Motto: An Universe made of 10^{122} etherons

Ether and Etherons - A Possible Reappraisal of the Ether Concept

by Ioan-Iovitz Popescu
iovitzu@gmail.com; *http://www.iipopescu.com/*

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Outline

Abstract. A new explanation of the Newtonian law of gravitation is given, proceeding from the following statements: a) the Universe is finite and filled with some particles of very small mass, traveling at speed of light; b) all material bodies in the Universe are made up of such particles called “etherons”; c) the matter in the Universe is prevailingly under the form of etherons. The uncertainty principle of quantum mechanics and some dimensionless relations of relativistic cosmology - among which Mach’s principle - are adopted in view of establishing the intrinsic characteristics of etherons as well as their number in the Universe. By applying statistical ratiocinations to the etheronic background, expressions of Hubble’s and Newton’s constants are derived in terms of some kinetic entities pertaining to the ether. The emergence of the inverse square law of force entails at the same time a very strong coupling of the etherons in a nucleon and a saturation character of the binding forces. A wide discussion is undertaken concerning the consistency of the physical world picture suggested

by the etheronic conjecture with the already constituted frame of conventional physics, drawing interesting and encouraging conclusions.

1. Historical considerations and problem setting

The idea of an universal medium filling the whole space is very old. Since Aristotle and Bhagavad-Gita until nowadays, the philosophers and the physicists and, more recently, the cosmologists strived to understand the "most subtle" state of matter, occasionally called "ether". The historical persistence of this concept, which escapes from the usual control by experiment – though intimately bound to the basic phenomena of the physical world, gets its motivation not only in the Latin aphorism "Natura abhorret vacuum", but mainly in the need to explain the phenomena by a causal infrastructure, whose existence is left to be subsequently tested. A study on the internal logic and the historical roots of various evaluations of the ether concept within the framework of the modern physical theories has recently been given by Liviu Sofonea and Nicolae Ionescu-Pallas [1].

The history of the luminiferous ether, prevailing in the European physics of the XIX-th century, is well known - see, for instance, Edmund Whittaker [2]. Some new aspects regarding the irrelevant character of the ether, as well as its compatibility with the special relativity theory, have been investigated by Nicolae Ionescu-Pallas [3]. The "irrelevance" of the ether seemed in the past stranger than today, when physicists are already used to "magnetic monopoles", "partons", "quarks" and others.

In the present paper we will consider such an irrelevant entity - the "etheron" - in connection with the cosmological role of the ether, so much discussed in the last decade. Fist of all we will shortly expose the major achievements in cosmology as obtained by adoption or adaptation of the ether concept just to satisfy the modern principles of "covariance", "minimal action", "physical field" and so on.

The first serious attempt to elaborate an etheronic scheme of the matter is due to Georg Szekeres [4]. Extensions of this trial, aiming to obtain separate conditions of conservation for the ether and the substance, have been done by Nicolae Ionescu-Pallas [5] in his recent treatise entitled "General Relativity and Cosmology". Retaining the hypothesis of the existence of two kinds of conservative "matter" – ether and substance – and trying at the same time to lessen the differential order of the field equations, Nicolae Ionescu-Pallas and Liviu Sofonea [6] succeeded to build a cosmological model; here appears a sort of universal ether and Newton's constant G, as well as the cosmological constant Λ, vary just to ensure an adiabatic expansion of the Universe. The latter model, called also "Cosmologia Veradiensis", allows to get an idea of the way to reconcile the ether concept with the present theories of Big Bang and expanding Universe. Another remarkable model - also based on the ether concept and having some common features with Cosmologia Veradiensis, is due to Nathan Rosen [7]. The

exceptional value of Rosen's model consists in the fact of representing an oscillating system, thus preventing the collapse at maximum contraction.

The question of what effectively consists the physical structure of the ether remains an extremely controversial subject, in spite of valuable suggestions made by physicists of mark such as E. Sudarshan et al. (the ether as a superfluid state of particles and antiparticles [8]), J. P. Vigier et al. (the ether made up of bosons of minute mass [9]), A. Das and P. Agrawal (the ether of quanta or particles of extremely tiny mass [10]), J. R. Rao et al. (the ether of particles responsible for the "strong" gravity [11]).

Let us remind, finally, two hypotheses based on options favorable to an ether with discrete structure. The first, due to Nicolae Ionescu-Pallas and Ioan Gottlieb [12], accredits the opinion that the Hubble's expansion would be determined by a scalar field with quanta of a tiny rest mass, as given by the expression

$$m_0 = (3/2)(\hbar H/c^2) \approx 10^{-69}\ \text{kg} \qquad (1)$$

where H is Hubble's constant, c the light speed in vacuum and $\hbar = h/2\pi$ the Planck's reduced constant "h-bar". The second hypothesis, more recent, argues on the possibility of an universal medium structured of neutrinos [13].

In continuation will be presented some considerations regarding relation (1) which represents, in fact, the starting point of our approach. Let us first observe that this relation, basic for the following, results immediately if the Hubble's constant, H, is interpreted as the angular frequency, ω_0, of an oscillatory process occurring at cosmic scale. Thus, considering the temerarious identification of the physical Universe with a three-dimensional isotropic harmonic oscillator, with the proper frequency $\omega_0 = H$, one observes that relation (1) is a consequence of the expression of the ground state energy, namely $(3/2)\hbar\omega_0 = (3/2)\hbar H = m_0c^2 \approx 10^{-33}$ eV. As a support may be invoked the model of oscillatory Universe of Richard Tolman [14], according to which the angular frequency of the cosmic pulsation is $\omega_0 \approx H$. We are also led to accept that the neighboring "excited" states of the Universe are energetically equally distant by $\hbar\omega_0 = \hbar H$ and that the minimal energy which can be exchanged between the interacting material systems is given by the quantum $\hbar\omega_0 = \hbar H$.

In the following we will call "etheron" the quantum of energy of $\hbar\omega_0 = \hbar H = m_E c^2$. Because the energy of this quantum is extremely small (of the order 10^{-33} eV) and, on the other hand, since the gravity is the most feeble of known interactions, there arises the plausible supposition that the etherons represent the exchange particles associated to the gravitational interaction. Moreover, as we will further argue, we are led to postulate the existence of an interaction associated to any form of energy of the type "Energy = Energy + Etherons", where Energy means any

substructure of the Universe, including elementary particles. Generally, the existence of an interaction of this type leads to a stationary potential of the Yukawa type, $\Phi \sim (1/r)\exp(-r/\lambda)$, where $\lambda$is the Compton wavelength associated to the particle mediating the interaction. For gravitational interactions, presumably mediated by etherons, $\lambda_E = \hbar/m_E c \approx c/H \approx R \approx 10^{26}$ m, that is of the order of magnitude of the Universe radius. For strong interactions, mediated by pions (a presumably "multi-etheronic" process, $m_\pi \approx n m_E$), $\lambda_\pi = \hbar/m_\pi c$ ($\approx \lambda_E/n$) $\approx r_n \approx 10^{-15}$ m, that is of the order of magnitude of nucleon radius. The mass quantification introduces in this way a finite range for all interactions, which cannot exceed the dimension of the Universe. By calling "etheron" this quantum of mass there should be no envision about the properties of absolute reference frame of the ether. The ether concept would only reflect the occurrence of some entities having particle properties, by the "condensation" of which (under the form of inertial mass and of "interaction" mass of "transit" etherons) we have to explain the extremely complex structure of micro-objects challenging us nowadays.

