matter, based on four kinds of point-like stable particles, are derived and then compared with the observed physical properties of particle systems. The four stable particles are the electrons (e), positrons (p), protons (P) and the eltons (E). These carry two kinds of conserved elementary charges, $q_i = \{\pm e\}$ and $g_i = \{\pm g \cdot m_e, \pm g \cdot m_P\}$. Composite particle systems have conserved total electrical charges, $Q = \Sigma\, q_j$, and total gravitational charges, $G = \Sigma\, q_j$. The interactions between particles are non-conservative. The binding energies and sizes of bound states of two-particle systems are determined with Lagrange multipliers h, $h^0 = h/387$ and $\underline{h}$. These stable states have different gravitational and inertial rest masses. The composed stable many-particle systems are the stable neutron and stable atoms (isotopes) with gravitational charges, $G > 0$. Unstable bound systems are the unstable neutron, excited atomic states and unstable particles (mesons and baryons) with lifetimes between 881.4 s and 10^{-25} s. Many-particle systems with gravitational charges, $G = 0$, are neutrinos and neutrino-like particles; these systems cannot condensate on each other. Elton-based stable particle systems with gravitational charges, $G < 0$, predicted by the theory, are rarely observed. Condensed matter composed of atoms with different signs of $G > 0$ and $G < 0$ gravitationally repulse each other; however, both kinds of matter have the same electromagnetic structure.

Introduction

The Atomistic Theory of Matter (ATOM) has solved the main tasks of physics **[1]**: the determination of what matter is and from which constituents matter is composed to ascertain the two fundamental interactions (electromagnetism and gravitation). The time developments of such physical systems have also been deduced **[2]**. Only stable elementary particles have the same gravitational and inertial rest masses, $m^g(i) = m^i(i)$, i = e, p, P, E. A new physical axiom system defines ATOM:

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

- The elementary particles carry two kinds 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 masses of proton and electron.

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

Concerning 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.

This axiom system is the fundamental basis of the atomistic theory of matter, based on stable elementary particles which carry two kinds of conserved charges. In conventional physics the eltons are called “antiproton”. Protons and eltons are treated as stable elementary particles which are not composed of other particles. The elementary particles can be described with probability current densities, $j_i^{(n)\nu}(x)$ in finite ranges of Minkowski space, $\{x\} \varepsilon \Omega$. The elementary particles fulfill the conservation equations, $\partial_\nu j_i^{(n)\nu}(x) = 0$, i = e, p, P, E, as subsidiary conditions which cause Lagrange multipliers, λ_k. This paper discusses stable bound states of composite particle systems, $N = N_P + N_E + N_p + N_e$, which different gravitational, $m^g(N)$, and inertial rest masses, $m^i(N)$. At first, we discuss electric neutrally two-particle systems, (P,e), (e,p), (P,E) and (E,p) and determine the binding energies and the sizes of these systems in connection with Lagrange multipliers. This paper does not use the hypothesis of the universality of free fall (UFF), energy conservation, quantization of energy, the energy-mass equivalence, $E = m^*\cdot c^2$, and the hypothetical quark theory.

Many-Particle Systems

Generally, the total electric charges, Q(N), are conserved for many-particle systems composed of $N = N_P + N_E + N_p + N_e$ elementary particles, i = e, p, P, E, in finite Minkowski space, Ω,

$Q(N) = + e\cdot((N_P - N_E) + (N_p - N_e))$, with the elementary electric charge e.   (1)

Since electromagnetism and gravitation always act simultaneously, and since the electric force is approximately 10^{+42} time greater than gravity, one can only experimentally study gravity effects by examining electrically neutral systems.

Electrically neutral particle systems must be $N_P + N_p = N_E + N_e$. Only such systems have stable bound states.

The total gravitational charges, G(N), of composed systems are also conserved

$$G(N) = + g\cdot((N_P - N_E)\cdot m_P + (N_p – N_e)\cdot m_e), \text{ with } m_P/m_e = 1836.1. \quad (2)$$

The universal gravitational constant is $G = g^2/4\cdot\pi$. We can subdivide the many-particle systems into total gravitational charges with G(N) > 0, G(N) = 0 and G(N) > 0. The gravitational interaction between two composed particles/bodies depends on the product $G(N_l)\cdot G(N_2)$. If $G(N_l)\cdot G(N_2) > 0$ the gravitational force is attractive, if $G(N_l)\cdot G(N_2) < 0$ it is repulsive.

For a composed system the gravitational mass

$$m^g(N) = + |(N_P - N_E)\cdot m_P + (N_p – N_e)\cdot m_e)|. \quad (3)$$

is a conserved entity. The gravitational mass can also be zero.

The inertial rest masses of stable bound states

$$m^i(N) = + (N_P + N_E)\cdot m_P + (N_p + N_e)\cdot m_e – E(\text{binding},\lambda_k)/c^2 \geq 0, \quad (4)$$

are functions of the binding energy, $E(\text{binding},\lambda_k)$, which itself depends on the discrete Lagrange multipliers **[2]**, λ_k. Since $m^g(N)$ and $m^i(N)$ are different, the UFF doesn’t hold. The inertial mass, $m^i(N)$, can also be zero if

$$E(\text{binding},\lambda_k) = ((N_P + N_E)\cdot m_P + (N_p + N_e)\cdot m_e)\cdot c^2. \quad (5)$$

These bound states are the energetic lowest states, the ground states (Gs) of many-particle systems.

Two-Particle Electrically Neutral Systems: (P,e), (e,p), (P,E) and (E,p)

At first, we regard the electric neutrally two-particle which have bound states.

Sommerfeld’s discovery, show us that for a hydrogen atom, H = (P,e), there is a known connection between the Planck constant, h, the “ground state energy”, the reduced mass $m_{eP}' = m_e\cdot m_P/(m_P + m_e)$ and the two natural constants, e and c,

$$h = e^2/2\cdot c\cdot(m_{eP}'\cdot c^2/2\cdot E(\text{H-atom},h))^{1/2}. \quad (6)$$

The energy, E(H-atom,h), radiates from the hydrogen atom. Since we consider the Planck constant as Lagrange multiplier, $\lambda_k = h$, **[2]** we take this relation and generalize it with different Lagrange multipliers

$$\lambda_k = e^2/2\cdot c\cdot(m_{ij}'\cdot c^2/2\cdot E(binding,\lambda_k))^{1/2}, \qquad (7)$$

for two particles, i and j, with the binding energy E(binding,λ_k). The expression

$$(2\cdot E(binding,\lambda_k)/m_{ij}'\cdot c^2)^{1/2} = (v_{(i,j)}/c)/(1 - (v_{(i,j)}/c)^2)^{1/2},$$

is known as the relativistic relative velocity of particles, ($v_{(i,j)}/c$), in bound states at the binding energy E(binding,λ_k). In a hydrogen atom the electron moves with the relative velocity, $v_{(e,P)}/c = 1/137.036 = 0.729736\cdot 10^{-2}$, around the proton and produces a stable bound state in a timely stationary mutual interaction field.

