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Plasma universe cosmology, electric charge and coherent quantum vacuum dynamics

Abstract

One of the most interesting conjectures made within Plasma Universe cosmology is the assumption that space is penetrating by a network of filamentary electrical currents ideally reproducing, at different space scales, cellular structure. This implies electricity could be, in some sense, related to a fundamental, yet undiscovered deep property of the space itself. Strictly related to this model is the hypothesis, claimed by Bailey in 1960, according to which stars carry about a net electric charge whose extent is directly proportional to their mass and to the gravitational constant G. On the other hand, past and recent researches have shown inertia and gravity could actually both be the manifestation of the dynamics of Zero Point Fields, also know as Quantum Vacuum. In particular, in a series of previous papers, this author suggested the idea that G can be expressed as a function of quantum vacuum mass-density equivalent and that its value could be not actually constant but variable with the distance from the mass generating the gravitational field. Furthermore, we recently proposed a model (CMH) in which mass can be considered as the result of a superradiant phase transition of quantum vacuum due to the coherent interaction between matter and ZPF. In this paper, starting from the above results and from Bailey's hypothesis, it will be shown that also the presence of electric charge on stars, as predicted by Plasma Universe cosmology, could be related to matter-ZPF interaction. This results could suggest a deeper interpretation of Plasma Universe Theory as related to a universal property of space itself described by Zero Point Field as well as interesting insights towards a possible unification between electromagnetism and gravitation.

Keywords

Bailey's hypothesis; Electric charge; Gravity; Inertia; Plasma universe; Quantum vacuum, QED coherence.

INTRODUCTION

Plasma Universe (PU) model involves an as much interesting as drastically different view, as regards as the "traditional" picture mostly represented by Big Bang (BB) cosmology, of the structure of the Universe. It is substantially based on three fundamental assumptions[1]: a) the validity of the same physical laws of plasma physics from the cosmological to laboratory scales; b) the universal space is filled with a network of electric, often filamentary, currents able to transfer energy and momentum over intergalactic distances, giving to the space a cellular – like structure; c) the importance of well – know but not always completely understood phenomena like pinch effect, critical velocity and double layers on cosmological scale.

The experimental evidence that more of 99.99 % of our "visible" Universe is in the form of plasma makes this theory even more suggestive. Its consequences on cosmology and on the large-scale dynamics of Universe are, of course, very important. In particular, the formation of the whole range of galaxy types would be traced back to the development of large-scale field-aligned electrically charged filaments extending hundreds of megaparsec or more in space. The interaction between two of these filaments makes particles to acquire energy and to produce, at the narrow pinch regions, galaxies and the full electromagnetic radiation spectrum. This would be the reason why galaxies are observed along long filaments[2]. It is quite obvious that,

within this picture, a fundamental role is assigned to electromagnetic interaction that appears the truly "fundamental" force. A so radical assumption is, nevertheless, not basically justified in terms of more fundamental principles within the Plasma model.

A meaningful consequence of the assumptions made by PU model is the concept of "electric stars"[3] according to which a star, in contrast to the common definition, can be considered as a body satisfying two conditions: a) it forms the anode focus of a plasma glow discharge; b) it radiates energy supplied by an external source. In particular, within this model, a primary role in the formation of stars is played by the electromagnetic pinch effect in parallel Birkeland current filaments[4] producing high concentration of plasma (plasmoid) along their shared axis.

Surprisingly (for the supporters of BB theory) this picture agrees with the recent ESA discover about the existence of an "incredible" network of structures like filaments indicating a chain of "near-simultaneous start-formation events" in our galaxy[5].

In the "electric universe" predicted by PU cosmology, stars are characterized by a pinch, continuously operating from their birth, and are not "single" objects isolated in space but electrically connected entities through "wiring harness" to their galactic energy source. In this model stars then are described by an equivalent electric circuit (see Alfen[3]) giving the electric current flow to and from the star in connection with its galaxy, characterized by its own electric circuit as well.

As discussed by Bailey[6], this also means the existence of a net electric charge on the stars induced by their own gravitational field. In this way a deep relationship between gravitational and electrical field is suggested.