Another reflection inspired by relation (1) is connected to the observance of the process of emission, respectively of absorption of the quantum of energy $\hbar\omega_0 = \hbar H$. Thus, according to the uncertainty principle of Werner Heisenberg, the lapse of time during which such a process occurs with certainty is given by $\tau \approx (1/2)\hbar/\hbar\omega_0 = 1/2\omega_0 = 1/2H$, that is of the order of magnitude of the cosmic epoch (of the Universe "age"). Due to their tiny mass and extreme rarity of the events (collisions, processes) in which they are involved, the etherons travel (almost) at light speed, revealing rather quantum than particle properties. Arguments in favor of this seemingly strange situation (but essential for what follows) are brought within the theory of Louis de Broglie regarding the photons with non-zero rest mass and with velocity close to the light speed in vacuum [15]. In this context, the mass of the order of magnitude given by expression (1), $m \approx \hbar H/c^2 \approx 10^{-69}$ kg , is also presently mentioned as the "photon rest mass" or the "boson mass" [16]. **Note added on January 6, 2003:** An expression of the quantified mass in a "space-time cavity" [29], indicates again the etherons as the ultimate building blocks of matter [see Addendum 4].

Another interesting argument in favor of quanta of energy $\hbar\omega_0 = \hbar H$ is the following. Thus, due to the fact that, according to a "gedanken experiment", the detection time of an etheron is of the order of 1/H, one can not avoid an uncertainty of the order $\hbar\omega_0 = \hbar H$ in the measurement of energy, respectively a mass uncertainty of the order $\hbar\omega_0/c^2 = \hbar H/c^2$. Adopting the Einstein's static model with cosmological constant, any fluctuation of the Universe mass, M, induces, via the relation $GM/c^2R = \pi/2$, a fluctuation of the curvature radius, R, of the Universe (where G is Newton's constant). From $\delta M = \hbar H/c^2$ in association with the last relation it results $\delta R = (2/\pi)(\hbar G/c^3)(H/c)$ or $\delta R^2 = (4/\pi)(\hbar G/c^5)(HR/c)$. Since $HR/c \approx 1$ and $L_P = (\hbar G/c^3)^{1/2}$ is the Planck's gravitational length, it results that the

quadratic fluctuation of the Universe radius of curvature is of the order of magnitude of Planck's gravitational radius, namely

$$(\delta R^2)^{1/2} = (2/\pi^{1/2})(HR/c)^{1/2}(\hbar G/c^3) \approx L_P \approx 10^{-35}\ \text{m} \qquad (2)$$

This conclusion agrees with the opinion of Arthur Eddington regarding the fluctuations of the curvature radius of the Universe [17].

The energy quantum $\hbar\omega_0 = \hbar H$ denominated here as "etheron" is assumed to be, by definition, the constitutive particle of the cosmic ether. As far as the etheron has the smallest mass compatible with the uncertainty principle of quantum mechanics, it follows that the ether represents the most "fine" fluid, yet having a discrete (corpuscular) structure [see Footnote 1]. For sure, the ether is a form of existence of the matter but qualitatively different from the common (atomic and molecular) substance or radiation (photons). Moreover, we will assume that the ether is governed by the principle of inertia and produces by its presence a modification of the space-time geometry. According to the static model of Einstein, the mass of the Universe (conceived as finite but unbounded) is given by the expression $M = (\pi/2)c^2R/G$; the magnitude of the radius of curvature, R, is of the order c/H. Thus, the mass of the whole Universe, predicted theoretically, is exclusively expressed in terms of universal constants, namely $M \approx c^3/GH \approx 10^{53}$ kg. A second way of estimation of this mass is based on the formula $M = 2\pi^2R^3\rho$ where $R \approx c/H$ and ρ is the mass density in the Universe, an observational quantity deduced from the mass and distribution of the galaxies. As it is known, the theoretical estimation $M \approx 10^{53}$ kg is about two orders of magnitude greater than the "observational" mass, as if the Universe mass would be stored in the space under a form which escapes to the conventional observation (the problem of the so called "hidden mass"). We take this opportunity to suggest that the "hidden mass" could be under the form of ether.

In order to explain the universal law of gravitation by means of the ether concept, as argued above, we need still two essential hypotheses, namely: a) all material bodies are build up of etherons; b) the universal attraction is, actually, the result of the de-compensation of the hydrodynamic pressure, exerted upon the bodies by the universal ether, as a result of mutual screening. The aim of this article is to present the way of acting of these hypotheses and the manner in which one can obtain the global consistency of the model, both in itself and in comparison with the already established frame of general relativity and modern cosmology. We mention that the explanation of the gravitation, as will be presented in this article, has some common traits with the theory of Iosif Adamut, a theory based on the Lesage's hypothesis and on a medium made up of quanta [18].

But before proceeding to the demonstration of the gravity law, let us present an additional argument regarding the speed of the etherons, as well as the consequences which follow from their ultra relativistic character. For this purpose,

we will appeal again to the uncertainty principle - this time with reference to the relationship coordinate-momentum. Thus, the smallest possible error in the determination of the momentum of a physical system is given by the momentum p_E of an etheron (randomly emitted or absorbed), that is $\delta p = p_E = m_E v_E = (\hbar H/c^2)v_E$. This quantity should be corroborated with the greatest possible error of the position coordinate δx in conformity with Heisenberg's relation $\delta p \delta x \approx \hbar/2$. Since the "characteristic dimension" of the Universe is c/H it results that $\delta x \approx (1/2)(c/H)$ and, consequently, $v_E \approx c$. By developing this argument we considered the quantity $\hbar H/c^2$ as the dynamic mass rather than the rest mass of the etheron. Actually, we can assume that the speed of the etheron is not just, but a little less than c - so that the rest mass should be of the same order as the dynamic mass (for instance, if $v_E/c = (1/2)3^{1/2} \approx 0.866$, then $m_{0E} = (1/2)m_E = (1/2)\hbar H/c^2$. On the other side, in conformity with the representations of statistical mechanics, one can assume that the velocities of the etherons are distributed around a mean value a little smaller than c and in a narrow band which, practically, can be neglected. A similar situation, in which "particles having quantum properties", of given energy, move at speed c, occurs in the theory of gravitation of J. L. Synge [19].