The distance between proton and electron in the “ground state” of a hydrogen atom is also known. Expressed with h it is

$$r_{(e,P)} = h^2/(4\cdot\pi^2\cdot m_{eP}'\cdot e^2). \qquad (8)$$

We also generalize this relation for the relative distances of any two-particle stable bound system composed of i and j particles and Lagrange multiplier, λ_k, as

$$r_{(i,j)} = \lambda_k{}^2/(4\cdot\pi^2\cdot m_{ij}'\cdot e^2). \qquad (9)$$

The phenomenological relations, Eqs. (7) and (9), are very helpful when connecting the Lagrange multipliers with physical properties of two-particle systems. From known binding energies, E(binding,λ_k), we are able to calculate the Lagrange multipliers, λ_k, and with λ_k the relative distances between two particles in timely stationary bound states, without solving ab initio variation calculations. With $v_{(i,j)}$ and $r_{(i,j)}$ can be calculated the magnetic moments of two-particle systems.

The particle system (P,e) gives a hydrogen atom as a timely stationary bound state (binding energy E(H-atom,h) = 13.6 eV), corresponding to the Lagrange multiplier, $\lambda_k = h$. The Planck constant, h, has the value $h = 4.136\cdot 10^{-15}$ eV·s.

The gravitational mass of hydrogen atom is

$$m^g(H) = + m_P - m_e, \qquad (10)$$

and its inertial rest mass in the stable bound state is

$$m^i(H) = + (m_P + m_e) - E(binding,H)/c^2 = + (m_P + m_e) - 13.6\ eV/c^2. \qquad (11)$$

The energy 13.6 eV is radiated from the hydrogen atom. In a hydrogen atom the relative distance between electron and proton is given by the Bohr radius

$r_{(e,P)} = h^2/(4\cdot\pi^2\cdot m_{eP}'\cdot e^2) = 0.529\cdot 10^{-8}$ cm. (12)

For the electron-positron system the bound positronium state, Ps = (e,p), is also observed. Since the reduced mass is $m_{ep}' = m_e/2$, its binding energy is the half of binging energy of a hydrogen atom, E(binding,Ps) = 6.8 eV, and its size is r(Ps) = $2\cdot 0.529\cdot 10^{-8}$ cm = $1.058\cdot 10^{-8}$ cm. The gravitational mass for positronium is zero, $m^g(Ps) = 0$, and its inertial rest mass is

$m^i(Ps) = 2\cdot m_e - 6.8\ eV/c^2 \approx 1.022\ MeV/c^2$. (13)

The mean lifetime of the so called *para-positronium* (*p*-Ps) is $0.125\cdot 10^{-9}$ s and that of the *ortho-positronium* is $142\cdot 10^{-9}$ s. Positronium radiates its energy, $2\cdot m_e\cdot c^2$ = 1.022 MeV (approx.) and forms a stable bound state called electron-neutrino, ν_e = (e,p). The inertial rest mass of the electron-neutrino is zero,

$m^i(\nu_e) = 2\cdot m_e - E(binding,\nu_e)/c^2 = 0$. (14)

The binding energy of the electron-neutrino is $E(binding,\nu_e) = 2\cdot m_e\cdot c^2$. From this binding energy we can determine the value of a second Lagrange multiplier, $\lambda_k = h^0$, according to Eq. (7) as

$h^0 = e^2/2\cdot c\cdot (1/8)^{1/2} = h/387$. (15)

According to Eq. (9), the distance between the particles in the electron-neutrino is

$r(\nu_e) = 0.703\cdot 10^{-13}$ cm. (16)

The particles move with the relative velocity in electron-neutrino, ν_e

$(v(\nu_e)/c)/(1 - (v(\nu_e)/c)^2)^{1/2} = (4)^{1/2} \rightarrow (v(\nu_e)/c) = (4/5)^{1/2} = 0.894\%$. (17)

Electrons and positrons do not annihilate each other, they form a state ν_e.

A similar calculation can also be made for the proton-elton system, (P,E). The protonium, (Pn), calculated with h and Eq. (7), has the binding energy

$E(Binding,Pn) = e^4\cdot m_{PE}'/8\cdot h^2 = 12.459$ KeV, (18)

with $m_{PE}' = m_P/2$. Protonium is called as “antiprotonic hydrogen” in conventional physics.

According Eq. (9) the size of the protonium is

$$r(Pn) = 0.577\cdot10^{-11} \text{ cm}. \quad (19)$$

In protonium, the relative velocity of the particles, v_{PE}/c, is

$$(v(Pn)/c) \approx (4\cdot12.459 \text{ KeV} /938.272 \text{ MeV}) = 0.531\cdot10^{-4} . \quad (20)$$

But it was not until 2006 that scientists realized protonium can be generated during experiments.

Similarly to the positronium, the protonium radiates $2\cdot m_P\cdot c^2$ = 1876.544 MeV energy (approx.) and forms a proton-neutrino, ν_P = (P,E). For a proton-neutrino, ν_P, the gravitational mass and the inertial rest mass are zero

$$m^i(\nu_P) = 2\cdot m_P – E(binding,\nu_P)/c^2 = 0. \quad (21)$$

The binding energy of the proton-neutrino is $E(binding,\nu_P) = 2\cdot m_P\cdot c^2$= 1876.544 MeV. With this binding energy we can determine (according to Eq. (7)) another Lagrange multiplier and it has the same value, $\lambda_k = h^0 = h/387$, as the electron-neutrino. The size of the proton-neutrino, ν_P, is according Eq. (9)

$$r(\nu_P) = 0.383\cdot10^{-16} \text{ cm}. \quad (22)$$

The particles move in ν_P with the relative velocity

$$(v(\nu_P)/c)/(1 – (v(\nu_P)/c)^2)^{1/2} = (4)^{1/2} \rightarrow (v(\nu_P) /c) = 0.894\%. \quad (23)$$

Also protons and eltons do not annihilate each other. The (e,p) and (P,E) particle systems have gravitational charges zero.

With the Lagrange multiplier, h^0, we can calculate a further stationary bound state of the proton-electron system, (P,e), that of a stable neutron N^0. The binding energy of N^0 is (according Eq. (7))

$$E(binding,N^0) = 2.04 \text{ MeV}, \quad (24)$$

and its size is

$$d(N^0) = 2\cdot r(N^0) = 0.702\cdot10^{-13} \text{ cm}. \quad (25)$$

It is nearly as big as the electron-neutrino, according to Eq. (16). The electron moves in N^0 around the proton at the relative velocity

$$(v(N^0)/c)/(1 – (v(N^0)/c)^2)^{1/2} = (2\cdot2.04/0.5107)^{1/2} \rightarrow (v(N^0)/c) = 0.942\%. \quad (26)$$

Established physics has concluded that nearly 74% of matter in our universe is composed of hydrogen atoms, 24% is ^{4}He atoms and only less than 2% of all the matter is heavier atoms. But, the free flying stable neutrons and neutrinos are not counted. It is also fail to count the elton-hydrogen atoms, elton-^{4}He atoms and heavier elton-atoms. This reduces the total of H-atoms and ^{4}He atoms to fewer than 37 % and 12%.

