On Winterberg's unified field theory.

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Summary. — Winterberg assumes positive and negative Planck masses in order to have a zero cosmological constant and to overcome the divergence problems of quantum electrodynamics. But pairs of opposite Planckions undergo runaways and the "contact" actions assumed by Winterberg are unable to produce his claimed vortex rings. Moreover the contact interactions cannot exist if the local potential V is given by a three-dimensional Dirac delta function $V \propto \delta(\mathbf{r})$ as assumed by Winterberg. This potential corresponds to point-like particles having mutual zero cross-section. The appearance of the electric field is unjustified and in contradiction with MacCullagh's condition used by Winterberg. We suggest a possible solution. Other difficulties regard: *i*) the non-annihilation of the positive and negative Planckions, although they are antiparticles to each other, and *ii*) the justification of the elementary particle masses which are small fractions of the Planck masses. The introduction of the acceleration in the Lagrangian leads to contradictions and bizarre results. Finally, Winterberg thinks of having derived special relativity from prerelativistic physics by demanding invariance of the Lorentz condition under both Galilei and Lorentz transformations, which is impossible. What is worse is that Winterberg does not refer to the same space-time events in writing his transformations. Seven proposals to improve Winterberg's theory are given.

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1. – Introduction

Many assumptions or models appeared paradoxical when new fields of research were started. Only many years later they have been understood as particular cases of a more general theory or they have been substituted by more reasonable assumptions. Yet, they proved useful as an initial breakthrough, and some of them still wait for their more reasonable substitution. For instance, Bohr-Sommerfeld's assumption that the electrons move on particular orbits only, was bizzarre and its success has been explained by modern quantum mechanics (QM). Indeed, the Bohr-Sommerfeld orbits are those having maximum probability of finding an electron between r and $r + dr$.

However, still some qualitative questions remain unanswered in QM, such as why radiation in stable states is absent. A satisfying answer to this problem has been given in the new field of research called stochastic electrodynamics (SED), which interprets the atomic world in a classical way [1, 2]. According to classical electromagnetism all particles (which, in general undergo an accelerated motion) must radiate e.m. waves so that space is filled with e.m. waves coming from all directions, with random amplitudes and random phases. Now it is known that any charged oscillator, *e.g.* a hydrogen atom, absorbs energy from a stochastic e.m. field. Thus the stability of atoms is explained: on the average, the radiated e.m. power is equal to the absorbed power. Some paradoxes which arise in the orthodox (or Copenhagen) interpretation of QM, like Schrödinger's cat, are immediately resolved. The cat in the box is <u>not</u> a mixture of alive and dead cats but has simply a probability of being alive (or dead). Heisenberg's uncertainty principle is intrinsic to any stochastic process because the diffusion velocity is inversely proportional to the size of the confinement. Bohr's complementary principle is overcome, as well. An electron is a particle and its jiggling motion due to the stochastic field generates a wave-like behaviour. By stochastic electrodynamics (SED) it is also possible to explain some phenomena otherwise unexplained, such as the origin of the most energetic cosmic rays [3]. If improved by the Zitterbewegung, SED may lead to the derivation of the Schrödinger equation [4] and also to corrective terms to this equation [5]. The derivation has been performed in the usual three dimensional space for each particle (when there are N particles it is sometimes convenient, though unnecessary, to consider the $3N$ degrees of freedom of the particles as denoting a point in the configuration space). Fundamentally, SED is classical electromagnetism in which the zero point field (ZPF) of quantum electrodynamics (QED) is considered as real and generated by the radiation of all the particles of the universe. If this is its cause, the power spectral density $G(\omega) \propto \omega^3$ must have an upper cut-off and, in any case, it must have a strong dip in correspondence to the Compton frequency ω_c of the electron because of its strong absorption due to electron-positron pair production. Then, for $\omega > \omega_c$ the spectrum $G(\omega)$ may still increase [2] with ω, but it is sufficient to have the strong dip corresponding to ω_c to forsee a new phenomenon. In fact, $G(\omega)$ with a dip is no longer Lorentz invariant (it is such for $G(\omega) \propto \omega^3$ only), and there is a privileged system S_0 for which the spectrum is isotropic while for any other system S it is $G = G(\omega, \theta)$. Let us consider a charged oscillator, such as a proton with two electrons, brought (in a particle accelerator) to a speed v with respect to S_0 such that the dip at ω_c is seen displaced in the atom system S because of the Doppler effect and of such entity that the waves reaching the rear part of the atom have $\gamma(1-\beta)\omega_c = \omega_0'$ where $\beta = v/c$, $\gamma = (1-v^2/c^2)^{-1/2}$ and ω_0' is the oscillator's proper frequency. In such case there would be an electromagnetic pressure on the rear part of the particle smaller than that on the front part and a friction should arise [6] starting from an energy $\simeq 10^{13}$ eV(1). The experiment, possible by the designed superconducting supercollider (SSC) will either disprove SED or put limits to both QED and special relativity (SR).

However, SED is not completely settled but, in any case, the assumptions of QM have been useful(2).

