The Revenge of Old Classical Physics: no Space for Photons or Relativity

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The old classical theory of extended elementary particles is introduced; in the first part, the basic non linear equations for stable particles are presented, together with some simple solutions for semi-infinite media. In the second and third parts, the well-known failures of classical physics in the microscopic domain are refuted with old classical arguments; the major arguments of modern physics against the application of classical physics in the microscopic domain are rejected. It is concluded that, although the old classical theory is in a immature state of development, there is no need to introduce modern concepts, like photons or relativity, to describe microscopic phenomena; they can be described in old classical terms.

I. Introduction

Although the concepts of relative space and time are completely foreign to the classical taste in physics, the original meaning of 'classical physics' has been corrupted by the quantum revolution, as nowadays the term includes both special and general relativity. Moreover, the term 'classical electron model' refers either to the point model - an absurdity in classical terms - or to the naïve spherical model - an inherently unstable structure that is obviously inappropriate to predict the parameters of the electron. [1-5]

The 'old classical physics' to be considered here assumes absolute space and time, and within this framework Maxwell's equations for the electromagnetic field and Newton's equation for the gravitational field, together with their respective force equations, provide all that is needed to describe natural phenomena. To predict microscopic phenomena in perfect detail, the extended structure of the elementary particles must be first found, by solving the old classical field equations to be presented. These equations are not well known, and are exceedingly complicated, so up to now their exact solutions have not been found. Although the exact shape of the electron is not yet known, approximate ring models are available [6-13], so this unsolved problem does not preclude the old classical theory from making some reasonable assumptions, and from there to stand up on its own feet, to counter many well known arguments against its validity.

The search for an old classical model for the stable electron structure is not very popular, due to the widespread belief that the truth is taught in colleges and universities about the failures of classical physics in the quantum domain. This paper attempts to challenge this belief, by providing factual evidence that - in general - the most popular arguments against classical physics are false. These dogmatic reasons do not require much substance, as long as they serve well their pedagogical purpose: to ensure that the new students of physics reject the classical order in the microscopic domain, and embrace instead the ambiguous uncertainty of quantum physics. The revenge of old classical physics undermines this purpose, providing more able classical models that contradict the current dogma that modern physics preaches against classical physics.

The subject at hand is extensive; classical physics has, for so many decades and in so many areas, been unfairly attacked and humiliated within the microscopic domain that only a series of monographs could do fair revenge in the subject. In this introductory paper, no attempt will be made to demonstrate the factual evidence collected in defense of old classical physics; most of the arguments given below are quite straightforward, some of them are available in the literature, and all of them can be rigorously demonstrated.

II. Foundations of the Old Classical Theory

A. Basic Equations for Elementary Particles

1. Conditions for Stability

Assume the center of mass of the elementary particle at rest; the first condition for stability is the absence of electromagnetic radiation, as otherwise the particle's mass will decay with time. This condition is automatically satisfied if the electromagnetic fields do not vary with time; thus, we assume static fields in the analysis of this particular problem. The electrostatic field $\mathbf{E}$ can then be derived from a scalar potential ϕ ($E = -\nabla\phi$) and the magnetostatic field $\mathbf{H}$ can be derived from a vector potential $\mathbf{A}$ ($\mathbf{H} = \nabla \times \mathbf{A}$). The source of the electrostatic field is the charge density ρ, and the source of the magnetostatic field is the current density $\mathbf{J}$ that obeys the continuity equation, which in static fields is $\nabla \cdot \mathbf{J} = 0$. Maxwell's equations in vacuum (permeability ε_0, permittivity μ_0) for the potentials are:

$$\nabla^2\phi + \rho / \varepsilon_0 = 0 \quad , \quad \nabla^2\mathbf{A} + \mathbf{J} = 0$$

where Lorentz's gauge ($\nabla \cdot \mathbf{A} = 0$) has been implicitly assumed. The electromagnetic self-stress over the charged volume is:

$$\mathbf{f}_E = \rho(\mathbf{E} + \mu_0 \mathbf{J} \times \mathbf{H})$$

The gravitational field $\mathbf{F}$ can be derived from a scalar potential ψ ($\mathbf{F} = -\nabla\psi$). The source of the gravitational field is the mass density δ. Newton's equation in terms of the gravitational constant G is:

$$\nabla^2\psi - 4\pi G\delta = 0$$

The gravitational self-stress is:

$$\mathbf{f}_G = \delta\mathbf{F}$$

The relation between the electromagnetic fields and the sources of the gravitational field must be defined. The simplest assumption is that all mass and angular momentum are of purely electromagnetic origin; the perennial charge density ρ is the fundamental source, and due to its primordial flow at a velocity υ, a current density $\mathbf{J} = \rho\upsilon$ is created. Maxwell's equations allow the potentials ϕ and $\mathbf{A}$ to be found in terms of ρ and $\mathbf{J}$. Once the electromagnetic field is defined, the most logical candidate for the source of the gravitational field is the mass density associated to the energy density of the sources:

$$\delta = \tfrac{1}{2}(\rho\phi + \mu_0\mathbf{A}\cdot\mathbf{J})/c^2 = -\tfrac{1}{2}(\varepsilon_0\phi \cdot \nabla^2\phi + \mu_0\mathbf{A}\cdot\nabla^2\mathbf{A})/c^2$$

In this way the gravitational potential ψ can be found in terms of ρ and $\mathbf{J}$.

In this context, the mass density δ is a static and stationary property of the electromagnetic fields and their sources. There is no mass movement inside the stationary particle; only the charge density ρ flows at a velocity υ. When the particle is at rest, there are no angular moments or forces of mechanical origin. The gravitational force equation can be written as:

$$\mathbf{f}_G = \rho\left[-\tfrac{1}{2}\nabla\psi(\phi + \mu_0\mathbf{A}\cdot\upsilon)/c^2\right]$$

The quantity within square brackets is the effective electric field that accounts for the gravitational force, so in this model gravity is naturally pictured as a second-order electromagnetic effect.

The second condition for stability is that the total self-stress vanishes anywhere within the charged volume. The following equilibrium condition must hold: $\mathbf{f}_E + \mathbf{f}_G = 0$. It can be written as:

$$(\nabla^2\phi)\cdot(\nabla\phi) - Z_0^2\cdot(\nabla^2\mathbf{A})\times(\nabla\times\mathbf{A}) + \left[\tfrac{1}{2}(\phi\cdot\nabla^2\phi + Z_0^2\mathbf{A}\cdot\nabla^2\mathbf{A})/c^2\right]\cdot\nabla\psi = 0$$

where $Z_0 = \sqrt{\mu_0/\varepsilon_0}$ is the free space impedance. The equilibrium condition is nonlinear due to the dependence of ψ on $\mathbf{A}$ and ϕ.

Poisson's equation for the gravitational potential ψ is:

$$\nabla^2\psi + 2\pi G(\varepsilon_0\phi\cdot\nabla^2\phi + \mu_0\mathbf{A}\cdot\nabla^2\mathbf{A})/c^2 = 0$$

The third condition for stability is that the primordial flow of charge is perennial; the electromagnetic fields should do no work. This requires that $\mathbf{E}\cdot\mathbf{J} = 0$:

$$\nabla\phi\cdot\nabla^2\mathbf{A} = 0$$

The three previous equations must be simultaneously satisfied to find $\mathbf{A}$, ϕ and ψ. These are the basic non linear equations that an old classical model for elementary particles must satisfy within its charged region. This is a plausible old classical formulation for stability - not necessarily the only one.

2. Primordial Boundary Value Problem

In toroidal coordinates (η, θ, φ) we assume a continuous and finite distribution of charge density $\rho(\eta, \theta, \varphi)$ inside a torus whose boundary is a toroidal surface defined by $\eta = \eta_0$. The region inside the boundary surface $(\eta > \eta_0)$, where the conditions for stability must hold, is named Poisson's region, because here ϕ and ψ obey Poisson's scalar equation, while $\mathbf{A}$ obeys Poisson's vector equation.

Outside the boundary surface $(\eta < \eta_0)$ there are no sources $(\rho = \mathbf{J} = \delta = 0)$ so this outer volume is named Laplace's region, because here ϕ and ψ obey Laplace's scalar equation, while $\mathbf{A}$ obeys Laplace's vector equation:

$$\nabla^2\phi = 0 \quad , \quad \nabla^2\mathbf{A} = 0 \quad , \quad \nabla^2\psi = 0$$

In Laplace's region, the boundary conditions at infinity $(\eta \to 0,\ \theta \to 0)$ require that the potentials achieve the asymptotic values that characterize the following observables of the particle: the charge Q that fixes the value of ϕ, the vector $\mathbf{M}$ that fixes the value of $\mathbf{A}$ and the mass m that fixes the value of ψ.