One of the most important consequences resulting from the ultra relativistic character of the etherons resides in the fact that the "primary aggregates" buildup of etherons should reveal themselves as exceptionally stable, due to the major contribution of the part of speed dependent binding energy. In spite of the fact that this assumption cannot be directly proven, we can, however, illustrate it in the sole rigorous case of the two-body problem within the frame of special relativity. Specifically, let us refer to a potential inversely proportional with the distance between the particles, a case independently elaborated by Alfred Schild [20] (starting from the symmetric electrodynamics) and by Nicolae Ionescu-Pallas and Liviu Sofonea [21] (starting from the "invariantive mechanics" of Octav Onicescu). Schild's formula reads

$$E = m_{01}c^2(1-v_1^2/c^2)^{1/2} + m_{02}c^2(1-v_2^2/c^2)^{1/2} \qquad (3)$$

where the energy E of the system vanishes as (v_1 , v_2) come closer to c. As it will be shown in the following, the "etheronic model" appears particularly encouraging, inasmuch as it allows the deduction of Newton's law for gravitation, as well as the fact that primary aggregates, directly made up of etherons, have a mass defect comparable to the sum of the etheronic constituents. Actually, as it is known, an almost unity ratio between the binding energy and rest energy is characteristic for nucleons [22]. Is there an indication that the "partons" or the "quarks" might be modes of etheronic collective motion?

2. Basic cosmological relationships

Until here we prepared the following remarkable hypothesis: “The Universe is filled almost exclusively with particles of tiny mass, m_E , moving at random at light speed, c . The aggregated mass, stored in stars and galaxies, can be formally considered as constructed of such particles of mass m_E - called here etherons - whose number is proportional to the ratio between the inertial mass of the body and the mass of etherons. In order to exploit this supposition for the clarification of the “mechanism” of gravitation, we need a corpus of quantitative relationships already established and allowing a conciliation of the etheronic theoretical approach with relativistic cosmology. This will be achieved by adopting the following set of six simple relationships

$$m_Ec^2/\hbar H = k_1 \qquad GM/c^2R = k_2 \qquad m_EcR/\hbar = k_3 \qquad (4\text{-}6)$$
$$m_Ec^2/(\hbar^2/m_ER^2) = k_4 \qquad r_EN_E^{1/2}/R = k_5 \qquad V/2\pi R^3 = k_6 \qquad (7\text{-}9)$$

where k_1 , k_2 , …, k_6 are non-dimensional constants of the order of magnitude of unity; (c, $\hbar = h/2\pi$) are the speed of light in vacuum and the Planck’s reduced constant; (G, H) are Newton’s constant, respectively Hubble’s constant; (m_E , r_E , N_E) are the mass, dimension, and total number of etherons in the finite Universe; finally, (M, R, V) are the mass, dimension (that is the curvature radius), and the volume of the finite (but unbounded) Universe. The fact that we adopted simultaneously the static model of Einstein and the Hubble’s constant does not necessarily constitutes a contradiction by virtue of two reasons: 1) the expansion is not the sole explanation for the constant of Hubble; 2) even the static model provides the right order of magnitude of the characteristics of the Universe. Let us comment upon the origin and opportunity of the relationships (4-9).

Relation (4) simply affirms that the etherons exist; this is our axiomatic point which we accept together with its sustaining arguments.

Relation (5) is an expression of the Mach principle, independent of adopted cosmological model. For the static model of Einstein with positive curvature $k_2 = \pi/2$; for the expanding Universe $k_2 = \pi$ [6].

Relation (6) represents an adaptation to the etheron of the relation of Feza Gürsey [23] and Fred Hoyle [24] and requires a scalar particle of an extremely small mass. This is compatible with relation (4), showing that the curvature radius, R, and the ratio c/H have the same order of magnitude [5].

Relation (7) is, formally, a consequence of relation (6) and introduces a restriction for the unknown constants (k_3 , k_4), namely $k_4 = k_3^2$. However, this relation has a relevant physical meaning, allowing us to consider it as an independent relationship. Thus, this affirms that the rotation quantum $\hbar^2/m_ER^2$ has the same order of magnitude as the oscillation quantum $\hbar\omega_0 = \hbar H \approx m_Ec^2$. In other words, the uncertainty relations discussed above can be rewritten in a form

replacing the oscillation quantum with the rotation quantum. This fact can be interpreted as a proof of the stability of the Universe not only against oscillations (when an energy of the order $m_E c^2$ is by chance emitted or absorbed), but likewise against rotations (when an energy of the order $\hbar^2/m_E R^2$ is involved in a similar manner).

Relation (8) represents an *ad litteram* transposition for etherons of the famous relation established by Arthur Eddington for protons [17]. A simplified version of Eddington's reasoning, given by Nicolae Ionescu-Pallas [5], is: "If in the finite and unbounded Universe of Einstein would exist a single particle (proton), this would be described by a wave which, due to the space curvature, would prescribe an incertitude of the center of inertia equal to R. Assuming that in the Universe there exist a finite number N_p of protons, the uncertainty is reduced according to the laws of statistical mathematics to $R/N_p^{1/2}$. This quantity is identified by Eddington with the spatial extension of the particle (which becomes, in this way, non punctual)". Obviously, if the free particles filling predominantly the Universe are not protons, but etherons, the above reasoning is equally valid also for our model of etheronic Universe, whence it results relation (8).

Relation (9) has a pure geometric content and affirms that the Universe volume and the third power of its characteristic dimension (of the curvature radius) are in a constant ratio. Thus, the constant k_6 has the value 2/3 in an Euclidean geometry and the value π in a Riemannian geometry (topological closure).

The most plausible values which will be adopted here for the set of constants (k_1 , …, k_6) are the following:

$$k_1 = 1 \ , \quad k_2 = \pi/2 \ , \quad k_3 = 1 \ , \quad k_4 = 1 \ , \quad k_5 = 1/2 \ , \quad k_6 = \pi \qquad (10)$$

The value $k_1 = 1$ results from the manner in which we concretized the etheron concept. The values $k_2 = \pi/2$ and $k_6 = \pi$ arise from the static cosmological model of Einstein. The special value $k_5 = 1/2$ was chosen to give correctly the proton dimension ($r_p = 1.4\ 10^{-15}$ m) when formula (8) is used in the original interpretation of Eddington. The value $k_3 = 1$ results as a consequence of the relationship $R = (k_3/k_1)c/H$, of the choice already done for $k_1 = 1$ and of the accepted fact of contemporary cosmology that, in the present epoch, $R \approx c/H$ [5, 6, 25]. Once the value $k_1 = 1$ is admitted, it then results $k_4 = k_3^2 = 1$.

Further we shall see that the set of constants (10) leads to a very strong coupling for etherons, assumed to be the constituents of the nucleon. It is interesting to notice how a macroscopic condition at cosmic scale such as, for instance, the topological closure of the Universe, leads to an energetic consequence at infra-nucleonic level.

3. The ether as an ultra relativistic gas

Many physical properties of the ether can now be derived from the statements presented above, expressed by the fundamental cosmological relationships (4-9), from the (presupposed) quantum properties of the etheron, and from the conventional methods of statistical mechanics.