Another famous example of a seemingly paradoxical assumption was Einstein's invariance of the light speed. Although partially understood by Reichenbach [8],

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(1) A composite, charged system is necessary to detect this new effect. Monopolar particles, such as electrons, are not subject to any slowing down because the Zitterbewegung is "rigid", *i.e.* independent of external forces, as used in [6]. That is why there are particles with a maximum measured energy of 10^{21} eV in the cosmic rays.

(2) In passing, we notice that the recent experiment [7] that contradicts de Broglie's guided-wave theory and is in agreement with QM, is not against SED. In fact SED coincides to first order with QM and only differs by small corrective terms which are of the order of 1% of the Lamb shift [5]. The second article of Ref. [4] has mainly been written to clarify the difference between the stochastic approach and the de Broglie guided-wave theory. As clearly stated in the introduction of that article, the extention of the Schrödinger equation to many particles in SED is useful to show its difference from de Broglie's theory which was already known to work well with a single particle but not with many particles.

it was in 1977 that Mansouri and Sexl, in three famous papers [9], have shown that Einstein's assumption is simply due to the internal synchronization, performed either by slow clock transport or by Einstein's method. It is now fully recognized that neither light speed invariance nor nonconservation of simultaneity are peculiar of SR because we can have them in prerelativistic physics and elimininate them from SR [10]. What is peculiar of SR is the longitudinal contractions of the rods and the slowing down of the clock rates, whose genesis may be ascribed to the ZPF of SED [10].

Although overcome by SED, Einstein's assumption proved useful, as those of QM. Are Winterberg's assumptions of the same kind? We leave the arduous answer to our posterity and try to disclose all the assumptions implied in Winterberg's works and what are their main drawbacks, at the same time giving suggestions to overcome them.

2. – Winterberg's attempted Planck ether theory with negative masses leads to self-acceleration

Among the different attempts to develop an ether theory the most recent and radical one is that of Winterberg [11] marketed under the name "*Planck Aether Theory*". He proposed that there might be an underlying nonrelativistic superfluid substratum of densely packed positive and negative Planck masses, permeating all of space, and making up what may be called the Planck ether. Precisely, Winterberg, in the alleged "Planck Aether Theory", assumes positive Planckions (with inertial and gravitational masses both positive) and negative Planckions (with inertial and gravitational masses both negative), so that for both types of Planckions Einstein's equivalence principle is formally satisfied. The introduction of negative masses has two aims, namely: i) To have a cosmological constant (in general relativity) exactly equal to zero; ii) To overcome the divergence problems of relativistic quantum field theories.

Unfortunately a negative mass, with negative total energy, has a negative inertia so that it accelerates itself and the kinetic energy would tend to minus infinity. A simple way to show that a particle with negative inertia undergoes a self-acceleration is to consider the contribution to the inertia due to the acceleration field radiated by the particle itself. During all its past history the particle has undergone at least one action by part of an external field (the action is continuous if we consider the vacuum fluctuations due to the ZPF). When the particle was accelerated any part of it radiated an acceleration field which acted on all the other parts of the particle at a retarded time. The mutual actions of all the parts of the particle produce a force opposite to the acceleration. If the mass is positive (as occurs for all the physical particles) the retarded force generates an acceleration smaller and opposite to the initial acceleration. But if the inertial mass is negative the initial acceleration is increased and an avalanche process occurs [12].

The self-acceleration of a system composed of two interacting particles with positive and negative masses is still more evident. In the case of repulsion the mutual (or interaction) energy W_0 is positive because the work of the external forces necessary to bring the particles to a finite distance starting from an initial, infinite, mutual distance (at which the interaction energy is zero) is positive. This is required to relate energies to m_0c^2. The particle with positive mass accelerate away from the other particle because of the mutual repulsion. On the contrary, the particle with negative mass accelerates toward that with positive mass because its inertia is negative and $\mathbf{F} = -|m_-|\ \mathbf{a}$. The system self-accelerates keeping the same mutual distance the two particles had initially at rest and the total energy of the system, being positive, tends to an infinite positive value ($W = \gamma\ W_0 \to \infty$ for $v \to c$). In the case of mutual attraction, the self-acceleration points from the positive mass toward the negative mass and the total energy tends to minus infinity (because the algebraic sum of the two formation energies vanishes, $mc^2 - |m_-|c^2 = 0$ for $|m| = |m_-|$) and the interaction energy is negative.

The above unstable behaviour persists even if the interactions have such a short range so as to be considered as point-contact interactions, as assumed by Winterberg. In fact even in the limit of a force expressed by a Dirac delta function, the work (line integral of the force, or stresses along the displacement) has to be finite otherwise no change of kinetic energies would occur. Now the stresses arising during a collision between Planckions have an inertia (positive for compression and negative for tension). The stresses, with their inertia, have the same effect as the fields, the simplest example of them is the electromagnetic one (for the gravitational case see Ref. [13]). Moreover, the discrepancy in behaviour with respect to a normal, physical system is still more accentuated when there are many particles with negative masses.

It is of no help to Winterberg's theory that the Planck ether is assumed to be a highly degenerate two-component Bose superfluid, described by two completely symmetric wave functions. In fact, this assumption would require long-range fields much stronger than the gravitational field, where the presence of the gravitational field implies a self-acceleration for a negative mass. If, as later assumed by Winterberg, the positive and negative Planckions behave as two superfluids which can mix with each other without distroying their independence, the situation is still worse, *i.e.* the whole negative superfluid behaves as a big particle and increases the self-acceleration each particle would have if isolated.