The boundary conditions at the interface require that the three potentials and their derivatives with respect to the radial coordinate η are continuous at $\eta = \eta_0$. The continuity equation $(\nabla\cdot\mathbf{J} = 0)$ requires that the normal component of the current density must vanish at the boundary $(J_n(\eta_0, \theta, \varphi) = 0)$. The continuity of the charge density at the interface requires $\rho(\eta_0, \theta, \varphi) = 0$. Although this seems to be a plausible requirement, it is not mandatory from the point of view of Maxwell's equations.

The primordial boundary-value problem can be considered to be solved when a solution for $\mathbf{A}$, ϕ and ψ is found that satisfies: **1)** the conditions for stability in Poisson's region; **2)** the boundary conditions at the interface; **3)** Laplace's equations in Laplace's region; **4)** the observable boundary conditions at infinity.

Surface sources (ρ_S, J_S, δ_S) are not acceptable in a rigorous old classical model because they require discontinuity of the normal derivatives of the potentials. Nevertheless, surface sources are useful in approximate models; in this case the appropriate limiting form of the boundary conditions at the interface must be employed. In toroidal surface models the potentials may satisfy Laplace's equation inside the boundary surface; in this case Poisson's region is reduced to the interface.

3. Properties of Elementary Particles

Assuming that the fields are known, the basic properties of the stationary particle can be computed. [14,15]. The charge Q of the particle ($-e$ for the electron and $+e$ for the proton) is equal to the volume integral of the charge density over Poisson's region:

$$Q = \iiint \rho \, dv$$

The mass m of the particle (m_e for the electron and $m_p \approx 1836 \cdot m_e$ for the proton) is equal to the volume integral of the mass density over Poisson's region:

$$m = \iiint \delta \, dv$$

The magnetic moment vector $\mathbf{M}$ of the particle ($\mathbf{M}_e$ for the electron and $\mathbf{M}_p \approx \mathbf{M}_e / 658$ for the proton) is equal to the following volume integral over Poisson's region:

$$\mathbf{M} = \frac{1}{2} \iiint \mathbf{r} \times \mathbf{J} \, dv$$

For the electron $M_e \approx e\hbar / 2m_e$ where $h = 2\pi\hbar$ is Planck's constant. The Compton wavelength of the electron is $\lambda_c = 2\pi\bar{\lambda}_c = h / m_e c \approx 2.4 \times 10^{-12}$ m, so $M_e \approx e\bar{\lambda}_c c / 2$. This last equation and the stability condition to be considered below require that the particle's largest dimension be of the order of $2\bar{\lambda}_c$.

The angular moment vector, or spin $\mathbf{S}$, of the particle ($S_e = S_p = S = \hbar / 2$ for both the electron and proton) is equal to the following volume integral over the whole space (Poisson's and Laplace's regions):

$$\mathbf{S} = \iiint \left[\mathbf{r} \times (\mathbf{E} \times \mathbf{H}) / c^2 \right] dv$$

Assuming that the magnetic moment and the spin are parallel along a certain axis, the g factor ($g_e \approx 2$ for the electron and $g_p \approx 5.6$ for the proton) of the particle is:

$$g = (2m / Q)(M / S)$$

In electron scattering experiments, the maximum electric field produced by the particle is measured. The effective scattering radius r_{eff} of the electron is equal to the radius of an equivalent spherically symmetric shell of surface charge, that has total charge e and that produces the same maximum electric field. [16]

Sommerfeld was wrong when - after presenting some shortcomings of the spherical model - he claimed without proof that the spin and the magnetic moment of the electron are *"inaccessible to Maxwell's electrodynamics"* [3].

B. Known Solutions of the Basic Equations

The basic equations are very complicated and scarcely known, so currently only very simple solutions in semi-infinite media can be presented.