Moreover, the proton-electron system, (P,e), can also radiate all of its mass as energy, to obtain

$$E(\text{binding},(P,e)) = (m_P + m_e)\cdot c^2 = 938.781\ \text{MeV}. \qquad (27)$$

in order to get its inertial mass equal to zero

$$m^i((P,e)) = (m_P + m_e) - E((P,e))/c^2 = 0. \qquad (28)$$

The corresponding Langrage multiplier is

$$\underline{h} = e^2/2\cdot c\cdot((m_e\cdot m_P)^2/2\cdot(m_e+m_p)^2)^{1/2} = h/22769, \qquad (29)$$

and the radius of this energetic lowermost ground state (Gs) is

$$r(Gs) = r_{Bohr}\cdot 1.4\cdot 10^{-8} = 0.748\cdot 10^{-16}\ \text{cm} \qquad (30)$$

Similar calculations can also be performed with elton and positron, (E,p).

The radius r(Gs) in Eq. (30) leads to the greatest mass density of matter

$$\rho_{max} = (m_p+m_e)/(4/3\cdot\pi\cdot r(Gs)^3) = 1.75\cdot 10^{+24}\ \text{g/cm}^3. \qquad (31)$$

The maximum mass density is ca. 10^9 times greater than the mass density of neutron-stars. Under their mutual interactions, elementary particles cannot approach each other closer than ca. 10^{-17} cm, despite the $1/r^2$ singularity of the static electromagnetic and gravitational forces. The elementary particle pairs e, p, and P, E can neither be annihilated, nor created. Accordingly, neither the Big Bang theory is valid, nor are Black Holes really space-time singularities. The elementary particles can only accumulate and disaggregate in course of time. Furthermore, Dark Matter doesn't exist, since the astrophysicists applied an incorrect gravitation law during their calculation of galactic movement. The principle of two kinds of supernova explosions is immediately recognizable. The one kind is when shell electrons are electromagnetically disturbed and drop in the nuclei. The energy production of the Sun happens because of forming neutrons from H atoms through electromagnetic disturbance radiating 2.04 MeV energy and not due to nuclear fusions. The other kind of supernova explosion is when neutrons and nuclei with the sizes of 10^{-13} cm are electromagnetic disturbed and drop in a state with a size of $2\cdot r(Gs) = 1.45\cdot 10^{-16}$ cm.

Many-Particle Electrically Neutral Systems Composed of P, e, p

Many-particle systems composed of (P,e,p) are normal proton-based matter. Because the sizes of N^0 and ν_e are almost the same, we conclude that the unstable neutron, N, has the composition, N = (P,e,p,e) and its decay gives a proton, an electron, an electron-neutrino and gamma ray (without weak interaction), as observed

$$N = (P,e,p,e) \rightarrow P + e + (e,p) + \gamma\text{ - ray} = P + e + \nu_e + \gamma\text{ - ray}. \quad (32)$$

The gravitational mass of N is the same as for N^0

$$m^g(N) = m_p - m_e, \quad (33)$$

however, the inertial mass of the unstable neutron is

$$m^i(N) = m_p + 3\cdot m_e - E(binding,N)/c^2 = m_p + 3\cdot m_e - 0.24\ MeV/c^2. \quad (34)$$

The binding energy of N can be calculated from the observed inertial mass of the unstable neutron, $m^i(N) = 939.565\ MeV/c^2$, to be E(binding,N) = 0.24 MeV.

Apparently, the nuclei of our isotopes do not contain elton particles. The eltons are excluded from the nuclei because the proton-neutrino, as a proton-elton pair, has a size of $0.383\cdot 10^{-16}$ cm, and it is too small to remain in nuclei with sizes greater than 10^{-13} cm. Our isotopes are only composed of protons, electrons and positrons. An electrically neutral isotope contains A protons, N_p positrons and $(A + N_p)$ electrons, whereby Z electrons are in the electron shells.

The gravitational mass of an electrically neutral isotope is

$$m^g(A,Z\ isotope) = A\cdot(m_P - m_e), \quad (35)$$

and its inertial rest mass is

$$m^i(A,Z\ isotope) = A\cdot(m_P + m_e) + 2\cdot N_p\cdot m_e - E(binding,A,Z\ isotope)/c^2. \quad (36)$$

Only the inertial rest mass, $m^i(A,Z$ isotope), contains the number of positrons, N_p, within the nucleus. The gravitational mass, $m^g(A,Z$ isotope), only depends on mass number, A, and is a multiple of $(m_P - m_e)$. With a variation principle

[2], the binding energy of isotopes can be calculated with *ab initio* calculations. Here, A protons, N_p positrons and $(A + N_p - Z)$ electrons are in the nuclei and Z electron in the electron shells. The elementary particles in the nuclei are governed by the Lagrange multiplier, h^0, (without strong interaction) and the Z electrons in the electron shells are governed by the Planck constant h.

In nuclear physics, the proton (P) and the unstable neutron (N) are treated as independent particles, called nucleons, which compose the nuclei. The binding energies of isotopes are calculated (in nuclear physics) according the formula

$$E^{\text{nuclear physics}}(\text{binding, A,Z isotope}) = (Z\cdot m_P + N_N\cdot m^i(N) - m^i(\text{A,Z isotope}))\cdot c^2.$$

with the number of protons, Z, and the neutron number, N_N. For the neutron mass, the inertial rest mass of an unstable neutron, $m^i(N)$, is taken. The inertial rest masses of isotopes, m^i(A,Z isotope), are available from mass spectroscopy **[3]**.

The calculations of isotope binding energies of are flawed, because the inertial masses of the neutrons are different,

$$m^i(N^0) = (P,e) = m_P + m_e - 2.04 \text{ MeV},$$

$$m^i(N) = (P,e,p,e) = m_P + 3m_e - 0.24 \text{ MeV}.$$

It is also obvious that the numbers of (e,p) pairs in particles systems (i.e. the number of positrons, N_p, in the nuclei), are not unambiguously determined if we consider only inertial rest masses. The gravitational masses of an isotope only depends on the mass number $A = Z + N_N$. The difference between the gravitational mass and inertial rest mass of isotopes leads to UFF violation **[4]**. With the gravitational mass, (m^g(A isotope), the relative mass defect is known

$$\Delta(\text{A,Z isotope}) = (m^g(\text{A isotope}) - m^i(\text{A,Z isotope}))/m^i(\text{A,Z isotope}),$$

for all isotopes and they are in the range

$$-0.109\% \text{ (hydrogen atom)} < \Delta(\text{A,Z isotope}) < +0.784\% \text{ } (^{56}\text{Fe isotope}).$$

We could perform the same calculation for elton-isotopes if we exchange protons with eltons and electrons with positrons. This would calculate the elton-based, condensed matter. The proton-based matter and the elton-based matter gravitationally repulse each other. The neutrinos and neutrino-like particles (composed of the same number of proton and elton and the same number of electron and positron) transfer particle systems between proton-based matter and elton-based matter. Most probably, distinct galaxies exist as condensations of proton-based and of elton-based isotopes. The electrical properties of elton-based matter are those of proton-based matter. With the electromagnetic spectra we cannot decide between elton-based or proton-based matter.