During the past years a series of important results has been achieved suggesting that inertia and gravity was actually the manifestation of the interaction between massive bodies and QED Zero Point Fields also know as "Quantum Vacuum" as in the model proposed by Haish, Rueda and Puthoff[7] and, recently, in the CMH model (Caligiuri – Mass – Matter - Hypothesis) proposed by this author[8] within the framework of Coherent Quantum Field Theory according to which mass can be considered as the result of a superradiant phase transition of quantum vacuum due to the coherent interaction between matter and ZPF

Furthermore, in some other papers, this author suggested the idea that the gravitational constant G can be expressed as a function of quantum vacuum mass-density equivalent and that its value could be actually not constant but variable with the distance from the mass generating the gravitational field.

In this paper, starting from the above results and from Bailey's hypothesis, it will be shown that also the presence of electric charge on stars, as predicted by Plasma Universe cosmology, could be related to (coherent) matter-ZPF interaction. This results could suggest a more fundamental foundation of Plasma Universe Theory as related to a universal property of space itself described by Zero Point Field as well as new insights towards a possible unification between electromagnetism and gravitation through coherent quantum vacuum dynamics.

The hypothesis of electric stars

The concept of "electric star" (and in particular of electric Sun) can be dated back to the works of F. W. Bessel that, in 1834, proposed the idea of there being electric charge on Sun and to the discovery by Sir J. Herschel, in 1852, of a connection between magnetic storms on Earth and sunspots. But in order to have a more accurate model of electric stars we must wait for the later experimental and theoretical developments made by Birkeland[9] and Alfen[1,3]. According to the Alfen's model of electric star, the Sun can be viewed as an unipolar inductor producing an electric current circulating in a closed virtual circuit and composed by the currents flowing outward along the polar axis in opposite directions with respect the core (Birkeland's currents) and the inward current in the equatorial plane closing, at large distance from the Sun, as a pinched current.

The model of Sun as "electric star", rather than a sphere of hot gases whose dynamics should be ruled by the equilibrium between gravitation and thermonuclear reactions pressure as suggested by the commonly accepted picture, is able to explain a wide part of astrophysical phenomena, yet completely not understood like, for example, the photosphere dynamics, the origin and cycle of sunspots, the Sun composition in terms of light and heavy elements.

More generally, the schematization of Sun as electric star somehow implies the presence on it of a certain amount of electric charge as claimed by Bailey[6]. In particular, he found that, in order to explain, at least at a qualitative or "semi-quantitative" level, a certain numbers of astrophysical phenomena among which the magnetization of Earth, the Van Allen belt of radiation, the maximum energy value of primary cosmic rays and the Sun's north polar magnetic field vector, a star like our Sun should carry a net electric negative charge Q_S given by

$$\left|Q_S\right| = \beta_S \sqrt{G} M_S \qquad (1)$$

where G is the gravitational constant, M_S is the star's

mass and β_S is a dimensionless coefficient, typical of the star whose value, for the Sun, is of order of 0.03. In Bailey's theory the value of β_S is also related to the spatial distribution of electric charge so that, for a star in which $\beta_S \simeq 1$, this charge would be concentrated mainly near the star's surface giving rise to an electrostatic instability due to the Coulomb repulsion among equal charges and, in case, to their expulsion form the star itself.

In his work[6] Bailey also discusses two possible alternative origins of such electric charge: the first one related to the thermonuclear processes in the core of a star; the second one involving the charge transfer between "our" four-dimensional universe U_4 and an hypothetical five-dimensional universe U_5 of which "our" U_4 would represent an hyper-surface.

The first hypothesis is not so interesting being directly related to the commonly accepted model of star dynamics that, on the other hand, shows important and yet unsolved flaws[10] as, for example to cite just one of these directly related to PU formulation, the lack of explanation of the eleven-years sunspot cycle whose solution could be instead simply given in terms of power oscillations of interstellar Birkeland current filaments within the PU model.

The second hypothesis is obviously much more interesting since it suggests a quantum interpretation of the phenomenon leading to a possible unification of electromagnetism and gravitation within the framework of Quantum Field Theory as we'll also suggest, within a novel conceptual scheme, in this paper.

Electric charge as a function of ZPF DYNAMICS

As already claimed, the Bailey's expression (1) suggests a possible unification between gravitational and electromagnetic interaction due to the presence of gravitational constant G. Nevertheless, despite the suggestive Bailey's hypothesis about the interaction between a five-dimensional and four-dimensional manifolds, the origin of this charge, in terms of QFT, remains substantially unveiled.