1. Solutions Neglecting Gravitational Fields

As first approximation the gravitational field is neglected, the equilibrium condition is simplified to $\mathbf{f}_E = 0$, this leads to a single linear equation:

$$(\nabla^2 \phi) \cdot (\nabla \phi) = Z_0^2 \cdot (\nabla^2 \mathbf{A}) \times (\nabla \times \mathbf{A})$$

In this approximate case, the problem arises that the lossless equation $\mathbf{E} \cdot \mathbf{J} = 0$ is a consequence of the equilibrium condition $\mathbf{f}_E = 0$ (it is deducted from $\mathbf{f}_E \cdot \mathbf{J} = 0$), so there are not enough independent equations to solve for $\mathbf{A}$ and ϕ. Anyhow, some particular solutions that satisfy the equilibrium condition can be found by assuming a simple form for $\boldsymbol{\upsilon}$ and a suitable relation between $\mathbf{A}$ and ϕ that satisfies Poisson's vector equation:

$$\nabla^2 \mathbf{A} = -\mathbf{J} = -\rho \boldsymbol{\upsilon} = \varepsilon_0 \boldsymbol{\upsilon} \nabla^2 \phi$$

In simple geometries, when the charge density ρ flows at the speed of light, the magnetostatic cohesive force is exactly equal to the electrostatic repulsive force. The two luminal solutions to be considered below also satisfy the lossless condition.

In rectangular coordinates (x, y, z), if $\boldsymbol{\upsilon}$ is a constant vector, and $\mathbf{A}(x, y, z) = \varepsilon_0 \boldsymbol{\upsilon} \cdot \phi(x, y, z)$, then the luminal condition ($\boldsymbol{\upsilon} \cdot \boldsymbol{\upsilon} = c^2$) and the condition $\mathbf{E} \cdot \mathbf{H} = 0$ are necessary for stability. A particular type of luminal rectangular solution that satisfies $\mathbf{f}_E = 0$ in a charged region is $\boldsymbol{\upsilon} = c \cdot \hat{\mathbf{z}}$, $\mathbf{H} = H_y(x)\hat{\mathbf{y}}$ and $\mathbf{E} = E_x(x)\hat{\mathbf{x}}$.

In cylindrical coordinates (r, φ, z), when the current flows in the z direction ($\boldsymbol{\upsilon} = \upsilon_z \hat{\mathbf{z}}$, $\mathbf{A} = A_z \hat{\mathbf{z}}$) and the potentials are independent of z (semi infinite geometry), luminal solutions ($\boldsymbol{\upsilon} \cdot \boldsymbol{\upsilon} = c^2$) with $A_z(r, \varphi) = \varepsilon_0 \upsilon \cdot \phi(r, \varphi)$ satisfy the equilibrium condition. This result is independent of the charge distribution $\rho(r, \varphi)$ and does not require axial symmetry about the z axis.

Pauli was wrong when he stated that *"electrodynamics is quite incompatible with the existence of charge"*, as he incorrectly concluded that the only possible solution for $\mathbf{f}_E = 0$ is $\boldsymbol{\upsilon} = 0$ which immediately leads to $\rho = 0$. [1]

Oppenheimer was wrong when he stated that there is no suitable distribution of charge and current that can produce $\mathbf{f}_E = 0$, his *"general proof"* assumes *a priori* that $\rho = 0$, so it is not applicable to Poisson's region. [5]

In spherical coordinates (r, θ, φ), a spherically symmetric model rotating about the z axis ($\boldsymbol{\upsilon} = \upsilon \hat{\boldsymbol{\varphi}}$, $\mathbf{A} = A_\varphi(\eta, \theta)\hat{\boldsymbol{\varphi}}$) cannot be stable because the magnetostatic force vanishes on the axis of rotation, so there is no way to balance the repulsive electrostatic force in this axis. The spherical model is discarded as an old classical model.

Jackson was wrong when - after considering the instability of the spherical model - he concluded without proof that *"a purely electromagnetic model of matter must be abandoned"* [2]. He and many other authors [1,3-5] were misguided when they seemed to believe that spherical symmetry is the only possibility for an old classical electron model.

In toroidal coordinates (η, θ, φ), with axial symmetry and toroidal currents ($\mathbf{\upsilon} = \upsilon(\eta, \theta)\hat{\varphi}$, $\mathbf{A} = A_\varphi(\eta, \theta)\hat{\varphi}$), it can be shown that there is no stable solution. In particular, the luminal condition ($\upsilon = c$) does not satisfy the equilibrium condition, except in the limiting case of an infinitely thin ring ($\eta_0 \to \infty$).