Symmetry considerations in ATOM are connected to simultaneously exchanges of protons with eltons and electrons with positrons,

proton $\leftrightarrow$ elton, or $(+ e, + g\cdot m_p) \leftrightarrow (- e, - g\cdot m_p)$, (37)

electron $\leftrightarrow$ positron, or $(- e, - g\cdot m_p) \leftrightarrow (+ e, + g\cdot m_p)$. (38)

Since the electrical and gravitational interactions contain the product of the sums of elementary charges of two bodies,

$Q_1\cdot Q_2 = \Sigma_i q_i\cdot \Sigma_j q_j$ and $G_1\cdot G_2, = \Sigma_i g_i\cdot \Sigma_j g_j$, (39)

that are in bound states. Since the coupling of the probability density currents on the electromagnetic field is

$+ \; j^{(em)}{}_{\nu}(x)\cdot A^{(em)\nu}(x) = + \Sigma_{i=e,p,P,E}\, q_i\cdot j_i{}^{(n)}{}_{\nu}(x)\cdot A^{(em)\nu}(x)$, (40)

and for gravitation **[2]**

$- \; j^{(g)}{}_{\nu}(x)\cdot A^{(g)\nu}(x) = - \Sigma_{i=e,p,P,E}\, g_i\cdot j_i{}^{(n)}{}_{\nu}(x)\cdot A^{(g)\nu}(x)$, (41)

- we conclude that the simultaneous exchange of the particle pairs doesn’t change the interactions, since the signs of the probability current densities and those of the fields are also changed. However, the symmetry considerations exchange proton-based matter for elton-based matter.

To focus on the capture of electrons by protons: - if the kinetic energies of electrons are not too large, the Coulomb forces between these particles declines the paths of electrons, and during these defections the electrons lose energy. This continues up to a point where the electrons can no longer escape and are captured by the protons. The captured electrons continue to radiate their energy until they reach the ground states of the electron shell. Electron motion of in exited and in ground states is governed by a Lagrange multiplier, called the Planck constant, h. However, in these atomic ground states, the electron + nucleon system is not at their lowest energetic state. For instance, if a hydrogen atom at ground state is disturbed by electromagnetic radiation, the electron can further lose energy and through the attractive Coulomb force the electron can approach the proton forms a stable neutron, N^0. It will transfer its binding energy

$E(\text{binding},N^0) = 2.04$ MeV as electromagnetic radiation. It should be noted, that excited atom states are resonance capable, unstable particle systems with lifetimes of $10^{-4} – 10^{-10}$ s. In excited states the charge densities of electrons, $e\cdot j_e^{\nu}(x)$ oscillate between frequencies, $h\cdot(\nu_i – \nu_j)$ and the excited states simultaneously radiate electromagnetic rays with the same time dependencies of $h\cdot(\nu_i – \nu_j)$. The energy is delivered continuously; neither the energy of the particle system, nor that of the radiation is quantized. The radiating atoms are damped oscillations.

Observed Mass Splitting of Mesons and Neutrino-Like Particle Systems

We have seen that there are two timely stationary, stable basic neutrinos, the electron-neutrino, $\nu_e = (e,p)$, and the proton-neutrino, $\nu_P = (P,E)$, with inertial rest masses and gravitational masses of zero. Further neutrino-like particle systems can also be formed as stable bound states, for instance e.g. a composite-neutrino

$$\nu_c = (P,e,p,E). \qquad (42)$$

All neutrino-like particle systems have the same numbers of protons and eltons and the same numbers of electrons and positrons, $N_P = N_E$ and $N_e = N_p$. The gravitational masses of all neutrino-like particle systems are zero, but the inertial rest masses don't have generally to be zero. The experimental identification of neutrino-like particle systems is not pronouncedly because these don't have electrical and gravitational charges. However, we can usual observe them indirectly through the decays of the agglomeration with an electrically charged elementary particle. Fortunately, such particle systems are unstable. The charged Myons are not elementary particles, they are composite particles

$$\mu^+ = (P,e,p,E,p) \rightarrow p + (e,p) + (P,E) = p + \nu_e + \nu_P, \qquad (43)$$

$$\mu^- = (e,P,e,p,E) \rightarrow e + (e,p) + (P,E) = e + \nu_e + \nu_P. \qquad (44)$$

They are agglomerations of e/p to a ν_c. The lifetimes of charged Myons are $2.2\cdot 10^{-6}$ s. The inertial rest masses are ca. 207 times greater than the electron mass,

$$m^i(\mu^\pm) = 2\cdot m_P + 3\cdot m_e - E(\text{binding}, \mu^\pm)/c^2 = 105.658 \text{ MeV}/c^2. \qquad (45)$$

The binding energy is

$$E(\text{binding}, \mu^\pm) = (2\cdot m_P + 3\cdot m_e)\cdot c^2 - 105.658 \text{ MeV} = 1772.419 \text{ MeV}.$$

Since the binding energy of a proton-neutrino is E(binding,ν_P) = 1876.544 MeV, r(ν_P) = $0.383\cdot10^{-16}$ cm, and further r(Gs) = $0.748\cdot10^{-16}$ cm, we say that the structures of charged Myons are governed by the Lagrange multipliers h^0 and $\underline{h}$. We identify the electrically neutral Myon (such a particle is excluded by particle physics) as

$$\mu^0 = \nu_c = (P,e,p,E). \tag{46}$$

This identification is experimentally difficult to verify. It has some similarity with to the postulated tau-neutrino of particle physics, ν_τ, (discovered, Fermilab, 2000) which has a very small inertial rest mass. Generally, the experimental identification of particle systems containing (e,p)-pairs, and/or (P,E)-pairs is difficult because these particle pairs are electrically and gravitationally neutral.

Nevertheless, we identify the charged Pions due to their decays as

$$\pi^+ = (P,e,p,e,p,E,p) \rightarrow \mu^+ + \nu_e, \tag{47}$$

$$\pi^- = (e,P,e,p,e,p,E) \rightarrow \mu^- + \nu_e, \tag{48}$$

and the neutral Pion as

$$\pi^0 = (P,e,p,e,p,E) \rightarrow \gamma\text{-rays} + \mu^0 + \nu_e \text{ or } \pi^0 \rightarrow \gamma\text{-rays} + \nu_e + \nu_e + \nu_p. \tag{49}$$

However, the decay into gamma rays, $\pi^0 \rightarrow 2\ \gamma$-rays, is theoretically prohibited.

The inertial rest mass of a charged Pion is ca. 273 times greater than that of the electron,

$$m^i(\pi^\pm) = 2\cdot m_P + 5\cdot m_e - E(\text{binding}, \pi^\pm)/c^2 = 139.570 \text{ MeV}/c^2. \tag{50}$$

The binding energy of a charged Pions is

E(binding, $\pi^\pm$) = 1739.528 MeV,

and its lifetime is $2.6\cdot10^{-8}$ s.

The inertial rest mass of the neutral Pion is only ca. 264 times greater than that of the electron,

$$m^i(\pi^0) = 2\cdot m_P + 4\cdot m_e - E(\text{binding}, \pi^0)/c^2 = 134.976 \text{ MeV}/c^2, \tag{51}$$

E(binding, π^0) = 1743.612 MeV,

and its lifetime is $8.4\cdot10^{-17}$ s. Probably, π^0 is an exited state of (P,e,p,e,p,E).