Any comparison with Dirac's negative energy states is inapplicable, because Dirac's antiparticles, the positrons, have positive energies and inertial masses. In orthodox quantum mechanics (QM) it is a question of interpretation so that many results, as the ZPF and the spin (or Zitterbewegung) motion are not considered in a realistic sense. But in Winterberg's theory the Planckions with negative inertia are required in a realistic sense in order to have a total zero inertia for the Planckions and therefore to eliminate any friction for the observable particles moving in the sea of the Planckions. Moreover, the total energy of the Planckions must vanish if the cosmological constant is to be zero. A small unbalance would produce a close Universe of a few centimeters in diameter according to general relativity. This can be avoided if one addresses a different gravitational theory in which the gradients of the ZPF only are effective [14]. But a zero inertia for the Planck fluid is demanded by the observed absence of friction for a particle (or body) moving with subluminal velocity in vacuum.

3. – A spherical Dirac delta function for the potential is incompatible with a finite radius r_p for the Planckions

Winterberg assumes that the potential between Planckions is given by a Dirac delta function

$$V(\mathbf{r}) = \pm f^2 \, r_p^2 \, \delta(\mathbf{r}) \tag{1}$$

(see Eq.(2.1) of Ref. [11], where f is a coupling constant and r_p the size of a Planckion). With a finite radius r_p he should have taken a distribution of Dirac delta forces on the surface of the small, almost rigid balls

$$\mathbf{F}_s(\mathbf{r}) = V_0^* \, \hat{\mathbf{r}}_p \, \delta[\mathbf{r} - (\mathbf{r}_{0s} + \mathbf{r}_p)] \ , \tag{2}$$

where $\mathbf{r}_{0s}$ is the position of the centre of the s-th ball and $\hat{\mathbf{r}}_p$ the unit vector. The corresponding potential is the classical well

$$V_s(\mathbf{r}) = V_0 \, \Theta(r_p - |\mathbf{r} - \mathbf{r}_{0s}|) \ , \tag{3}$$

where $\Theta(x) = 1$ for $x > 0$ and $\Theta(x) = 0$ for $x < 0$.

When the hight of the well tends to infinity and $r_p \to 0$ then Eq.(3) becomes Eq.(1). But this is in contradiction with the finite size of the Planckions assumed by Winterberg who insists on the contact actions between Planckions, i.e. on collisions on the external surfaces of the spherical Planckions of radius r_p.

Another drawback of Eq.(1) is that it leads to a vanishing cross-section, *i.e.* to a collisionless model.

In QM sometimes a Dirac delta function for the potential is used [15] but it is a one-dimensional Dirac delta function $V(x) = V_0\delta(x)$ corresponding to a discontinuity of V on the whole plane $x = 0$. A two-dimensional delta function implies a discontinuity on a line and finite cross-sections with strings but zero cross-sections with point-like particles. A three-dimensional delta function (as expressed by Eq.(1)) implies a discontinuity on a point, hence zero cross-sections with other point-like objects having the same potential. Even with a one-dimensional $\delta(x)$ there is not only a net repulsion but also a probability of a transparency across the plane $x = 0$. In fact the quantum penetration of a barrier cannot be neglected and once a particle has passed the first Dirac delta for the force $\mathbf{F} \propto \boldsymbol{\nabla} V$ the particle finds a second, opposite Dirac delta function of the force acting on it. There is a probability of reflection and of transmission [15].

In any case, since one can think that quantum mechanics implies a smearing of the particle sizes and therefore that a finite cross-section may exist even with a spherical delta function for the potential, let us show that the cross-section σ vanishes in this case.

The spherical delta function $\delta(r)$ is related to the three-dimensional Delta function by [16, 17]:

(4) $$\delta(r) = \delta(\mathbf{r})\, 2\pi r^2 \ ,$$

with the same physical dimension as in Eq.(1) but with a variable r, tending to zero where $\delta(\mathbf{r}) \neq 0$ while a fixed, finite value r_p appears in Eq.(1).

Landau and Lifshitz [16] have treated the scattering against the spherical square potential well of depth U_0 and radius a in the limit

(5) $$ka \ll 1 \ ,$$

where k is the propagator (hence $\hbar k$ is the momentum of the incoming particle) and

$$k \ll \kappa = \sqrt{2mU_0}/\hbar \tag{6}$$

i.e. for slow particles (in comparison with the potential strength U_0). Since we are interested in the limit $U_0 \to \infty$ and $a \to 0$ when the potential becomes a Dirac function $\delta(r)$, conditions (5) and (6) are both satisfied. Under these conditions the partial amplitudes with $l \neq 0$ are small compared with that of the S-wave scattering. In such approximations the scattering amplitude (for κa different from an odd multiple of $\pi/2$) is given by

$$f = [\tan(\kappa a) - \kappa a]/\kappa \ , \tag{7}$$

so that the cross-section is

$$\sigma = 4\pi\,|f|^2 = 4\pi\,|\tan(\kappa a) - \kappa a|^2/\kappa^2 \ . \tag{8}$$

By letting $a \to 0$ and U_0 go to infinity as $1/a$ as required by the condition of normalization $\int dr\ \delta(r) = 1$ we obtain a vanishing cross-section:

$$\sigma \simeq \frac{4}{9}\pi\, a^2\, (\kappa\, a)^4 \ . \tag{9}$$

Condition (6) is also well satisfied for $U_0 \propto a^{-1} \to \infty$.