Let us start with the intrinsic characteristics of the etheron, whose similarity with those of the photon is transparent. Thus, the energy E_E , the mass m_E , the momentum p_E , and the associated de Broglie wavelength $\lambda_E = \hbar/p_E$ are given by the relations

$$\begin{aligned} E_E &= m_E c^2 = k_1 \hbar H \approx 10^{-33} \text{ eV} \\ m_E &= E_E/c^2 = k_1 \hbar H/c^2 \approx 10^{-69} \text{ kg} \\ p_E &= m_E c = k_1 \hbar H/c \end{aligned} \qquad (11)$$

respectively

$$\lambda_E = \hbar/p_E = c/k_1 H = R/k_3 \approx 10^{26} \text{ m} \qquad (12)$$

The last relation represents the mathematical equality of two rather different entities, thus binding the quantum properties of the etheron with the geometrical properties of the Universe.

Further, from equation (5) and the equality $R = (k_3/k_1)c/H$ we can express the mass of the Universe in the form

$$M = (k_2 k_3/k_1)(c^3/GH) \approx 10^{53} \text{ kg} \qquad (13)$$

Since the ether represents the dominant component of matter in the Universe, we can suppose that the entire mass of the Universe is practically constituted of free etherons. This allows to write $M = N_E m_E$, where N_E is the total number of free etherons in the Einstein Universe,

$$N_E = M/m_E = (k_2 k_3/k_1^2)(c^5/\hbar G H^2) \approx 10^{122} \qquad (14)$$

The dimension of the etheron can be derived from equations (8), (14) and $R = (k_3/k_1)c/H$, so that

$$r_E = k_5(k_3/k_2)^{1/2}(\hbar G/c^3)^{1/2} = k_5(k_3/k_2)^{1/2} L_P \approx 10^{-35} \text{ m} \qquad (15)$$

As expected, the dimension of the etheron is of the order of magnitude of the Planck's length, that is of the quantum fluctuation of the space (according to formula (2)).

Let us proceed to the statistical properties of the ether by defining, firstly, a "classical" cross section for the etheron - etheron collision with the help of the formula $\sigma_E = \pi(2r_E)^2$, that is

$$\sigma_E = 4\pi k_5^2(k_3/k_2)\hbar G/c^3 = 4\pi k_5^2(k_3/k_2)L_P^2 \approx 10^{-70}\ m^2 \qquad (16)$$

A particular meaning of the last formula consists in the fact that it allows to express Newton's constant of the universal attraction in terms of the cross section σ_E , a quantity of statistical nature, that is

$$G = (1/4\pi)(k_2/k_3k_5^2)c^3\sigma_E/\hbar \qquad (17)$$

This unexpected result can be an evidence that gravitation itself might be of statistical origin (in terms of the hydrodynamic model of Lesage). We shall mention in this context that Edward Milne, in his "Kinematic Relativity" [26], deduced for the first time the Newtonian law of the attraction force within a theory which is compatible with Mach's principle.

Another interesting relationship, connecting infra-microscopic and ultramacroscopic entities, is $L_P^2 = k_2k_3\lambda_E\lambda_U$, where $\lambda_U = \hbar/Mc = (k_1/k_2k_3)\hbar GH/c^4$ is the Compton length associated to the Universe [see Footnote 2].

In spite of the their tiny mass and dimension, the density of etherons in the Universe is impressing. Indeed, from $V = 2\pi k_6R^3 = 2\pi k_6(k_3c/k_1H)^3$ and from the assumed homogeneity and isotropy of etheron distribution, we get

$$n_E = N_E/V = (k_1k_2/2\pi k_3^2k_6)Hc^2/\hbar G \approx 10^{43}\ m^{-3} \qquad (18)$$

so that the mean distance between etherons is $r_{EE} = 0.554n_E^{-1/3} \approx 10^{-15}$ m and characterizes the "radius" of statistical fluctuations (within which the punctual elementary particles set up).[1]

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[1] A similar ratiocination can be applied for the determination of etheron density, ρ_n, within nucleons (protons or neutrons). Thus, dividing the nucleon mass of about 1.67×10^{-27} kg by the etheron mass of about 1.35×10^{-69} 10 kg, we get the total number of etherons per nucleon to be about 1.24×10^{42}. On the other side, the nucleon radius is about 10^{-15} m, hence the nucleon volume is about 4×10^{-45} m^3. Finally, we get the etheron density within nucleons to be about $\rho_n = 3.1\times10^{86}$ etherons/m^3. This number is about 44 orders of magnitude higher than the cosmic average of "only" 10^{43} etherons/m^3. Finally, the mean distance between nucleonic etherons is about $0{,}554\times\rho_n^{1/3} \approx 7.4\times10^{-30}$ m. The latter is presumably the quark radius.

The quantities σ_E and n_E define the "classical" mean free path for etheron – etheron collision, namely

$$l_E = (1/2^{1/2})n_E\sigma_E = (1/8^{1/2})(k_3k_6/k_1k_5^2)c/H = (1/8^{1/2})(k_6/k_5^2)R \approx 10^{26}\ \text{m} \qquad (19)$$

amounting to the order of the curvature radius of the Universe.

We also can define the mean collision frequency of etherons, i.e.

$$\nu_E = c/l_E = 8^{1/2}(k_1k_5^2/k_3k_6)H \approx 10^{-18}\ \text{s}^{-1} \qquad (20)$$

In this way the Hubble's constant (the second of cosmological interest, besides Newton's constant) gets a statistical explanation too.

Finally, another three statistical characteristics of the etheronic gas complete the table of the properties of this strange fluid, namely the collision rate R_E, the pressure P_E of the ultra relativistic etheron gas (analogous to the Planck's radiations pressure), and the temperature T_E of the etheronic gas, as given respectively by

$$R_E = (1/2)n_E^2\sigma_E c = (1/2\pi)(k_1^2k_2k_5^2/k_3^3k_6^2)H^2c^2/\hbar G \approx 10^{25}\ \text{m}^{-3}\text{s}^{-1} \qquad (21)$$

$$P_E = (1/3)n_E m_E c^2 = (1/6\pi)(k_1^2k_2/\ k_3^2k_6)H^2c^2/G \approx 10^{-13}\ \text{atm} \qquad (22)$$

$$T_E = (3P_E/a)^{1/4} \approx 30\ \text{K}\ [\text{where } a = (8\pi^5/15)k^4/c^3h^3] \qquad (23)$$

Adopting for the Hubble's constant the value $H = 1/(6.53\ 10^{17}\ \text{s})$ and for the constants k_i the probable values given by the set (10), it results a temperature of the etherons of about 30 K, a value which is only one order of magnitude higher than that observed for the cosmic Planck radiation. This estimation of the ether temperature accounts for the fact that the partial pressure of the free etherons is considerably higher than that of the complex etheronic aggregates (such as presumably are the elementary particles and the photons).

4. Deduction of the universal law of attraction

Now we will proceed to the deduction of the famous law of the Newtonian force. The demonstration will start firstly with two nucleons and, then, we will examine the circumstances in which the result can be extended to macroscopic bodies. Thus, let us consider two spherical and homogeneous bodies (nucleons), A and B, containing N_A and N_B etherons respectively, placed in the universal ether (the etheronic gas) at a distance r_{AB} greater than any radius of the considered material spheres. In addition, we will assume that $r_{AB} << l_E \approx \lambda_E \approx R$ so that the potential of the Yukawa type becomes practically Newtonian and the scattering of etherons is negligible.