In this paper, starting from the results obtained by this author and discussed in a series of previous works, we propose the idea that electric charge could actually arise from the Coherent Quantum Electrodynamics interaction between matter and ZPF or Quantum Vacuum. But this could be only achieved by relating the gravitational constant G and the mass M_S themselves to such dynamics.

As regard the gravitational "constant" G we have shown[11,12] that, within a "fluid-dynamic" approach (FDA) to the description of gravitational interaction, the value of G can be actually expressed as a function of "fluid" density and, ultimately, as a function of the distance from the massive body generating the gravitational potential. In this model, the physical space is considered to be filled with a constitutive medium like a perfect barotropic fluid[13] described in terms of its own pressure p_f, density ρ_f and an equation of state $p_f = f(\rho_f)$. Being a perfect medium this fluid would not interfere with the motion of any body and should be a neither entropic nor dissipative system, resulting continuous at every scale.

In this picture the force of gravity is then "reduced" to a pressure force and so, ultimately, to a contact action at the scale of elementary particles due to the presence of vacuum fluid. It is then produced by the occurrence of density (and pressure) gradients in such a fluid whose non-zero compressibility could also allow for a finite time of propagation of interaction within the fluid medium itself able to give a simple explanation of the conjectured gravitational waves in terms of classical physics concepts.

The gravitational field vector $\vec{g}$ is then expressed in terms of pressure and density field variables as

$$\vec{g} = -\frac{\nabla p_f}{\rho_f} \tag{2}$$

and the relation between the source of gravity (the massive bodies) and the gravitational field is established through a dynamic equation connecting the matter density field with the density and pressure fields entirely analogous to the Poisson equation for gravitational potential ϕ

$$\nabla^2 \phi = 4\pi G \rho_m \tag{3}$$

where ρ_m is the matter distribution density in which G is assumed to be a constant.

However, as we have already discussed in previous papers[11,12,14,15], G can be considered as a function of ZPF energy density

$$G(\rho_{ZPF}) = \frac{1}{t_P^2 \cdot \rho_{ZPF}} \tag{4}$$

where ρ_{ZPF} is the so-called Mass – Density – Equivalent (MDE) of Quantum Vacuum energy density (equal to ρ_{QV}/c^2 where ρ_{QV} is the Quantum Vacuum Energy density) and $t_P = 5.391 \cdot 10^{-44}\, s$ is the Planck time. According to CMH hypothesis[8], as we'll se in the following, the mass can be viewed as the result of the coherent dynamics of ZPF (not necessarily restricted to the e.m. one) and its presence then alters the local value of Zero Point Energy whose decrease, in the presence of mass, is associated with a more stable

matter+e.m. field interaction. This means, by (4), that far from any massive body, the ZPE density has its unperturbed value (with respect the gravitational interaction) given by

$$\rho_{QV,0} = \frac{m_P c^2}{l_P^3} \tag{5}$$

where $m_P = 2.177 \cdot 10^{-8} kg$ and $l_P = 1.616 \cdot 10^{-35} m$ respectively are the Planck mass and length and G assumes the value given by

$$G = \frac{l_P^3}{m_P c^2 t_P^2} \tag{6}$$

When a variable value of G is considered in the above FDA, the dynamical equation relating the gravitational potential and the matter density field, provided we assume $\rho_f = \rho_{ZPF}$, is given by the generalized version of (3) as

$$\nabla^2 p_f = \rho_{ZPF} \int_{\partial A} G\left(\left|\vec{x} - \vec{x}'\right|\right) \frac{\rho_m\left(\vec{x}'\right)}{\left|\vec{x} - \vec{x}'\right|^3} \left(\vec{x} - \vec{x}'\right) \cdot \vec{n} dS \tag{7}$$

where $\vec{x}$ indicates a point P outside a given mass distribution, $\vec{x}'$ a point P' inside it, $\rho_m\left(\vec{x}'\right)$ is a mass-density function describing such distribution, ∂A is a closed surface surrounding it and $\vec{n}$ is a unit vector orthogonal to dS.

If we consider the case of a weak and slow-varying gravitational fields we can also suppose in (7) the function $G\left(\vec{x}\right)$ to be almost uniform within the volume V associated to the considered distribution of mass described by ρ_m.