Notice that a vanishing cross-section is obtained even if $U_0 \to \infty$ as a^{-2} in such a way as to keep the first energy level of the square well unchanged. Under this condition Demkov and Ostrovski [17] obtain a finite cross-section with singular potentials including a delta symbol. Actually they consider singular potentials with zero range which are <u>not</u> true Dirac delta functions. Indeed they substitute it by suitable boundary conditions on the wave function at the singular point.

Finally, we point out that a result similar to that given by Eq.(9) is obtained by using a spherical "potential hump" of height U_0. Once more the solution is found in the same page of Ref. [11] and is similar to Eq.(7) with the hyperbolic function tanh substituted for the trigonometric tan:

$$f = [\tanh(\kappa a) - \kappa a]/\kappa \ , \tag{10}$$

with the same vanishing cross-section in the limit $a \to 0$ (hence $\kappa a \to 0$):

$$\sigma \simeq 4\pi \, |f|^2 \simeq \pi \, a^2 (\kappa a)^4 \ . \tag{11}$$

Hence Winterberg's model is collisionless, *i.e.* his postulated contact-interactions do not exist.

In a private communication Winterberg told us he got the idea of Eq.(1) from Gross [18] who used a three-dimensional Dirac delta function. However Gross started from a nonlocal potential $V(\mathbf{x} - \mathbf{y})$ depending on two different points, $\mathbf{x}$ and $\mathbf{y}$ respectively, and integrated over $\mathbf{y}$. Then, comparing the Bernoulli equation for the Hartree fluid to the classical fluid equation Gross has shown that a delta-function interaction $V(\mathbf{x} - \mathbf{y}) \propto \delta(\mathbf{x} - \mathbf{y})$ corresponds to a pressure p for a gas with mass density ρ given by $p = \overline{V} \ \rho^2/2$ which is similar to Eq.(5.3) of Winterberg [11]. Gross [18] used therefore a delta connecting two separated points (in order to reduce a nonlocal potential to a local one) while Winterberg uses a local delta function $\overline{V}(\mathbf{x}) \propto \delta(\mathbf{x})$. In another private communication Winterberg referred to the Encyclopedia of Physics [19] where the energy $\nu(\mathbf{r}_{ij}) = V \, \delta(\mathbf{r}_{ij})$ is expressed by a three-dimensional delta function. But $\mathbf{r}_{ij} = \mathbf{r}_i - \mathbf{r}_j$ as clearly shown in Appendix 8, p.504, Eqs.(A 8.5) and (A 8.9) of Ref. [19], corresponds to the model of Gross. Here also Winterberg did not see the physical meaning of the two indices i and j used as subscripts in $\mathbf{r}_{ij}$.

To guarantee the validity of the Hartree approximation for the Planckions model, Winterberg is compelled to use the 'regular' potential V given by Eq.(3.7) of Ref. [11]

(12) $$V = f^2\, r_p^2\, [n_+ - n_-]\ ,$$

which is in apparent contradiction with the starting expression (1) (n_+ and n_- are the concentrations of positive – and negative – mass Planckions respectively). The Hartree approximation cannot produce such a drastic result (12) from (1) (otherwise it would mean that it could not be applied in this case).

4. – Winterberg's short range forces and even the quantum potential are unable of engendering orderly ring vortices

Even if Winterberg had used the correct potential well (3) which is able of producing scattering with finite probability, the range of the force would be extremely short and no orderly motion could be obtained. The process would be a Markovian diffusion of the Planckions. On the contrary Winterberg states (without any attempt of proof) that the positive mass Planckions separate from the negative mass Planckions and group together in small vortex rings. The analogy of a tornado vortex is of no help because the vortex is produced by the Coriolis force which is a field whose range is equal to the Earth's radius. Moreover, such vortex has to be very large compared to the diffusion distance covered by the gas molecules during a period of rotation. Roughly it has to be larger than $\simeq 10^5$ times the mean free path of the air molecules. This is not the case for Winterberg's vortices whose size is $\simeq 5 \times 10^3$ times the Planckions radius which, in turn, is always much smaller than the mean free path. Moreover, for Planckions, there are no long-range fields as the Coriolis or the electromagnetic ones. Note that the long-range interactions are demanded at least by the boundary and/or initial conditions. For instance, jets injected into a fluid imply long range forces which keep together the atoms of the nozzle injecting the fluid. The vortices in a lake produced by an oar demand long range forces which preserve the oar as a quasi-rigid body. Similarly, for the boiling water in a pot. The long range forces preserve the shape of the pot's walls, of the pipe convoying the fuel, etc. On the contrary, according to Winterberg, only point-contact interactions act on his Planckions and no long range interaction would be effective.