Each of the bodies would be in thermodynamic equilibrium if it were alone in the Universe, as a result of the compensation of the ether pressure exerted in all the directions of the space, supposed isotropic and homogeneous. The total hydrodynamic force acting on an etheron is just the Pascal force

$$F_E = P_E\sigma_E = (2/3)(k_1^2k_5^2/k_3k_6)\hbar H^2/c \approx 10^{-78}\ \mathrm{N} \qquad (24)$$

ensuring the equilibrium of the considered etheron against the surrounding etheronic background. However, in the presence of another body there appears a de-compensation produced by the latter. Let us suppose that the considered etheron belongs to the body A and evaluate the de-compensation produced by another etheron belonging to the body B. Because we consider $r_{AB} << l_E \approx R$, the mutual screening of the considered etheron pair results geometrically

$$\delta F_E = -F_E(d\Omega/4\pi) = -F_E[\pi(2r_E)^2/4\pi r_{AB}^2] = -F_E\sigma_E/4\pi r_{AB}^2 \qquad (25)$$

The Newton's force between the two bodies (A, B) will be the resultant of all screenings of the etherons of the body A by the etherons of the body B (and conversely), that is

$$F_{AB} = N_AN_B\delta F_E = -GM_AM_B/r_{AB}^2 \qquad (26)$$

where Newton's constant has the expression

$$G = (1/4\pi)(k_2/k_3k_5^2)c^3\sigma_E/\hbar \qquad (17)$$

and the mass of the bodies (A, B) is

$$M_{A,B} = (2/3)^{1/2}[k_1k_5^2/(k_2k_6)^{1/2}](\hbar H/c^2)N_{A,B} \qquad (27)$$

Let us analyze this expression of the mass by replacing the values of the adopted constants (10); we get

$$M_{A,B} = (1/2\pi 3^{1/2})m_EN_{A,B} = m_EN_{A,B} - [1 - (1/2\pi 3^{1/2})]m_EN_{A,B} \qquad (28)$$

It results from this that the ratio between the binding energy per etheron, E_{bE} , and the energy of the free etheron is extremely high, namely

$$E_{bE}/m_Ec^2 = 1 - (1/2\pi 3^{1/2}) = 0.908 \qquad (29)$$

a fact which is qualitatively confirmed by the exceptional stability of some elementary particles [see Footnote 3]. On the other side, the binding energy is proportional with the number $N_{A,B}$ of constituents, revealing a saturation character, a fact either in accordance with the known properties of infra-nuclear forces [22]. For sure, we not expect to be able to systematically deduce the structure and the

properties of matter at infra-nucleonic level from the sole cosmological hypothesis (the existence of the etheron) of interest for gravitation. However, if the microscopic consequences of this assumption prove to be consonant with the principal features of the infra-nucleonic interactions, this very fact is heartening in some respect.

We shall further investigate the gravitational interaction of two nuclei. Proceeding exactly as above, we get

$$F_{A,B} = - GM_AM_B/r_{AB}^2$$

where

$$M_{A,B} = Km_EN_{A,B} = Km_E(N_{A,B}^{(p)}n_p + N_{A,B}^{(n)}n_n) = m_pN_{A,B}^{(p)} + m_nN_{A,B}^{(n)}$$

Here $K = (2/3)^{1/2}k_5^2/(k_2k_6)^{1/2}$ and the new notations represent: $N_{A,B}^{(p)}$, the number of protons in the nucleus A, respectively B; $N_{A,B}^{(n)}$, the number of neutrons in the same nuclei; n_p , n_n , the number of etherons constituting a proton, respectively a neutron. $N_{A,B}$ still represents the total number of etherons of the body (here nucleus) A, respectively B, but $M_{A,B}$ no longer represents the masses of the nuclei - because no longer include their binding masses. This difficulty can be avoided by considering the saturation character of the nuclear forces, so that the binding masses are proportional with the number of nucleons. Actually, in the presence of nuclear matter the mass of a nucleon is not $m_{p,n}$ but $m_{p,n}[1 - (8/939)]$ so that, consequently, the mass of a nucleus is not $M_{A,B}$ but $M^*_{A,B} = M_{A,B}[1 - (8/939)]$. Introducing a new constant $G^* = G[1 - (8/939)]^{-2}$ we are able now to write the macroscopic law of the Newtonian force as

$$F_{AB} \cong - G^*M^*_AM^*_B/r_{AB}^2 \qquad (26')$$

where, this time, $M^*_{A,B}$ are the masses of the bodies and the new constant G* has to be identified with Newton's constant proper. Yet better approximations for the masses can be done with the help of the well known expression of Weizsäcker. At the precision level of the latter, the determination of the gravity constant from the force law of Newton leads to values slightly dependent on the nature of the material used in experiments. The present status of the experimental technique does not allow, however, to test in this way the etheronic hypothesis. If we identify the Newton's constant with G*, and not with G , then, according to the etheronic model, it follows that the gravitational interaction between two nucleons is weaker by the factor $[1 - (8/939)]^{-2}$ than the value of the field theory, which involves an universal coupling for gravitation. Neither this possibility is suitable for the experimental proof with the presently available equipment.

Further advance from nuclei to macroscopic bodies (with atomic and molecular structure) do not present any difficulty, the errors being nevertheless

smaller than those already introduced when estimating the nuclear masses.

5. Conciliation with other theories of gravitation

In the preceding paragraphs we conceived the ether as an universal fluid, predominantly spread in the Universe and being, in many ways, similar to common fluids. Consequently, we performed some statistical ratiocinations and gave a statistical interpretation of Newton's constant, G, and of Hubble's constant, H. On the other hand, the peculiar properties of the ether as compared with common gases have been concretized in the ultra relativistic character of the etheronic gas and in the minute values of the mass and dimension of the etheron. Besides this, we based our reasoning from known cosmological formulae, left formally unchanged but with their meaning so adapted as to promote the etheron concept. Proceeding in this way, we implicitly assumed that there is no contradiction between the adapted cosmological framework and the assumed hypothesis of the ether. This actually means that the geometric properties of the space-time are practically defined only by the ether and not by the common matter. Since no real movement of the cosmic ether is observed, it results a co-mobile metric and, consequently, we can write

$$R_{\mu\nu} - (1/2)g_{\mu\nu}R + \Lambda g_{\mu\nu} = -(8\pi G/c^2)(\hbar H/c^2)n_E\,\delta_{0\mu}\delta_{0\nu} \qquad (30)$$

This represents a modified version of Einstein's equation [27], compatible with the formulae (4-9), with the constants (10), and with the condition $\Lambda = 1/R^2$. In this way the constant of Hubble gets the statute of an actual constant.

The transition from the static to the dynamic model (of an expanding Universe), if necessary, should be accomplished by preserving this character of veritable constant for H. More specific, this means that the model leading to an expansion law of the form $R(t) = R(t_0)\exp[H(t - t_0)]$ is preferable versus the model for which $H \sim 1/t$. To this aim, for the future there remains to further investigate the collective properties of the ether in order to obtain a set of relativistic hydrodynamic equations capable to explain such fundamental phenomena as the expansion of the Universe, propagation at light speed of small transverse perturbations, stability, spin, and charge of the particles.