With these assumptions the general equation (7) formally reduces to the form (3), although it now represents an approximate field equation valid under restricted conditions. From a fluid-dynamical point of view, the above hypothesis also corresponds to assume a low value of fluid compressibility K that allows us to linearize the equation of state $p_f = f\left(\rho_f\right)$ around the "unperturbed" value $\rho_{f,0}$ (calculated at a point far from the considered massive body), and obtain[11,12], after some simple algebraic manipulations and for a spherically symmetric case, the equation

$$u_{f,0}^2 \ln\left(\frac{\rho_f}{\rho_{f,0}}\right) = U\left(\rho_f\right) \tag{8}$$

with the boundary condition $U\left(\rho_{f,0}\right) \equiv 0$, where

$$u_{f,0} \equiv u_f\left(\rho_{f,0}\right) = \sqrt{\left(\frac{dp_f}{d\rho_f}\right)}_{\rho_f = \rho_{f,0}} \tag{9}$$

and U is a "potential" such that $\vec{g} = -\nabla U$ as usual. In the case of a static gravitational field generated by a spherical mass M of radius R, the differential equation (8) can be easily solved for $r > R$ being here $\left(\rho_m(r) = 0\right)$ just the Laplace equation whose solution, in spherical coordinates, is given by

$$p_f\left(\vec{r}\right) = p_f\left(r\right) = A + \frac{B}{r} \tag{10}$$

with the constants A and B depending on the boundary conditions. If we assume $p_f\left(r \to \infty\right) = A = p_{f.0}$ and observing that $p_f\left(r\right)$ is a decreasing function of r (so that $B < 0$), we have

$$g = \frac{B}{r^2 \rho_{f,0} + \frac{B r}{c^2}} \tag{11}$$

from which, imposing the equivalence with the Newtonian law, we deduce $C = -\rho_{f,0} GM$ and finally

$$G\left(r\right) = \frac{G_0}{1 - \frac{G_0 M}{r c^2}} \tag{12}$$

where G_0 indicates the "unperturbed" value of gravitational constant.

In the proposed model the value of G_0 is then directly related to the "unperturbed" value of ZPE density through the (6) so we can put

$$G_0 = \frac{l_P^3}{m_P c^2 t_P^2} \tag{13}$$

In this way the gravitational "constant" G is expressed as a function of QV-related quantities, of the mass generating the gravitational potential and of the distance from it. We must now investigate the relationship between mass itself and ZPF.

The idea that inertial and gravitational masses m_i and m_g could be ultimately an emergent property of matter/field interactions is without doubt one of the most intriguing one in physics. On this basis Haisch and Rueda (HR) proposed a relativistic model in which both the gravitational and inertial masses, associated to a body, characterized by a proper volume V_0, are given by[16]:

$$m_g = m_i = \frac{V_0}{c^2} \int d\omega\, \eta\left(\omega\right) \rho_{ZPF}\left(\omega\right) \tag{14}$$

where ω is the angular frequency of ZPF mode, $\rho_{QV}\left(\omega\right)$ is the spectral energy density of quantum vacuum ZPF fluctuations and $\eta\left(\omega\right)$ is a function that would quantify the fraction of ZPF energy density that electromagnetically interacts with the particles contained in the "useful volume" V_0, given by

$$\eta\left(\omega\right) = \sum_{k=1}^{N} \left(\frac{\pi^2}{V_0}\right) \frac{\delta\left(\omega - \omega_k\right)}{\omega^2} \tag{15}$$

the ω_k being a set of "internal" resonance frequencies.

In this way a material body, with respect the electromagnetic interaction, is pictured as a resonant cavity in which a suitable set of ZPF modes oscillate.

Nevertheless, despite its clear theoretical considerable significance, the HR model is affected by some important critical points related, for example, to the physical origin of volume V_0 and to the meaning and the form of function $\eta(\omega)$.

In order to overcome these difficulties and obtain a possible description of the inertia mechanism in more fundamental terms within the most general context of QFT, this author suggested[8] a novel model (CMH) in which both inertia and matter could be the result of the coherent interaction between a matter-wave describing the material system and (e.m.) radiation fields of ZPF, showing they (matter and inertia) both could be the manifestation of the local collective quantum coherent dynamics of Quantum Vacuum.

As already shown[17], the time evolution of any electromagnetic and matter quantum-interacting fields system, under suitable boundary conditions (almost always verified in condensed matter), spontaneously determines the emergence of a coherent electromagnetic field oscillating in tune with all the matter constituents.