In spite of this, Winterberg assumes that the Planck ether should be a highly degenerate two-component Bose superfluid described by two symmetric wave functions in a high-dimensional configuration space. Then he arrives (just after Eq.(3.7) of Ref. [11]) at the following quantum potential for the Planckions (strongly in contrast with the initially assumed point-contact interaction)

$$Q = \pm\hbar^2 \left(2\, m_p\, n_\pm^{1/2}\right)^{-1}\, \nabla^2\, n_\pm^{1/2} \quad . \tag{13}$$

Even with this logical jump, Winterberg does not achieve his hoped result. In fact, the quantum potential, together with a regular potential V, implies an inertial diffusion without friction. These potentials cannot produce orderly vortex rings but would tend to destroy any concentration of Planckions with the same sign (as required by a vortex including Planckions with the same sign). In fact, the acceleration $d\mathbf{v}_\pm/dt = \pm m_p^{-1}\ \nabla(V + Q_\pm)$ (as given by Eq.(3.6) of Ref. [11]) is directed away from any region where there is a difference $n_+ - n_-$ of concentrations (see Eq.(12)). Moreover Winterberg introduces the kinematic viscosity ν in his Eq.(4.3). It is true that he takes a large Reynold number, thus implying a small friction, but, given the extremely high frequencies of the Planckions vortices, the ring angular frequency should decay in times of the order of $10^{-30}s$. To overcome this drawback the sub-stratum has to intervene as a "deus ex machina", counterbalancing the diffusion action of the potentials and the friction damping. Not only, it must produce the desired radius $R \simeq 500\ r_p$ of the vortex ring, which is near the poorly defined grand unification scale.

5. – The MacCullagh condition $\nabla \cdot \mathbf{u} = 0$ contradicts $\nabla \cdot \mathbf{u} = 4\,\pi\,\rho_e$

The vortex rings assumed by Winterberg are similar to toroidal solenoids in which the surface currents circulating on circunferences contained in planes passing through the ring axis are substituted by Planckions of the same sign. In usual solenoids the centripetal force on the electrons is due to the attraction of the ions. But the Planckions moving around circular orbits in vacuum seem to have nothing that generates the centripetal force. A magic sub-substratum should take each Planckion by hand, separates groups of positive mass Planckions from those with negative mass and organizes them into the nice vortex rings. The centripetal force is, therefore, generated by Winterberg's ad hoc magic sub-substratum. But all this is insufficient to explain the transverse waves and to exploit Kelvin's gyrostatic ether model. In fact, if the axis of a vortex ring is rotated, the gyroscopic forces produce internal stresses tending to warp (or to break) the vortex ring but no net resultant force appears. At this point (Sect.6 of Ref. [11]) Winterberg considers a vortex ring as equivalent to four spinning tops lying along the sides of a square. This approximation can be tolerated since the tops lying on opposite sides spin antiparallelly and there is still zero resulting gyroscopic forces consequent to a rotation of the plane containing the axes of the four tops. On the contrary, the vortices considered by Kelvin correspond to a flowing along circular paths lying in a plane perpendicular to the symmetry axis. A series of these vortices is equivalent to a series of spinning tops all parallelly oriented and the gyroscopic effects are all coherent. But once the magic word "spinning top" is introduced, Winterberg postulates a net, resultant gyroscopic effect similar to that occuring in Kelvin's gyrostatic ether model.

The above postulate is not sufficient yet to fully recover Kelvin's model and an ether velocity $\mathbf{u}$ must be introduced by Winterberg. He considers the ether as an incompressible fluid and uses MacCullagh's condition $\boldsymbol{\nabla} \cdot \mathbf{u} = 0$ (above Eq.(6.8) of Sect.6 of Ref. [11]). Then, the ether velocity $\mathbf{u}$ is identified with the electric field $\mathbf{E}$, and without any justification Winterberg changes the original no-divergence condition $\boldsymbol{\nabla} \cdot \mathbf{u} = 0$, into $\boldsymbol{\nabla} \cdot \mathbf{u} = 4\pi\, \rho_e$, thus treating the electric charge density ρ_e by magic. Notice that this is the first time where the electric charge is mentioned and nothing is said about the possible electric charges of the Planckions and their Coulomb interactions.

6. – The introduction of an unphysical Lagrangian.

Hamilton's variational principle with a convenient invariant called Lagrangian has been introduced to obtain the already known equations of motion. Since this method works very well once the minimal action is used (*i.e.* when one builds the simplest invariant for the coupling, as $\rho_0 v^\alpha A_\alpha$ in electromagnetism, only using velocities and not accelerations), it has been extended [13] to find the equations of motion when the latter ones are not known a priori.

Lagrangians containing accelerations have been used in particular cases where the equations of motion were already known [20]. But Winterberg introduces a priori the acceleration in his Eq.(9.13) in such a way that he obtains an equation of motion that does not reduce to that of Abraham-Lorentz for low velocities and it is therefore wrong. Winterberg's equation resembles the Lorentz-Dirac equation of motion but it contains an extra factor 3/2 between the second and third term in the left hand side and, moreover, an extra differentiation of these two terms with respect to the proper time s. The consequence is that Eq.(9.19) reduces, for incipient motion ($u_\alpha \to 0$), to

$$k_0 \frac{du_\alpha}{ds} = -e \; f_{\alpha\beta} \; u_\beta + k_1 \left(\frac{3}{2} \frac{du_\nu}{ds} \frac{du_\nu}{ds} \frac{du_\alpha}{ds} - \frac{d^3 u_\alpha}{ds^3} \right) , \tag{14}$$

which contains the cube of the acceleration components and the third derivative of the velocity (instead of the usual radiation damping given by the second derivative of the velocity).