In the absence of such a theory, we will tentatively assume the validity of the following simple hydrodynamic equation of the Navier type

$$m_E n_E(\partial/\partial t + \mathbf{v_g}.\nabla)\mathbf{v_g} = -\nabla P_E + \mathbf{f} \qquad (31)$$

where the etheron pressure is given by $P_E = (1/3)n_E m_E c^2$ and the friction force, $\mathbf{f} = Cm_E\nu_E m_E\mathbf{v_E}$, has the most simple form. Introducing in equation (31) the expressions of the pressure and of the friction force, expressing ν_E through H and considering $v_E = c$, one gets the simple equation

$$\partial n_E/\partial r + (H/c)n_E = 0 \qquad (31')$$

where the value of the constant $C = (1/3)\pi 2^{1/2}$ was chosen to fit the relativistic law of the cosmological red-shift. Thus, considering also the photon as made up of (transit) etherons, the photon energy is $E_f = \hbar\omega \sim n_E m_E c^2$, so that from (31') there results the well known Hubble's law of red-shift

$$d\omega/\omega = -(H/c)dr = -Hdt \qquad (32)$$

The etheronic model allows to conceive a generalization of this law in the form

$$(1/E)dE/dt \leq -H$$

for any etheronic aggregate of total energy $E = \hbar\omega = mc^2$ [see Addenda 5 and 6 for applications]. The mode of explanation of this law, sketched above, is similar to that of the model of De Sitter's Universe, where the space-time geometric properties are likewise determined by ether (introduced with cosmological constant) [5].

Another interesting connection of the etheronic model can be achieved with the theory of gravitation of J. L. Synge [19]. In conformity with this theory, the Newton's law of the gravitation force is deduced by considering that the two bodies exchange mutually quanta propagating with the light speed. It results from this that the potential energy of the system of bodies equals the energy of transiting quanta. For attraction it is necessary to assume a negative mass of the quanta. By logical transposition, the quanta with negative mass can be interpreted, within the etheronic model, as a deficit of etherons caused by the mutual screening of the bodies. We notice that Synge's approach gives only the proportionality $F \sim 1/r^2$. In addition, for the complete deduction of the Newton's force law the following statements are necessary: 1) the capacity of etheronic emission, C^{Em}, of a body is equal to its capacity of absorption, C^{Abs}; 2) the capacity of emission is proportional to the number of etherons contained in the body; 3) the number of emitted quanta (etherons) is proportional to the capacity of emission of the emitting body and to the capacity of absorption of the absorbing body. Therefore, the potential energy of the two-body system (A, B) reads

$$U_{A,B}(r) = \Sigma_{transit}E_E \sim (C_A{}^{Em}C_B{}^{Abs} + C_B{}^{Em}C_A{}^{Abs}) \sim (C_A{}^{Em}C_B{}^{Em} + C_B{}^{Abs}C_A{}^{Abs}) \sim C_A{}^{Em}C_B{}^{Em} \sim N_A N_B \sim M_A M_B$$

In this way, the etheronic hypothesis can complete the demonstration of Synge, leading eventually to Newton's law of gravitational force with the requirement that any material body should be constructed of etherons.

A temerarious conjecture such as the etheronic hypothesis can rise many and difficult problems regarding, for instance, the motion of a large number of etherons

in a nucleon. Of course, when we speak of "partons" instead of etherons, the problems by no means become simpler and there is no satisfactory solution so far. A suitable model should explain the charge and the spin as hydrodynamic-statistical effects of the collective motion of particle constituents. Perhaps the relativity theory itself has to be reformulated in this respect on statistical bases, as recently sketched in a recent paper by J. C. Aron [28].

In spite of the serious problems raised by the etheronic hypothesis, the possibilities of partial explanation discussed above, as well as the suggested connections between the physical phenomena occurring at cosmic and infra-nuclear levels, are tempting and even encouraging for this model, as a possible way towards a more unitary picture of the physical world. If this way will be proven, then the gravity - this yet so poorly known interaction - will play a more important role then it is considered nowadays. The rise of the interest in the last decade for the concept of ether could be an indication in this respect.

6. Conclusions

A new explanation of the Newtonian law of gravitation is given, proceeding from the following statements: a) the Universe is finite and filled with some particles of exceedingly small mass, travelling chaotically at the speed of light; b) all the material bodies in the Universe are made up of such particles called "etherons"; c) the matter in the Universe is prevailingly under the form of etherons; d) the hydrodynamic mechanism of Lesage for the gravitational interaction is valid, the cosmic background being the ether made up of etherons. The uncertainty principle of quantum mechanics and some dimensionless relations of relativistic cosmology - among which Mach's principle - are adopted in view of establishing the intrinsic characteristics of etherons as well their number in the Universe. By applying statistical ratiocinations to the etheronic background (fluid), expressions of Hubble's and Newton's constants are derived in terms of some kinetic entities pertaining to the ether. The emergence of the inverse square law of force entails at the same time a very strong coupling of the etherons in a nucleon and a saturation character for the binding forces. A wide discussion is undertaken concerning the consistency of the physical world picture suggested by the etheronic conjecture with the already constituted frame of conventional physics, drawing interesting and encouraging conclusions.

Generally, we expect the etherons to have extraordinary, hardly conceivable properties. This is basically caused by the fact that the etherons carry almost 100 % of the mass of the entire Universe, that is $(M/m_E) \times m_E = 10^{122} \times 10^{-69}$ kg $= 10^{53}$ kg, while their proper volume is about 61 orders of magnitude smaller than the total Universe volume, a number derived from the given radius of the etheron of 10^{-35} m and of the Universe radius of 10^{26} m. In simple words, our observable Universe, excepting the volume occupied by the composing 10^{122} etherons, is void of mass,

though, actually, it contains the huge overall mass of 10^{53} kg carried solely by etherons with negligible volume.

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Footnotes

1. We remind here the conception about ether of the Roumanian philosopher Prince Grigorie Sturdza at the end of the 19th century; he has had at the time a correct intuition of the order of magnitude of the implied quantities, in spite of the incipient stage of the cosmology in that epoch.

2. It is interesting to accomplish, in this context, a comparison between gravitational and strong interactions. As argued above, it is plausible that the gravitational static potential is of the Yukawa type:

$$\Phi(r) = -(Gm/r)\exp(-r/\lambda_E) = -(mc^2/M)(R/r)\exp(-r/R)$$

where m is the mass of the body and the "coupling constant", G, is Newton's constant. A similar expression results for the strong interactions if we introduce the pion mass, m_π , nucleon mass, m_n , nucleon radius, r_n , Compton length of the pion, $\lambda_\pi = \hbar/m_\pi c \approx r_n$, Compton length of the nucleon, λ_n , cross section of the pion, $\sigma_\pi = \lambda_\pi\lambda_n$, and the nucleonic coupling constant, $G_n = c^3\sigma_\pi/\hbar \approx r_n c^2/m_n$. Let us remark some ratios between quantities at cosmic and infra-nucleonic scales, namely $\lambda_E/\lambda_\pi \approx 10^{41}$ and $G_n/G \approx 10^{39}$ [Kretschet, Caldirola and others (16)].