We continue by identifying charged Kaons: K^+, K^-, with lifetimes, $1.24\cdot10^{-8}$ s, and with inertial rest mass $m^i(K^{\pm})$ = 493.7 MeV/c^2. Experiments have shown that there are two neutral Kaons with two different lifetimes: $K^0{}_L = 5\cdot10^{-8}$ s and $K^0{}_S = 1\cdot10^{-10}$ s. The inertial rest mass is $m^i(K^0)$ = 497.6 MeV/c^2. It could be that

$$K^+ = (2P,2e,2p,2E,p) \rightarrow \mu^+ + \mu^0, \text{ 63\% of the } K^+ \text{ decays,} \quad (52)$$

or that

$$K^+ = (2P,4e,4p,2E,p) \rightarrow \pi^+ + \pi^0 , \text{ 22\% of the } K^+ \text{ decays.} \quad (53)$$

Furthermore, the compositions of negatively charged Kaon could be

K^- = (e,2P,2e,2p,2E), or K^- = (e,2P,4e,4p,2E).

The inertial rest mass of the charged Kaon is 966 times greater than m_e

$$m^i(K^{\pm}) = 4\cdot m_P + 5\cdot m_e - E(\text{binding}, K^{\pm})/c^2 = 493.677 \text{ MeV}/c^2, \quad (54)$$

or

$$m^i(K^{\pm}) = 4\cdot m_P + 9\cdot m_e - E(\text{binding}, K^{\pm})/c^2 = 493.677 \text{ MeV}/c^2.$$

The compositions of neutral Kaon could be (see the different decay modes)

$K^0{}_L$ = (2P,2e,2p,2E), or $K^0{}_S$ = (2P,4e,4p,2E).

The inertial rest mass of the neutral Kaon is ca. 973 times the electron mass

$$m^i(K^0{}_L) = 4\cdot m_P + 4\cdot m_e - E(\text{binding}, K^0{}_L)/c^2 = 497.648 \text{ MeV}/c^2, \quad (55)$$

$$m^i(K^0{}_S) = 4\cdot m_P + 8\cdot m_e - E(\text{binding}, K^0{}_S)/c^2 = 497.648 \text{ MeV}/c^2,$$

We identify the Tauon (experimentally detected: SLAC, M. L. Perl, 1977) as τ^- = (e,3P,5e,5p,3E), or τ^- = (e,3P,4e,4p,3E), which has diverse decay modes. The Tauon could have an observed inertial rest mass of

$$m^i(\tau^-) = 6\cdot m_P + 11\cdot m_e \text{ (or } 9\cdot m_e) - E(\text{binding}, \tau^-)/c^2 = 1776.82 \text{ MeV}/c^2, \quad (56)$$

and a lifetime of $2.9\cdot10^{-13}$ s. The tau-neutrino could be

ν_τ = (3P,5e,5p,3E), or ν_τ = (3P,4e,4p,3E).

There are diverse meson resonances observed with inertial rest masses all greater than ca. 540 MeV/c^2. Generally, for the final identification of meson resonances composed of elementary particles, all decays A → B + C must be studied with conservation of the elementary particles, e, p, P and E their charges.

Table 1. *The observed mass splitting of mesons and masses*

Name	Inertial Rest Mass	Gravitational Mass	Sum of Masses
P/E	938.272 MeV/c^2	m_P	elementary particle
e/p	0.511 MeV/ c^2	m_e	elementary particle
$\mu^{\pm}$	105.658 MeV/c^2	m_e	$2\cdot m_P + 3\cdot m_e$
μ^0	? MeV/c^2	0	$2\cdot m_P + 2\cdot m_e$
$\pi^{\pm}$	139.547 MeV/c^2	m_e	$2\cdot m_P + 5\cdot m_e$
π^0	134.976 MeV/c^2	0	$2\cdot m_P + 4\cdot m_e$
$K^{\pm}$	493.677 MeV/c^2	m_e	$4\cdot m_P + 5\cdot m_e$, or
$K^{\pm}$	493.677 MeV/ ^{2}	m_e	$4\cdot m_P + 9\cdot m_e$
K^0_L	497.648 MeV/c^2	0	$4\cdot m_P + 4\cdot m_e$
K^0_S	497.614 MeV/c^2	0	$4\cdot m_P + 8\cdot m_e$
τ^-	1776.82 MeV/c^2	m_e	$6\cdot m_P + 11\cdot m_e$ (or $9\cdot m_e$)

Table 2. *Two-particle bound states: binding energies, sum of masses and sizes*

(P/E, m_P = 938.272 MeV/c^2 stable elementary particles point-like)

(p/e, m_e = 0.511 MeV/c^2 stable elementary particles point-like)

H	$13.6\cdot 10^{-6}$ MeV	stable with h	$m_P + m_e$	$0.529\cdot 10^{-8}$ cm
N^0	2.04 MeV	stable with h^0	$m_P + m_e$	$0.702\cdot 10^{-13}$ cm
Gs	938.781 MeV	stable with $\underline{h}$	$m_P + m_e$	$1.496\cdot 10^{-16}$ cm
Ps	$6.8\cdot 10^{-6}$ MeV	stable with h	$2\cdot m_e$	$1.058\cdot 10^{-8}$ cm
ν_e	1.022 MeV	stable with h^0	$2\cdot m_e$	$0.703\cdot 10^{-13}$ cm
Pn	$3.19\cdot 10^{-3}$ MeV	stable with h	$2\cdot m_P$	$0.226\cdot 10^{-11}$ cm
ν_P	1876.544 MeV	stable with h^0	$2\cdot m_P$	$0.383\cdot 10^{-16}$ cm

It is from experiments unknown, whether neutrino-like particles are stable systems and if they have vanishing inertial rest masses. The inertial rest mass and lifetime of μ^0/ν_c = (P,e,p,E) is unknown. π^0 decays with γ-rays radiation and with a 98.82% decay probability. Therefore, it is possible that the experimentally observed π^0 (inertial rest mass, $m^i(\pi^0)$ = 134.976 MeV/c^2) is an excited state of the stable composite neutrino (P,2e,2p,E). The atomistic theory requires neutrino-like particles to be stable particle systems with vanishing inertial rest masses.