The reason of all this ad hoc manipulation is that Winterberg wants to recover his Eq.(9.19) and a consequent spin angular momentum given by Eq.(9.23) which, for a particle at rest, is given by Eq.(9.24), *i.e.* as the cross product between the velocity and the quantity p_α proportional to the acceleration (see Eq.(9.21)).

7. – Coordinate transformations regard the same physical events

A previous paper [21] by Winterberg is dedicated to obtaining coordinate transformations by accelerating a body initially at rest in one reference system S until it acquires the same velocity of the second reference system S', and then keeping it at rest with S'. Obviously, this is a trivial error because the coordinate transformations between two systems S and S' must concern the same physical event. The purpose of considering the same rigid body, once at rest with S and then brought to rest with respect to S', is to eliminate the mixed terms $\partial^2/\partial t\, \partial x'_s \ldots$ which appear in Eq.(7.4) of Ref. [11], here written only for the scalar potential φ after having expanded the square,

$$\left\{ \nabla'^2 - \frac{1}{c^2}\left[\frac{\partial^2}{\partial t^2} + \left(u_s \frac{\partial}{\partial x'_s}\right)^2 - 2\, u_s \frac{\partial^2}{\partial t\, \partial x'_s}\right]\right\} \varphi' = -4\pi\rho \ , \tag{15}$$

where the occurence of two indices s implies summation over s.

This is an evident particular case and, in general, the considered physical object has internal motion so that it cannot be at complete rest with any system. In this case $\partial\varphi'/\partial t \neq 0$ (and similarly $\partial \mathbf{A}'/\partial t \neq 0$) and the mixed terms can be eliminated only for a single plane wave [22]. Such terms cannot be eliminated for a superposition of plane waves and, to a better reason, for the velocity fields due to charges in motion. Even with the wrong elimination of the mixed terms a relativistic expression is not obtained since the charge density ρ changes in Lorentz transformations because of the invariance of the charge and the longitudinal contraction of the volume elements, but it is invariant under a Galilei transformation.

Moreover Winterberg demands that the Lorentz gauge is made Galilei invariant (Eq.(7.5) of Ref. [11]). But the Lorentz gauge is Lorentz invariant and it cannot be at the same time Galilei invariant. In fact, by applying the Galilei transformation to the Lorentz gauge one gets the different gauge $\mathbf{\nabla} \cdot \mathbf{A} + c^{-1}\, \partial\varphi/\partial t \neq 0$.

8. – Other difficulties in Winterberg's theory and some suggestions to overcome them

Winterberg states that the Planckions of positive mass do not annihilate with those of negative mass in spite of the fact that they are assumed to have contact, attractive interactions. Although not explicitly affirmed, the positive mass Planckions are understood to be the antiparticles of the negative mass Planckions. In modern physics, a particle which has just the same properties of another particle except one which is equal and opposite, is the antiparticle of the second one. Unless explicitely stated, a particle coming in contact with its antiparticle annihilates and produces photons or other particles. A pair of Planckions should disappear into nothing because $-|m_-|\, c^2 + mc^2 = 0$.

The value of the Planckion mass have been assumed to be $m_p = \pm\, 2.2 \times 10^{-5} g$ which is a huge value on the elementary particle scale. This implies that the elementary particles masses cannot be obtained as naive combinations of Planck masses, as explicitly noticed by Winterberg in Sect.10 of Ref. [11]. The spinors are then considered as excitons of the substratum, made up from the positive and negative masses of the vortex resonance (vortons).

Again with regard to the masses m of elementary particles, Winterberg arrives at his Eq.(10.6) which reads $m/m_p = 2\,(r_p/R)^6$, where m_p is the Planck mass, $r_p \simeq 10^{-33}$ cm the Planck length and R the radius of a vortex ring. Consequently, in order to have different masses, R must be quantized but no hint is made for this purpose. Then, in order to obtain the lowest quark mass it must be $R/r_p \simeq 4600$, a value about 10 times larger than that estimated by Winterberg, *i.e.* $\simeq 500$. But what about the electron which requires $R/r_p \simeq 5376.4$? This is still larger than the only one value estimated by Winterberg. Perhaps all the other particles can be thought of as multiples of the lowest quark mass, but what about the submultiples?