According to QFT, matter and fields continuously perform quantum fluctuations of the same type of those characterizing the QED ZPF. Above a critical density $\rho_{crit} = \left(N/V\right)_{crit}$ and below a threshold temperature T_0, an ensemble of atoms or molecules, placed in the empty space (namely without any matter or radiation field different than ZPF), spontaneous "decays" into a more stable state (characterized by alower energy and so strongly favored) in which the above quantum fluctuations become strongly amplified and phase correlated. These coherent oscillations are confined within defined spatial regions, called "Coherence Domains" (CDs), associated to the wavelength of the tuning electromagnetic field, whose extension is of the order of

$$L \sim \frac{2\pi}{\omega_0} \tag{16}$$

where ω_0 $(c = \hbar = 1)$ is the energy associated to the transition between a given couple of levels of energy of the matter quantum field driving the coherent evolution of the system. Without entering into a detailed mathematical analysis of the coherent dynamics of a matter-e.m. field coupled system, already considered in other places[17] we just recall the evolution of such a system can be obtained, in the case of a two-levels (E_1, E_2) system, by introducing a wave-field describing the (coherent) behavior of a system composed by N generic identical matter-quantum elementary systems that, in this picture, are considered as the "quanta" of matter-wave field ($\vec{x}_i$ is the coordinate of center of mass of i-th quasi-particle and δ_i is a coordinate describing the "internal" structure of elementary systems) namely

$$\Psi(\vec{x},\delta,t) = \sum_n a_n(t)\varphi_n(\vec{x},\delta) \tag{17}$$

where the functions $\{\varphi_n(\vec{x},\delta)\}$ form a complete set of orthonormal functions that diagonalize the "single-particle" Hamiltonian H_{sp} of the system, with relative eigenvalues $\{E_n\}$

$$H_p\varphi_n(\vec{x},\delta) = E_n\varphi_n(\vec{x},\delta) \tag{18}$$

and the "coefficients" $a_n(t)$ are operators unitarily connected to the annihilation operator $\hat{a}_n$ (that define the number operator $N = a^\dagger a$ of matter field) satisfying the equal-time relation $\left[a_n(t), a_m^\dagger(t)\right]_\pm = \delta_{nm}$. In the general case, the total Hamiltonian of the matter+e.m. interacting system can be written as

$$H_{tot} = H_K + H_{\rm int} + H_{field} + H_{SR} \tag{19}$$

where H_K is the "kinetic" term, $H_{\rm int}$ describes the interaction between the matter-quantum wave field and the free quantized field associated to that interaction (i.e. the gauge field mediating it), H_{field} is the free e.m. field Hamiltonian and H_{SR} is the "short-range" Hamiltonian, usually in the form of two-bodies interaction. We then introduce the "rescaled" fields:

$$\bar{\Psi}(\vec{x},\delta,t) = \varphi(\vec{x},\delta,t) + \frac{1}{\sqrt{N}}Q(\vec{x},\delta,t) \tag{20}$$

$$\bar{a}_{\vec{k}r}(t) = \alpha_{\vec{k}r}(t) + \frac{1}{\sqrt{N}}q_{\vec{k}r}(\vec{x},\delta,t) \tag{21}$$

where $a_{\vec{k}r}(t) \equiv \sqrt{N}\,\bar{a}_{\vec{k}r}(t)$ is the photon annihilation operator of mode $\vec{k}$ and polarization r describing the quantized free e.m. radiation field ($\vec{\varepsilon}_{\vec{k},r}$ is the polarization vector and V the quantization volume as usual)

$$\vec{A}(\vec{x},t) = \sum_{\vec{k},r}\frac{1}{\sqrt{2\omega_k V}}\left[\vec{\varepsilon}_{\vec{k},r}a_{\vec{k},r}(t)e^{-i\left(\omega t - \vec{k}\cdot\vec{x}\right)} + h.c.\right] \tag{22}$$

N is the (conserved) number of matter(-quantum) systems in interaction with the field contained inside the volume V, $\varphi(\vec{x},\delta,t)$, and $\alpha_{\vec{k}r}(t)$ respectively are the "classical" – like paths of the matter-wave and e.m. fields (in the condensed matter limit $N \to \infty$) and the functions $Q(\vec{x},\delta,t)$ and $q(\vec{x},\delta,t)$ represent the quantum fluctuations of the matter and e.m. fields around the paths $\varphi(\vec{x},\delta,t)$ and $\alpha_{\vec{k}r}(t)$.