Table 3. *Mesons: binding energies, g-charges, sum of masses and lifetimes*

Name	Binding Energy	Gravitational Charge	Sum of Masses	Lifetime in s
$\mu^\pm$	1772.419 MeV	$\pm g\cdot m_e$	$2\cdot m_P + 3\cdot m_e$	$2.2\cdot10^{-6}$
μ^0	1877.566 MeV (theor.)	0	$2\cdot m_P + 2\cdot m_e$	∞ (?)
$\pi^\pm$	1739.528 MeV	$\pm g\cdot m_e$	$2\cdot m_P + 5\cdot m_e$	$2.6\cdot10^{-8}$
π^0	1743.612 MeV	0	$2\cdot m_P + 4\cdot m_e$	$8.4\cdot10^{-17}$
$K^\pm$	3261.966 MeV	$\pm g\cdot m_e$	$4\cdot m_P + 5\cdot m_e$	$1.24\cdot10^{-8}$, or
$K^\pm$	3264.010 MeV	$\pm g\cdot m_e$	$4\cdot m_P + 9\cdot m_e$	
K^0_L	3257.484 MeV	0	$4\cdot m_P + 4\cdot m_e$	$5.0\cdot10^{-8}$
K^0_S	3258.706 MeV	0	$4\cdot m_P + 8\cdot m_e$	$1.0\cdot10^{-10}$
τ^-	3857.411 MeV	$- g\cdot m_e$	$6\cdot m_P + 11\cdot m_e$	$2.9\cdot10^{-13}$, or
τ^-	3858.433 MeV	$- g\cdot m_e$	$6\cdot m_P + 9\cdot m_e$	$2.9\cdot10^{-13}$

Observed Mass Splitting of Baryons and Neutrino-Like Particle Systems

We continue the prognoses of ATOM with the identification of baryons. In baryons, the number of protons and eltons differ always by one. The unstable neutron, N = (P,e,p,e) is already presented. The Λ^0 Lambda decays are

$\Lambda^0 \rightarrow P + \pi^-$ and $\Lambda^0 \rightarrow N^0 + \pi^0$, with lifetime of $2.63\cdot10^{-8}$ s.

The Sigma decays are

$\Sigma^+ \rightarrow P + \pi^0$ and $\Sigma^{*+} \rightarrow N + \pi^+$, with lifetime of $8.02\cdot10^{-11}$ s.

$\Sigma^0 \rightarrow \Lambda^0 + \gamma$-ray with lifetime $7.4\cdot10^{-20}$ s. The Σ^0 is an excited state of Λ^0.

$\Sigma^- \rightarrow N^0 + \pi^-$, with lifetime $1.48\cdot10^{-10}$ s.

The Xi decays are

$\Xi^0 \rightarrow \Lambda^0 + \pi^0$, with lifetime $2.90 \cdot 10^{-10}$ s,

$\Xi^- \rightarrow \Lambda^0 + \pi^-$, with lifetime $1.64 \cdot 10^{-10}$ s.

The negatively charged Omega decays are

$\Omega^- \rightarrow \Lambda^{*0} + K^-$, $\Omega^- \rightarrow \Xi^0 + \pi^-$, $\Omega^- \rightarrow \Xi^- + \pi^0$, with lifetime $8.2 \cdot 10^{-11}$ s.

Furthermore, there are many baryon resonances observed, all with inertial rest masses greater than ca. 1200 MeV/c^2. The lifetimes of the baryons, up to that of N, are less than 10^{-10} s.

For the baryon and meson composition of elementary particles, e ,p, P and E, all

particle reactions A + B → C + D, and decays A → B + C, (57)

must to be studied; for these studies the conservation of elementary particles are prime considerations. Such analyses are urgently needed and must be performed in detail to ascertain the elementary particles compositions of baryons and mesons **[1, 5]**.

The compositions of Lambda particle can be

Λ^0 = (2P,3e,2p,E) = (P,e) + (P,2e,2p,E), (58)

Λ^{*0} = (P,2e,3p,2E) = (E,p) + (P,2e,2p,E), .

The compositions of Sigma particles are

Σ^+ = (2P,2e,2p,E), Σ^- = (2P,4e,2p,E), (59)

Σ^0 = (2P,3e,2p,E), is an exited state of Λ^0.

Σ^{*+} = (P,2e,4p,2E), Σ^{*-} = (P,3e,3p,2E), (60)

Σ^{*0} = (P,2e,3p,2E), is an exited state of Λ^{*0}.

The Ξ particles are composed as

Ξ^- = (3P,6e,4p,2E), Ξ^0 = (3P,5e,4p,2E) (61)

Ξ^{*-} = (2P,4e,4p,3E), Ξ^{*0} = (2P,4e,5p,3E) (62)

There are also Λ^-, Λ^+, Λ^{++} particles registered, but not Ξ^+ and not Ξ^{*+}.

The composition of negatively charged Omega is probably

Ω^{-} = (4P,6e,4p,3E) or Ω^{-} = (4P,8e,6p,3E).

Table 4. *The observed mass splitting of baryons and masses*

Name	Inertial Rest Mass	Gravitational Mass	Sum of Masses
N	939.565 MeV/c^2	m_P - m_e	m_P + $3 \cdot m_e$
Λ	1115.683 MeV/c^2	m_P - m_e	$3 \cdot m_P$ + $5 \cdot m_e$
Σ^+	1189.37 MeV/c^2	m_P	$3 \cdot m_P$ + $4 \cdot m_e$,
Σ^0	1192.642 MeV/c^2	m_P - m_e	$3 \cdot m_P$ + $5 \cdot m_e$
Σ^-	1197.449 MeV/c^2	m_P - $2 \cdot m_e$	$3 \cdot m_P$ + $6 \cdot m_e$
Ξ^0	1314.86 MeV/c^2	m_P - m_e	$5 \cdot m_P$ + $9 \cdot m_e$
Ξ^-	1321.71 MeV/c^2	m_P - $2 \cdot m_e$	$5 \cdot m_P$ + $10 \cdot m_e$
Ω^-	1672.45 MeV/c^2	m_P - $3 \cdot m_e$	$7 \cdot m_P$ + $10 \cdot m_e$

In the hypothetical quark model, the baryons are classified by their isospins and their quark contents, giving six groups of baryons: nucleons (N), Delta (Δ), Lambda (Λ), Sigma (Σ), Xi (Ξ) and Omega (Ω). In quark model it is difficult to calulate the masses of baryons and mesons because the masses of quarks are unknown.

The here presented first attempts of compositions of baryons and mesons from elementary particles are agglomerations of neutrino-like and charged particles. At baryons and mesons "the chemistry of neutrino-like particles" can be studied.

The recognized neutrino-like particles that up to now are appearing in mesons:

μ^0 = (P,e,p,E), π^0 = (P,2e,2p,E), K^0_L = (2P,2e,2p,2E),

K^0_S = (2P,4e,4p,2E), ν_τ = (3P,5e,5p,3E), or ν_τ = (3P,4e,4p,3E),

and in baryons:

(P,2e,2p,E), (P,4e,4p,E), (2P,4e,4p,2E), (3P,4e,4p,3E), (3P,6e,6p,3E).

We conclude that also for baryons the Lagrange multiplier, h^0 and $\underline{h}$, govern the particle bound states as for mesons.