Why vortex rings or vortons constituted of either a positive mass m^+ and a negative mass m^-? In Sects. 4, 6 and 10 of Ref. [11] the vortex rings are introduced and quantized with a single R value while in his Sect. 9 a positive-negative pair is explicitly used to describe spinors. Such a pair should self accelerate as discussed in our Sect.**2** and the substratum has to intervene not only to prevent self-acceleration but also to produce a rotation of the mutually fixed masses. The peripheral velocity must be relativistic so that, as guessed in Sect. 10 of Ref. [11], the relativistic factor must be of the order $\gamma \simeq 1000$. However Winterberg explicitly states that the spinor mass m must obey the double equation (9.27) here transcribed

$$(16) \qquad m = \left[k_0 - \frac{3}{2}\,k_1 \left(\frac{du_\nu}{ds}\right)^2\right] \gamma = \left[k_0 - \frac{1}{2}\,k_1 \left(\frac{du_\nu}{ds}\right)^2\right] \gamma^{-1} \ .$$

It appears from Eq.(16) that γ depends on the two arbitrary constants k_0 and k_1 and also on the square of the acceleration. But is du_ν/ds the acceleration of the positive or of the negative mass (which rotate while keeping a fixed mutual distance)? Or is it the acceleration of the centre of the two orbits in agreement with the solutions of the Dirac equations? The rotation of m^+ and m^- corresponds to the Zitterbewegung which is the solution for an electron at rest, whose momentum is zero. In fact Winterberg explains, after Eq. (9.27): "The limit $v \to 0$, that is $\gamma \to \infty$ corresponds to the Dirac equation. To keep m finite, one must, therefore, have in this limit

$$\text{(17)} \qquad \begin{cases} \lim\limits_{\gamma \to \infty} \left[k_0 - \dfrac{3}{2}\, k_1 \, (du_\nu/ds)^2 \right] \to 0 \ , \\ \\ \lim\limits_{\gamma \to \infty} \left[k_0 - \dfrac{1}{2}\, k_1 \, (du_\nu/ds)^2 \right] \to \infty \ . \end{cases}$$

Therefore, $k_0 \to 3\, k_1 \, (du_\nu/ds)^2/2$ and $k_0 \to \infty$". Consequently, by Winterberg's logic the constant k_0 must at the same time diverge and be proportional to the square of the acceleration (of what?)!

The electron has an electric charge and a magnetic moment. Where does charge come from in Winterberg's model? Do the Planckions have an electric charge? Which of the two rotating masses (m^+ and m^-) possesses an electric charge of what sign? If there is an accelerated charge why is there no e.m. radiation and radiation damping?

In Sect.6 Winterberg identifies the ether velocity $\mathbf{u}$ with the electric field $\mathbf{E}$. To obtain electromagnetism it would have been better to identify(3) $\mathbf{u}$ with the magnetic field $\mathbf{H}$ so that Eq.(6.3) of Ref. [11] becomes

$$\text{(18)} \qquad 2\, \frac{\partial \mathbf{\Phi}}{\partial t} = \boldsymbol{\nabla} \times \mathbf{A} = \mathbf{H} \ .$$

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(3) The identification of $\mathbf{u}$ with $\mathbf{H}$ is obvious to within a dimensional constant, $\mathbf{u} \propto \mathbf{H}$, and known as Heaviside identification, which gives $\boldsymbol{\nabla} \cdot \mathbf{H} = 0$ in vacuum since $\boldsymbol{\nabla} \cdot \mathbf{u} = 0$.

Then differentiating Eq.(6.2) of Ref. [11] with respect to time t and using Eq.(18) gives

$$\frac{\partial^2 \mathbf{A}}{\partial t^2} = -\frac{k}{2\rho}\,\boldsymbol{\nabla}\times\frac{\partial \boldsymbol{\Phi}}{\partial t} = -\frac{k}{4\rho}\,\boldsymbol{\nabla}\times\mathbf{H}\,, \tag{19}$$

where ρ has been assumed not to explicitly depend on t. Now Eq.(19) can be identified with $\boldsymbol{\nabla}\times\mathbf{H} = \partial\mathbf{E}/\partial(c\,t)$, which is one of the Maxwell equation "in vacuo", provided

$$c^2 = \frac{k}{4\rho} \qquad \text{and} \qquad \mathbf{E} = -\frac{1}{c}\,\frac{\partial \mathbf{A}}{\partial t}\,. \tag{20}$$

Obviously, this is in contradiction with Eq.(5.1) of Ref. [11], which shows that ρ depends at least on the position $\mathbf{r}$ so that the speed of light c cannot be a constant. But this is the "least evil" because, taking the curl of (20) gives $\boldsymbol{\nabla}\times\mathbf{E} = -\partial\mathbf{H}/\partial(ct)$ which is another Maxwell equation. Moreover Eq.(20) is the relation between $\mathbf{E}$ and $\mathbf{A}$ in the Coulomb gauge (used by Maxwell, $\boldsymbol{\nabla}\cdot\mathbf{A} = 0$, $\boldsymbol{\nabla}\cdot\mathbf{u} = 0$) which avoids Winterberg's strong contradiction of putting $\boldsymbol{\nabla}\cdot\mathbf{E} = 0$ (he identifies $\mathbf{u}$ and $\mathbf{E}$) and then of introducing $\boldsymbol{\nabla}\cdot\mathbf{E} = 4\pi\rho$.

9. – Conclusions

When we and others read for the first time Winterberg's papers [11, 21] we were bewildered. It is true that a unified field theory is at stake and any reasonable attempt is therefore welcome. That is why we mentioned in the Introduction the main assumptions made in the past and regarding the two revolutionary theories of our century (relativity and quantum mechanics) and gave a sketch of stochastic electrodynamics (SED) which gives intuive justifications to the bases of both relativity and quantum physics. Most of us work in SED which is now at the threshold of being accepted as a science [4, 5] and are therefore not very conservative but rather open minded in accepting novelties.