3. From (29) it would result that about 90.8 % of the mass of the constituents of a nucleon is annihilated, leading in this way to a very strong coupling. **Note added on January 6, 2003:** It is worthwhile to notice that some slight modifications of the constants k_i allow to approximate the mass expression (28) by $M_{A,B} = (1/4\pi)m_E N_{A,B}$, thus suggesting that the "ultimate" particle, the etheron, might result by the fusion of $4\pi \approx 12 \div 13$ etherons, just as needed to ensure the most compact, icosahedral symmetry [29]. Further considerations on the connection between the etheron conjecture and the modern string theory are given in [30].

Addenda

1. In a recent monograph by J. Heidmann, devoted to relativistic cosmology[2], the uncertainty relation $\Delta E \times \Delta t \approx \hbar/2$ is suggested to be valid at the scale of the whole Universe. Obviously, once accepted its extension to the Universe Age, that is $\Delta t \rightarrow$ Universe Age = 1/H, where H is Hubble's constant, from the above uncertainty relation we get the most tiny energy quantum $\Delta E = m_E c^2 = \hbar H/2$, respectively the most tiny mass $m_E = \hbar H/2c^2$ that can exist. Its numerical value is thus $m_E = \hbar H/2c^2 \approx 1.3494 \times 10^{-69}$ kg, where Planck's constant $\hbar = h/2\pi = 1{,}0546 \times 10^{-34}$ m^2 Kg /s, light velocity in vacuum c = 299792458 m/s, and Hubble's constant $H \approx 2{,}3 \times 10^{-18}$ s^{-1} (that is an Universe Age of $1/H \approx 4.35 \times 10^{17}$ s $\approx 13{,}8 \times 10^9$ years).

2. In the work of L. S. Mayants, "*On the existence of zero mass particles*" [Found. Phys., **11**, 577 (1981)], a concept is argued according to which the electromagnetic field is replaced by a gas of particles, called "emons", having a tiny but non-zero rest mass ($m < 10^{-50}$ kg). It is shown that the existence of emons do not contradict the special theory of relativity and confirms earlier hypotheses of Louis de Broglie regarding the massive photons [5, 15]. The theoretical considerations of Mayants are, in some way, similar to the ideas presented in this work - excepting the fact that these refer to electromagnetism and not to gravity.

3. Criticizing a few months ago the cosmological theory of Big Bang, Fred Hoyle claims that the magnitude of the cosmologic epoch $t \approx H^{-1}$ is too small to justify the huge information stored into highly organized beings (about $10^{40,000}$ specific modes of which about 2000 genes can be made up from about 1020 nucleotide chains). According to the opinion of Hoyle, the evolutional process leading to the apparition of intelligent life would necessitate several cosmological Hubble's epochs. If this critique will be proven as realistic, then the interpretation of Hubble's constant as a pure constant, and not as "1/Universe Age", will acquire an unexpected support.

4. **Note added on January 6, 2003 from [29]:** The free particle in a space-time cavity. Let us consider a rectangular space-time cavity (L, L, L, T) containing a free particle which is described by a Klein-Gordon steady state wave function of the form

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[2] Jean Heidmann, Relativistic Cosmology, Springer-Verlag, 1980. Quoting from the last paragraph, page 160: "The ultimate theory has been proposed by Tryon: the Universe could be a fluctuation of the vacuum in the sense of quantum mechanics", see also Edward P. Tryon, *Is the Universe a Vacuum Fluctuation?*, Nature, 246 (1973), pp. 396–397. The latter has been quoted as saying, "the Universe is simply one of those things that happens from time to time".

$$\Psi(x, y, z, t) = \sin(n_1\pi x/L)\, \sin(n_2\pi y/L)\, \sin(n_3\pi z/L)\, \sin(n_4\pi t/L)$$

where n_1 , n_2 , n_3 , n_4 are positive integers. The momentum components and the energy of the particle are thus subjected to the quantum conditions

$$p_xL = n_1\pi\hbar$$
$$p_yL = n_2\pi\hbar$$
$$p_zL = n_3\pi\hbar$$
$$ET = n_4\pi\hbar$$

Let us further consider the following quadratic form of positive integers, as suggested by the discrete Minkowskian metric

$$n_4^2 - (n_1^2 + n_2^2 + n_3^2) = (ET/\pi\hbar)^2 - (pL/\pi\hbar)^2 = (T/\pi\hbar)[E^2 - (L/T)p^2]$$

In order to ensure the largest conceivable freedom of the particle, the cavity will be extended to the observable Universe, thus obeying the cosmological relation $L = cT = c/H$ between the Universe size L and age T. Finally, we get in this way the quantization of the rest mass m_0 and of the rest energy $E_0 = m_0c^2$ of the free particle within the Universe in the form

$$(E_0/\pi\hbar H)^2 = n_4^2 - (n_1^2 + n_2^2 + n_3^2)$$

where $\pi\hbar H \cong 10^{-33}$ eV, according to the uncertainty principle extended to the whole Universe, represents the smallest energy that can be measured in the age of the Universe. The integers $n_i$have an upper limit imposed by the following two reasons. Thus, a first condition restricts the temporal quantum number according to $n_4 = E/\pi\hbar H \leq Mc^2/\pi\hbar H \approx 10^{122}$, where $M \approx Lc^2/G \approx 10^{53}$ kg is the mass of the Universe. A second condition confines the spatial quantum numbers according to $n_1^2 + n_2^2 + n_3^2 = (pL/\pi\hbar)^2 = L^2/(\lambda/2)^2 \leq (L/L_P)^2 \approx 10^{122}$, where $L_P = (\hbar G/c^3)^{1/2} \approx 10^{-35}$ m is the Planck's length (the quantum fluctuation of the space).

The above quadratic form of the four space-time quantum numbers, n_i , can be further split by analogy with the Dirac's method and gives $E_0/\pi\hbar H = \pm [\alpha_4 n_4 - (\alpha_1 n_1 + \alpha_2 n_2 + \alpha_3 n_3)]$, where the operators α_i have the following properties: $\alpha_4^2 = +1$; $\alpha_1^2 = \alpha_2^2 = \alpha_3^2 = -1$; $\alpha_i\alpha_j + \alpha_j\alpha_i = 0$ (i, j = 1, 2, 3, 4; i # j).

Similar conclusions can be drawn by changing the cubic Universe into a spherical one. Indeed, in the latter case we only have to introduce the corresponding quantum conditions and will eventually get the quantified mass in terms of the temporal, n_4 , principal, n, and orbital, *l*, quantum numbers, as

$$(E_0/\pi\hbar H)^2 = n_4^2 - (n + l/2)^2$$

subjected to the corresponding limitation to $(n_4)_{max} = (n + l/2)^2_{max} \approx 10^{122}$.