Table 5. *Baryons: binding energies, g-masses, sum of masses and lifetime*

Name	Binding Energy	Gravitational Mass	Sum of Masses	Lifetime in s
N	0.24 MeV/c^2	$m_P - m_e$	$m_P + 3 \cdot m_e$	881.5
Λ^0	1707.688 MeV/c^2	$m_P - m_e$	$3 \cdot m_P + 5 \cdot m_e$	$2.63 \cdot 10^{-10}$
Σ^+	1627.490 MeV/c^2	m_P	$3 \cdot m_P + 4 \cdot m_e$	$8.02 \cdot 10^{-11}$
Σ^0	1624.729 MeV/c^2	$m_P - m_e$	$3 \cdot m_P + 5 \cdot m_e$	$7.4 \cdot 10^{-20}$
Σ^-	1619.237 MeV/c^2	$m_P - 2 \cdot m_e$	$3 \cdot m_P + 6 \cdot m_e$	$1.48 \cdot 10^{-10}$
Ξ^0	3381.099 MeV/c^2	$m_P - m_e$	$5 \cdot m_P + 9 \cdot m_e$	$2.90 \cdot 10^{-10}$
Ξ^-	3375.0 MeV/c^2	$m_P - 2 \cdot m_e$	$5 \cdot m_P + 10 \cdot m_e$	$1.64 \cdot 10^{-10}$
Ω^-	4973.097 MeV/c^2	$m_P - 3 \cdot m_e$	$7 \cdot m_P + 10 \cdot m_e$	$8.2 \cdot 10^{-11}$

The sizes of baryons and mesons are in the range of ca. 10^{-13} cm and 10^{-15} cm.

In established physics, the list of elementary particles includes fermions and bosons **[6]**. Quarks and leptons belong to the fermions. Elementary bosons are considered to be responsible for the four hypothetical fundamental forces of nature and are called force particles (gauge bosons). The neutrinos, the Myons and Tauons are treated as elementary particles. Composite particles which interact via strong interaction are hadrons, which are subdivided into baryons and in mesons. Furthermore, atomic nuclei, atoms and molecules are also recognized. Condensed matter is recognized, and consists of atoms and molecules. Theoretical physicists are considering further hypothetical particles, and use string and membrane models in order to explain nature. However, the particles physicists do not understand what determine particle mass.

On the contrary, ATOM uses only two fundamental interactions (electromagnetism and gravitation) and recognizes that four kinds of stable elementary particles cause these interactions with two conserved charges. The interactions propagate with c and this constant is independent of the particle motion. The above derived explanation of composite particles offers the determination of masses, binding energies and sizes (at least for two-particle systems). We can also calculate the relative velocities; we are also able to calculate a further physical property of particle systems, the magnetic moments of particle systems with two or more particles. So, we are able to calculate all physical properties of two-particle systems, which themselves compose all other particle systems and condensed matter. These principles are sufficient.

The Dynamics of Physical Systems

For the formulation of dynamics, Lagrange, Euler and Hamilton produced a generalized description. They created the Lagrange formalism. The equations of motion can be derived according to the Hamilton principle. This allows the use of a more general form of interaction. Nevertheless, Lagrange, Euler and Hamilton did not create the most general description for physics. They asserted, for instance, that the positions and velocities (impulses) of particles/bodies, ($\mathbf{r}_i(t)$, $\mathbf{p}_i(t)$), can be precisely determined at every time, t,. 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 ATOM, I gave up on this assumption because perfect precise measurements cannot be performed.

Because the interactions are assumed to propagate with the constant speed c, space and time are connected. Therefore, I 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

$$\Delta(a_1,a_2) = a_{1\nu}\, a_2^\nu = c^2\cdot(t_1 - t_2)^2 - ((x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2). \qquad (63)$$

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 these are valid in each coordinate system of Minkowski space Ω.

The action integral is constructed with $A^{(em)\nu}(x) = (\phi^{(em)}(\mathbf{r},t)/c,\mathbf{A}^{(em)}(\mathbf{r},t))$ and $A^{(g)\nu}(x) = (\phi^{(g)}(\mathbf{r},t)/c,\mathbf{A}^{(g)}(\mathbf{r},t))$, as a manifest invariant Lagrange function **[7]**

$$L = \int^\Omega (dx)^4 \;\{\Sigma_{i=e,p,P,E}\; m_i\cdot c\; \partial_\nu j_i^{(n)\nu}(x) - (F^{(em)}{}_{\mu\nu}(x)\, F^{(em)\mu\nu}(x) + F^{(g)}{}_{\mu\nu}(x)\, F^{(g)\mu\nu}(x))/4$$
$$- \Sigma_{i=e,p,P,E}\;\; q_i\cdot j_i^{(n)}{}_\nu(x)\cdot A^{(em)\nu}(x) + \Sigma_{i=e,p,P,E}\;\; g_i\cdot j_i^{(n)}{}_\nu(x)\cdot A^{(g)\nu}(x)\}, \qquad (64)$$

with the help of the Faraday tensors

$$F^{(em)\mu\nu}(x) = \partial^\mu A^{(em)\nu}(x) - \partial^\nu A^{(em)\mu}(x), \qquad (65)$$

$$F^{(g)\mu\nu}(x) = \partial^\mu A^{(g)\nu}(x) - \partial^\nu A^{(g)\mu}(x). \qquad (66)$$

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, L, is not an expression of energy.

The field dynamics could be derived in the usual way within Ω using 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 covariant field dynamics are given by the equations

$$\partial^\mu \partial_\mu A^{(em)\nu}(x) = + j^{(em)\nu}(x) = + \Sigma_{i=e,p,P,E}\, q_i \cdot j_i^{(n)\nu}(x), \qquad (67)$$

$$\partial^\mu \partial_\mu A^{(g)\nu}(x) = - j^{(g)\nu}(x) = - \Sigma_{i=e,p,P,E}\, g_i \cdot j_i^{(n)\nu}(x). \qquad (68)$$

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 are wave equations with the propagation speed c.

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 give the subsidiary conditions of particles a new name: isopretic subsidiary conditions. This is 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, **[8]**

$$\delta L + \delta\, \Sigma_k \lambda_k/c \cdot (\, \Sigma_i \int^\Omega (dx)^4\, \partial_\nu j_i^{(n)\nu}(x)\,) = 0. \qquad (69)$$

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

$$j_i^{(n)\nu}(x) = (c\cdot\rho_i(\mathbf{r},t), \mathbf{j}_i(\mathbf{r},t)) = c\cdot\underline{\psi}_i(x)\gamma^\nu\psi_i(x),\ \nu = 0,1,2,3 \text{ and } i = e,p,P,E, \qquad (70)$$

and must be inserted in L in order to perform the variation. It is important to note, that the Dirac spinors $\psi_i(x)$ and the γ^ν matrixes come into the theory because neither the positions, nor the velocities (impulses) of the particles are precisely known. Concerning 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. Therefore, during the variation the spinors, $\psi_i(x)$, and the adjoin spinors $\underline{\psi}_i(x) = \psi_i(x)^{T*}\cdot\gamma^0$, i = e,p,P,E, must be treated as independent generalized variables. The derived equations of particle motions are

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

$i = e, p, P, E.$ (71)

The variation of Eq. (64) is stationary in Ω, if all the spinors, $\psi_i(x)$, fulfill these equations and if the fields fulfill the covariant wave equations Eqs. (67), (68).

Whether the variation is stationary is another problem; this does not concern us: indeed 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

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

for $i = e, p, P, E.$ (72)

The mutual fields of a composite particle systems, $A'^{(em)\nu}(x')$ and $A'^{(g)\nu}(x')$, 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 the COM system. Regardless, the Lagrange multipliers, λ_k, λ_k', only occur in the equations of particle motion because of particle numbers conservations. Such stationary bound states are independent of the boundary conditions **[11]**.