It is true that a unified field theory is at stake and any reasonable attempt is therefore welcome. However, it seems to us that Winterberg has gone too far, in particular by assuming a negative inertial mass and energy for one kind of Planckions. A negative inertia implies self-acceleration (as shown in [12]) because of the self reaction of any kind of fields, including those due to the stresses arising from point-contact collisions between Planckions. Obviously, the inconsistencies of negative masses occur if referred to conventional fields with conventional positive unit and norm [23], as implicitly assumed by Winterberg.

The contact interactions should be expressed by a three-dimensional Dirac delta function for the force and not for the potential as assumed by Winterberg (see our Sect.**3**). In fact a local potential (as used by Winterberg) expressed by a three-dimensional Dirac delta function of the position implies zero cross-section and therefore no action. Unfortunately, even a force expressed by a distribution of Dirac delta forces on the surface of a finite Planckion is unable to produce the ordered vortex rings assumed by Winterberg (see our Sect.**4**).

The short-range forces postulated by Winterberg are unable to produce the ordered vortex rings assumed by Winterberg (see our Sect.**4**).

In fact, vortices demand long-range interactions as the gravitational forces, the Coriolis forces or, at least the e.m. forces which preserve the connections between the atoms constituting a tube, a pipe or a pot.

Consequently, our first suggestion for future research is to eliminate the three-dimensional Dirac delta function potential. The second suggestion is to drop the negative inertia and the contact forces and to start directly from the postulated, basic Eq.(2.2) of Ref. [11]. The problem of negative masses and energies formulated with respect to new fields with *negative unit and norm*, called *isodual fields*, has been studied by one of us [24] and its implications for Winterberg's theory will be studied elsewhere.

The elimination of negative mass Planckions overcomes the other drawback emphasized in our Sect.**8**, *i.e.* the mutual annihilation of positive and negative Planckions which should vanish without the emission of photons because the algebraic sum of their masses is zero. The introduction of negative masses seemed important to Winterberg in order to avoid the consequent huge cosmological constant which would appear in general relativity. The second suggestion is that the use of the alternative gravitational theories of Ref. [14] eliminate any physical difficulties.

The fourth suggestion is the elimination of the Planckions as basic particles because their masses are much higher than those of the fundamental elementary particles (leptons, barions, etc.).

The fifth suggestion is the identification of the velocity $\mathbf{u}$ with the magnetic field $\mathbf{H}$ instead with the electric field $\mathbf{E}$ so as to avoid the strong contradiction between MacCullagh's condition (assumed by Winterberg) $\boldsymbol{\nabla}\cdot\mathbf{u} = \boldsymbol{\nabla}\cdot\mathbf{E} = 0$ and $\boldsymbol{\nabla}\cdot\mathbf{E} = 4\pi\rho$ (see our Sect.**5** and Sect.**8**).

The sixth suggestion is not to introduce the acceleration in the Lagrangian so as to avoid the bizarre results examined in our Sect.**6** and Sect.**8**.

The seventh suggestion is to forget any attempt to derive special relativity from Galilean relativity by considering coordinate transformations regarding different physical events. This is a physical error which, if maintained, would raise Winterberg to the level of some notorious Authors([4]).

Concluding, nothing can be saved in the work published in Ref. [21]. What is to be saved in Ref. [11] is the assumption of the basic Eq.(2.2) applied to ether-particles having a mass much smaller than that of a Planckion. Perhaps, if Winterberg uses long-range forces for the new ether-particles, the vortex sponge model may be retrieved and, in that case, he should use our suggestion of Sect.**8**, *i.e.* $\mathbf{u} \propto \mathbf{H}$. It is a more modest approach but useful for future developments.

We can also add that the errors in the examined "Planck aether theory" are not

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([4]) See Marinov [25] who claimed to have disproved special relativity by his 'two coupled mirrors experiment' and to have constructed a perpetuum mobile which supplies work without consuming any kind of energy. See Pappas who published an experimental paper [26] on electrodynamical forces at variance with the results obtainable by the Biot-Sawart law, hence in contrast with classical electrodynamics and then, during the 1988 London Conference on Physical Interpretations of Relativity Theory he announced to have measured vacuum signal speeds 600 times that of light. See Shannon [27] who assumes a static Universe which is untenable on experimental grounds because of the Hubble law, the cosmic background radiation, the relative abundances of the elements, the agreement between the Universe ages obtained by the Hubble expansion, the theory of the stellar evolution and the nucleosynthesis of the elements, and other proofs all in favour of the big bang theory. But even on theoretical grounds a static Universe is untenable because it would be unstable even if one introduces a cosmic repulsion, as shown by Eddington in 1924. The fact is that Shannon bases his theory on the expression $(x_\mu x^\mu)^{-1} = x^{-2} - y^{-2}$ which is equivalent to writing $(ab)^{-1} = a^{-1} + b^{-1}$.

due to Max Planck but are the sole merit of F.Winterberg [28]. Planck published formulas for the mass, length, and frequency named after him but did not propose to formulate with them an ether theory. Accordingly, in order to avoid further embarrassment of Planck and German science in general, Winterberg should have published his unteneable theory under his own name.

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