5. **Note added on January 6, 2003 from [30]:** A consequence of Hubble's law $(1/E)dE/dt \leq -H$, as extended from (32), would be that the orbits of motion in a central field of mass M will expand at a rate of the order of

$$\delta r/r \geq (4\pi^3/3)Hr^{3/2}/(GM)^{1/2}$$

per period, where r is the average dimension of the orbit (see the deduction of this formula in Addendum 6 below). Consequently, for instance, the orbit of the Moon in the field of the Earth would expand by $\delta r/r \geq 3\ 10^{-10}$ per period, while the orbit of the Earth in the field of the Sun would expand by $\delta r/r \geq 6\ 10^{-9}$ per period. However, this expansion might become significant at the galactic scale; thus, for a typical galaxy of mass $M \approx 10^{40}$ kg and a radius of 10^4 light years, the expansion becomes $\delta r/r \geq 0.1$ per period and might contribute to the formation of arms of the spiral galaxies [30].

6. **Note added on January 6, 2003 from [30]:** Let us consider a mass m orbiting in the central field of mass M >> m which decays according to the extended Hubble's law as considered above, i.e. $M = M_0\exp(-Ht) \approx M_0(1 - Ht)$. Denoting by r the average orbit radius, the outward acceleration induced by the net mass decrease $\delta M = M_0Ht$ is $\delta a = -\delta F/m = -G\delta M/r^2 = -GM_0Ht/r^2$or, integrating twice for t, the increase of the orbit radius is $\delta r = GM_0Ht^3/6r^2$. The relative radius increase per period is thus $\delta r/r = (1/6)GM_0H(t/r)^3 = (8\pi^3/6)GM_0H/v^3$, where we introduced the tangential velocity $v = 2\pi r/t$. On the other hand, from $mv^2/r = GmM_0/r^2$ we have $v = (GM_0/r)^{1/2}$, so that we finally get the expression $\delta r/r \geq (4\pi^3/3)Hr^{3/2}/(GM)^{1/2}$, as used in Addendum 5 above. Generally, as it is well known for an adiabatic Kepler orbit around a slowly varying mass M [L. D. Landau and E. M. Lifshitz, Mechanics], the eccentricity of the orbit remains unchanged, while the orbit radius vary as $r \sim 1/m$ or $dr/r = -dm/m$. On the other hand, according to the extended Hubble's law, $dm/m = -Hdt$. Finally, we obtain $dr/r = Hdt$, i.e. the planetary systems expand with the recession velocity $v_r = dr/dt = Hr$, the spiral trajectories getting progressively away from the force center.

Postscript

After this work has been sent for publication (in the journal of physics *Studii si Cercetari de Fizica* of the Roumanian Academy, subsequently published in the issue Stud. Cercet. Fiz., **34**, 451-468 (1982)), the author continued the discussions initiated at Timisoara (at the Annual National Conference on "*Progresses in Physics*", October 1981, where this work has been delivered as a plenary lecture). These have been carried out, among others, with Aretin Corciovei (at that time

acting as head of the Theoretical Physics Department of the Institute of Physics and Nuclear Engineering at Bucharest-Magurele). It was found appropriate to present shortly the critiques formulated by him in a postscript. Aretin Corciovei agreed with this procedure and sent to the author some of his objections. These are presented in the text (in italic fonts) to follow.

In the present work is introduced the concept of etheron as being the smallest particle that can exist and which mediates the gravitational interactions. For the computation of the mass of this universal particle three ways of approach are suggested. For some aspects of the problem is considered that the universe ought to be static, but actually models of dynamic universe will be needed. Three ways of approach of the etheron mass are discussed below.

1. It is considered that the uncertainty relations of Heisenberg are applicable to the scale of the whole universe and the time incertitude is identified to the universe age. It is also considered that the energy incertitude represents the minimal quantum which can be exchanged between parts of the universe. The mass associated with this minimal quantum is considered to be the mass of the etheron. In order to obtain the value $m_E = \hbar H/c^2$*, the author has to take the universe age equal to 1/H, H being Hubble's constant, that is to return to the hypothesis of an universe with a linear expansion in time. It should be noted that the hypothesis of an universe linearly expanding in time means to consider the velocity of a given galaxy (for instance relative to the Sun) as constant; but because the distance between this galaxy and other galaxy (in particular relative to the Sun) increases linearly in time, the "constant" H decreases linearly in time. Therefore, the mass of the etheron should diminish also linearly and the etheron in A.D. 2000 would have a mass slightly smaller than in Democritus times. However, all known particles have fixed mass. Thus, the hypothesis of a variable mass of the etheron is equivalent to a continuous creation of etherons in the electron in order to keep the electron mass constant.*

2. It is considered the whole universe as having an oscillatory motion. The pulsation ω *of the universe is identified to the Hubble's constant. It is considered that the states of the universe are characterized by the quantified energies of the harmonic oscillator with the pulsation* ω*. The spectrum is practically continuous, the difference* $\hbar\omega$ *between levels providing the energy of the smallest allowed quantum, the etheron. It is arrived again at* $m_E = \hbar H/c^2$*. Obviously, the hypothesis that the universe is oscillating in time contradicts the first hypothesis of an universe linear in time. This contradicts the hypothesis of a static universe as well.*

Let us comment a little the hypothesis that the universe is oscillating in time. Let us write, for instance, $R(t) = R_0|\sin\omega t|$ *for the time dependence of the distance (to the Sun) of a galaxy. At the present epoch T of the universe* $R(T) = R_0|\sin\omega T|$*. The Hubble's constant is* $(\omega\cos\omega T)/|\sin\omega t|$ *and we notice that, in order to get* $\omega =$

H , we should be at an extremely particular moment, T, given by HT = π/4 . Does the universe age satisfies such a particular relation? Finally, if we take R(t) = R_0(1 + sinωt), a possible way to obtain ω = H would be precisely T = 0. In other words, the hypothesis of the identification ω = H is extremely particular.

3. Finally, it is considered the radius of the universe as the maximal radius of gravitational interaction. Analogously to the potential used for nuclear forces, it is possible to introduce a potential of the Yukawa type for the gravitational potential, namely (1/r)exp(−r/R_U) , where R_U is the radius of the universe. The radius of the universe is equalized to the Compton length associated to the gravity quantum, the etheron, i.e. λ = ħ/m_Ec. It is considered R_U equal to c/H though nobody has observed Doppler shifts of some galaxies having velocities exactly equal to c. It results again m_E = ħH/c^2. In any way, the hypothesis that the galaxies found at the edge of the universe move at light speed contradicts the hypothesis of a static universe.

It is to be noticed that all three ways of approach of the problem suppose contradictory models of universe evolution, including the static model adopted in order to use the relation GM/c^2R_U = π/2 (yet in the static model H is meaningless).

Finally, it is still to be asked about the urgent experimental facts which led to the need of a new particle, the etheron, and which are its other characteristics (spin, charge, other internal quantum numbers).

It is possible to formulate also observations of detail. Here is given only an example. Thus, in the expression for the field equations of Einstein (formula 30) it is assumed that the common pressure vanish (remaining only the cosmological pressure), but in the next formula it is assumed that the etheron travels at light speed, a case in which the pressure is maximum.

The author (I. I. P.) of the present work hopes that the presentation of such critiques as Aretin Corciovei's above allows the perception of the problem from various perspectives.

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