There is a difference in the order of the differential equations that appear in ATOM and in conventional quantum mechanics. In ATOM the equations of particle motion are first order differential equations and the Lagrange multipliers appear linear connected to the time and space derivations. The spinors occur because neither the positions, nor the velocities of particles are precisely known. Furthermore, the ATOM does neither use generally the energy conservation in Ω, nor the quantization of energy. Since the formalism is described in finite ranges of Minkowski space, different boundary conditions on the surface of Ω can be described different unstable particle states for simultaneous determination of lifetimes, Γ, and energies with Lagrange multipliers **[10], [11]**.

Established quantum mechanics uses energy conservation and energy quantization with the Planck constant, h. Energy conservation can only be used in closed physical systems; therefore quantum mechanics uses infinite Minkowski space. Schrödinger **[9]** used the condition that the wave function must vanish at $|\mathbf{r}| \rightarrow \infty$. The correspondence principle applies the assumption that the initial quantum state can be precisely known at an initial time, $t = t_0$ and utilizes an ad hoc transformation within energy conservation

$E \rightarrow +i \cdot h/2\pi\, \partial/\partial t$, $\mathbf{p} \rightarrow -i \cdot h/2\pi\, \partial/\partial \mathbf{r}$. (73)

In quantum mechanics, the Planck constant appears quadratic in the spatial part of the differential equation because the equation of the energy contains $\mathbf{p}^2/2 \cdot m'$.

I strongly suggest that an entire other condition causes the appearance of

$$- h^2/(2 \cdot \pi \cdot m')\, \Delta\, \Psi(\mathbf{r}) \quad (74)$$

in the spatial part of the equation of wave functions for stable bound states, namely that the surface conditions for wave functions must be independent of boundary of finite space regions, V. In this case, stable bound states appear at a condition, $\beta^2 = - \beta$, whereby β is some parameter determining the wave function of stable states **[1]**, **[10]**, **[11]** **(**and not the quantization of energy). The description of (timely stationary) bound particle states in COM system and in finite space regions, V, uses the independency of wave functions form boundary conditions expressed with some parameter β and β determines the binding energy. This consideration justifies the relations

$$\lambda_k = e^2/2 \cdot c \cdot (\, m_{ij}' \cdot c^2/2 \cdot E(\text{binding},\lambda_k))^{1/2}, \quad (75)$$

and

$$r_{(i,j)} = \lambda_k{}^2/(4 \cdot \pi^2 \cdot\, m_{i,j}' \cdot e^2). \quad (76)$$

The binding energy is coupled with parameter, λ_k, which we have called the Lagrange multiplier. For two-particle systems it is

$$E(\text{binding},\lambda_k) = ½ \cdot m_{ij}' e^4/(4 \cdot \lambda_k{}^2). \quad (77)$$

On the other side, the binding energy can be expressed as difference of the sum of elementary particle masses minus the inertial rest mass, $m^i(i,j)$, multiplied by c^2. For two-particle yields

$$E(\text{binding},(i,j)) = ((m_i + m_j) – m^i(i,j)) \cdot c^2. \quad (78)$$

We obtain from

$$E(\text{binding},(i,j)) = ½\, m_{ij}' \cdot c^2 \cdot (v_{(i,j)}/c)^2/(1 - (v_{(i,j)\,j}/c)^2) \rightarrow$$

$$(v_{(i,j)}/c)^2/(1 - (v_{(i,j)}/c)^2) = e^4/(4 \cdot \lambda_k{}^2 \cdot c^2) < 1. \quad (79)$$

In two-particle systems this relation connects the relative velocity of particles with λ_k and with Eq. (76) to the relative distance with the same constant. I am strongly disposed to assume that the relative distances, $r_{(i,j)}$ and the relative velocities, $v_{(i,j)}$, are sharply determined by the interactions, despite the uncertainty surrounding initial positions and velocities.

In ATOM, the timely stationary of states only gives energy conservation for exceptional states with some Lagrange multipliers in Ω. With time-dependent fields, $A^{(em)\nu}(x)$ and $A^{(g)\nu}(x)$, we cannot understood energy conservation as a general principle of physics. But, energy conservation is considered as one of the most important basics of conventional physics. Such a principle does not exist in Nature. The atomistic theory of matter is a relativistic quantum field theory, but neither the energy quantization, nor the $E = m^{*} \cdot c^{2}$ principle are needed. In this paper, the prognoses of ATOM have been discussed in comparison to all observed stable and unstable particles. Neutrinos and neutrino-like particles are stable systems and are seen to have zero gravitational charges and zero gravitational masses.

The ATOM gives a completely different physical description of Nature than established physics. Yet, the scientifically problems of this new description have not be comprehensively discussed. This paper is a new start.

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 conserved and quantized. The ATOM defines a particle physics based on e, p, P and E. Besides the Planck constant, h, further constants (Lagrange multipliers), $h^0 = h/387$ and $\underline{h}$ are determined from the energetic stable bound states of two-particle systems. The compositions and mass splitting of observed unstable many-particle systems (mesons and baryons) are discussed. The binding energies of particle systems are determined the first time with the help of the observed inertial rest masses and the calculated gravitational masses. Tables define binding energies and sizes of two-particle systems, and binding energies, mass splitting and the compositions of mesons and baryons. The compositions of Kaons and Tauons are an, as yet, unsolved challenge. Particle reactions and particle decays can only be studied with the conservations of electric and gravitational charges which also conserve the gravitational masses. The conservation of gravitational masses means really mass conservation. In the contrary to established physics, in ATOM none of the concepts of conventional physics are used. These un-used concepts are: *universality of free fall*, *energy* *conservation and quantization, the quantization of interacting fields, weak and strong interactions, quark theories, further quantization of particle properties (for instance with spins), the particle-anti-particle concept, the subdivision of particles into fermions (quarks–leptons), bosons, hadrons and possible other hypothetical particles.* The atomistic physics is a paradigm shift away from energetic physics. The established energetic physics did not recognize that the elementary particles have two kinds of conserved charges and that the neutrinos are composed particles with zero gravitational charges and masses. The gravitational mass and the inertial (rest) mass are fundamental different. The atomic nuclei are consisting of protons, electrons and positrons. The neutrinos and neutrino-like particles have the same number of protons and eltons and the same number of electrons and positrons. These are both electrically as gravitationally neutral. The charged mesons have the same number of protons and eltons. In baryons, the numbers of protons differ from the number of eltons at least by one. Furthermore, the gravitation is regarded by particle physics as an interaction. 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, [7]. The ATOM does not use the special and general relativity theories. In the atomistic theory of matter only the relativity of particle motion between point-like particles and the relative movement to c are needed. Since the elementary masses of proton and electron, m_P and m_e, are not equivalent to energy, the energy-mass-equivalence, $E = m^* \cdot c^2$, is not valid. The Conservation of Energy and the UFF are indeed not present in Nature. The laws of Nature are non-deterministic, however causal.

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