By imposing the stationariness of the action

$$\delta\int_{t_i}^{t_f}\left(\bar{L}_m+\bar{L}_{em}\right)dt=0 \qquad (23)$$

where $\bar{L}_m$ and $\bar{L}_{em}$ respectively represent the matter and e.m. "rescaled" (i.e. written for the fields (20) and (21)) Lagrangian functions obtained by (19), we get (for a two-levels system with matter field described by the functions φ_0 and φ_1) three coupled Eulero – Lagrange equations (coherent equations) ruling the common space-time evolution of "classical" – like amplitudes of matter wave and e.m. fields given by

$$i\frac{\partial}{\partial t}\varphi_1=E_1\varphi_1+eJ\sqrt{\frac{N}{V}}\sum_{\vec{k}r}\frac{1}{\sqrt{2\omega_{\vec{k}}}}\left[\alpha_{\vec{k}r}e^{-i\left(\omega_{\vec{k}}t-\vec{k}\cdot\vec{x}\right)}\varepsilon_{\vec{k}r,1}+c.c.\right]\varphi_0 \qquad (24)$$

$$i\frac{\partial}{\partial t}\varphi_0=E_2\varphi_0+eJ\sqrt{\frac{N}{V}}\sum_{\vec{k}r}\frac{1}{\sqrt{2\omega_{\vec{k}}}}\left[\alpha_{\vec{k}r}e^{-i\left(\omega_{\vec{k}}t-\vec{k}\cdot\vec{x}\right)}\varepsilon_{\vec{k}r,1}+c.c.\right]\varphi_1 \qquad (25)$$

$$i\dot{\alpha}_{\vec{k}r}-\frac{1}{2\omega_{\vec{k}}}\ddot{\alpha}_{\vec{k}r}=eJ\sqrt{\frac{N}{V}}\frac{e^{-i\omega_{\vec{k}}t}}{\sqrt{2\omega_{\vec{k}}}}\varepsilon^*_{\vec{k}r,1}\int e^{-i\vec{k}\cdot\vec{x}}\left[\varphi_1^*\varphi_0+\varphi_1\varphi_0^*\right]d^3x \qquad (26)$$

where $J_i=J\delta_{i1}\sigma_1$ is the density current operator of each elementary system. Now by making use of the rotating-wave approximation $\varphi_i\left(\vec{x},t\right)=e^{-iE_i}\beta_i\left(\vec{x},t\right)$ and recalling we are interested in the modes such that $\left|\vec{k}\right|=\omega_0=E_1-E_2$ inside a CD (namely neglecting space dependence of field inside $V_{CD}\simeq L_{CD}^3$), we obtain the equations

$$i\frac{\partial}{\partial t}\beta_1\left(t\right)=eJ\sqrt{\frac{N}{V}}\frac{1}{\sqrt{2\omega_0}}\sum_r\int d\Omega_{\vec{k}}\alpha_{\vec{k}r}\varepsilon_{\vec{k}r,1}\beta_0\left(t\right) \qquad (27)$$

$$i\frac{\partial}{\partial t}\beta_0\left(t\right)=eJ\sqrt{\frac{N}{V}}\frac{1}{\sqrt{2\omega_0}}\sum_r\int d\Omega_{\vec{k}}\alpha^*_{\vec{k}r}\varepsilon_{\vec{k}r,1}\beta_1\left(t\right) \qquad (28)$$

$$i\dot{\alpha}_{\vec{k}r}-\frac{1}{2\omega_0}\ddot{\alpha}_{\vec{k}r}=eJ\sqrt{\frac{N}{V}}\frac{e^{-i\omega_{\vec{k}}t}}{\sqrt{2\omega_0}}\varepsilon_{\vec{k}r,1}\beta_0^*\left(t\right)\beta_1\left(t\right) \qquad (29)$$

The short-time behaviour of the solutions of equations (27)-(29) describes, when $\rho>\rho_{crit}$ (and $T<T_{crit}$ a critical value of temperature above which the thermal "noise" will destroy the phased oscillations), whose value depends on the particular system, an exponential "runaway" from a Perturbative Ground State (PGS), characterized by ZPF uncorrelated matter and e.m. fields oscillations, to a more energetically favourable Coherent Ground State (CGS) in which, instead, the matter-wave field performs, inside CDs, strong amplitude phased oscillations in tune with an e.m. field condensed from ZPF. This process can be interpreted as a Superrandiant Phase Transition (SPT) also characterized by the presence of quantum oscillations whose amplitudes $Q\left(\vec{x},\delta,t\right)$ and $q\left(\vec{x},\delta,t\right)$ can be obtained by the study of equations (27)-(29) as well. In[8] we have suggested the idea that this kind of SPT and its related quantum fluctuations are able to explain the origin of mass. In particular we have shown[8] the inertia can be related to the interaction between the Rabi-like oscillations in quantum amplitudes (of both matter and fields), characterizing the decay towards CGS, and the incoherent e.m. ZPF according to the equation:

$$M\simeq V_M\left(\frac{\omega_0}{2\pi}\right)^3F\int d^3\vec{k}\sum_n\left|R_n\right|^2\frac{\delta\left(\omega-\Theta_n\right)}{\omega} \qquad (30)$$

where $\left\{\Theta_n\right\}$ are the Rabi's frequencies of the matter-ZPF interacting system and $\left\{R_n\right\}$ their relative amplitudes depending on the quantum projection $\left\langle CGS\middle|PGS\right\rangle$, F is a constant factor related to the system and ω_0 is the "resonance" frequency of the coherent common oscillation of matter-wave and e.m. field inside the coherent domains of the considered body[8]. The meaningful results contained in the equations (12) and (30) allow us to obtain, through the equation (1), our final result

$$\left|Q_M\right|(r)\simeq V_M\left(\frac{\omega_0}{2\pi}\right)^3F\int d^3\vec{k}\sum_n\left|R_n\right|^2\frac{\delta\left(\omega-\Theta_n\right)}{\omega}$$

$$\left[\frac{m_Pc^2t_P^2}{l_P^3}-\frac{V_M}{rc^2}\left(\frac{\omega_0}{2\pi}\right)^3F\int d^3\vec{k}\sum_n\left|R_n\right|^2\frac{\delta\left(\omega-\Theta_n\right)}{\omega}\right]^{-\frac{1}{2}} \qquad (31)$$

that gives the value of electric charge associated to a mass M of a material body as a function of quantities related to the interaction between that body and ZPF only, in so suggesting, under the above assumptions, a deep relationship between the electrical charge predicted by Bailey and quantum vacuum dynamics.

CONCLUSIONS

In this paper we have shown the hypothesis of "electric stars" formulated within the theory of Plasma Universe cosmology can be originally reinterpreted, basing on some previous meaningful theoretical results, in terms of ZPF dynamics. In particular, by considering the suggested relationship between gravitational constant and ZPF mass-equivalent density on one side and the Coherent-Mass-Matter Hypothesis (in which inertia is considered as the result of the coherent interaction between matter and ZPF) previously proposed by this author, a relation between the electric charge appearing in Bailey's equation and the physical quantities describing the ZPF-matter (coherent) interaction for a given material body has been discussed. An unexpected result to be deeper investigated, with

respect the commonly accepted picture, is that the charge expression so obtained shows a radial dependence from the mass to which is linked.

But the main consequences of the above formulation is, without doubt, the possibility to interpret the macroscopic electric charge, associated to a star within the PU theory, as an emerging property of the star's mass itself due to its (coherent) interaction with ZPF (that is with the physical space itself) characterized, in the CGS, by a decreased energy of the system in turn affecting the value of gravitational constant G and ZPF mass-equivalent density on one side and the Coherent-Mass-Matter Hypothesis (in which inertia is considered as the result of the coherent interaction between matter and ZPF) previously proposed by this author, a relation between the electric charge appearing in Bailey's equation and the physical quantities describing the ZPF-matter (coherent) interaction for a given material body has been discussed.

An unexpected result to be deeper investigated, with respect the commonly accepted picture, is that the charge expression so obtained shows a radial dependence from the mass to which is linked.

But the main consequences of the above formulation is, without doubt, the possibility to interpret the macroscopic electric charge, associated to a star within the PU theory, as an emerging property of the star's mass itself due to its (coherent) interaction with ZPF (that is with the physical space itself) characterized, in the CGS, by a decreased energy of the system in turn affecting the value of gravitational constant G.

Despite the preliminary stage at which the formulation of a possible correlation between the macroscopic charge described by PU model and matter-ZPF interaction has been discussed in this paper, the results obtained so far also open the door to a original reformulation of PU theory on a QFT basis and, above all, to a novel possible interpretation of the relation between electromagnetic and gravitational interaction through the Quantum Vacuum dynamics whose development will be discussed in forthcoming publications.

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