This last fact makes the thin luminal ring a better guess than the naïve spherical model; nevertheless, the ring is only a rough average model of a complex electromagnetic and gravitational structure that should not display axial symmetry. This lack of symmetry implies that centers of mass and charge of the particle could be at a certain distance $< \lambda_c$ from the axis of rotation of the charge.

2. Solutions Considering Gravitational Fields

The general equilibrium equations are non linear, so in cylindrical coordinates (r, φ, z) a flow with uniform charge density and speed cannot be in equilibrium. Even the most elementary semi-infinite geometry with axial symmetry [$\rho(r)$, $\mathbf{\upsilon} = \upsilon(r)\hat{\mathbf{z}}$) is quite difficult to handle. To compute the absolute value of the potentials, it can be assumed that this geometry is an approximation to the cross section of a slender ring of known dimensions. A series procedure in powers of the radius r (normalized to the boundary radius) leads to a system of equations that can be solved iteratively to find the distribution of the sources. In this case only very specific functions $\rho(r)$ and $\upsilon(r)$ satisfy the equilibrium condition; the speed of the charge is subluminal ($\upsilon < c$).

An axially symmetric solution exists in cylindrical coordinates (r, φ, z) for a subluminal cylindrical shell with uniform surface charge ($\rho \to \rho_s$, $\mathbf{\upsilon} = \upsilon\hat{\mathbf{z}}$):

$$(\upsilon / c)^2 \approx 1 - K$$

where $K = 4\pi G m_e^2 \varepsilon_0 / e^2 \approx 2.4 \times 10^{-43}$ is the ratio of the gravitational and electrostatic forces between two electrons separated at distances much larger than the largest dimension of the particle ($r >> 2\lambda_c$).

If two parallel fibers of charge flow are apart by a distance much larger than their radii, they will be in mutual equilibrium when the previous equation for υ / c holds.

3. The Electron Ring Model

Consider an axially symmetric luminal ring of surface charge with large radius R and small radius $r << R$, rotating about its axis of symmetry. The parameters of this model are:

$$m \approx \mu_0 Q^2 (p-1) / 4\pi^2 R \quad , \quad M = \tfrac{1}{2} QRc$$

$$S \approx Z_0 Q^2 (p-2) / 4\pi^2 \quad , \quad g \approx (p-1)/(p-2) \approx 1 \quad , \quad r_{\text{eff}} \approx \sqrt{\pi r R}$$

with $p = \ln(8R/r)$ a constant to be fixed, that must be much greater than unity ($p >> 1$) for the model to represent the correct mass. As $g \approx 1$, this rough equivalent model can predict either the correct magnetic moment, or the correct spin of the electron, but not both of them together. The model must predict at least the charge and mass of the electron; these requirements provide an equation that relates R and p. Two basic ring models are here presented:

Correct spin model: To achieve the correct spin it is required that $S = S_e$. This leads to $R = \lambda_c / 2$. The predicted magnetic moment in this case is about half the correct value. The charge rotates at angular frequency $\omega_0 = 2m_e c^2 / \hbar$.

Correct moment model: To achieve the correct magnetic moment it is required that $M = M_e$. This leads to $R = \lambda_c$. The predicted spin in this case is about twice the correct value. The charge rotates at angular frequency $\omega_0 = m_e c^2 / \hbar$.

The ring models are only rough old classical approximations that provide an equivalent axially symmetric picture of a more complex and currently unknown asymmetrical electron structure. Both ring models share the following features that contribute to the revenge of old classical physics:

a. Very low self-stress

A rigorous solution in toroidal coordinates [8] shows that the electromagnetic self-stress is more than 90 orders of magnitude below the electrostatic self-stress. Although the ring models are not perfectly stable, they do provide a good numerical approximation to a stable structure. The cohesive character of the magnetostatic force is consistently ignored in works by those authors who - based on the obvious failures of the spherical model - consider classical electrodynamics to fail in the microscopic domain [1-5].

b. Very low scattering radius

The effective scattering radius r_{eff} of the models is less than 10^{-59} m, the current empirical limit is $r_{\text{eff}} < 10^{-18}$ m, so the ring electron satisfies this requirement by about 40 orders of magnitude. Hestenes is wrong when he states without proof that an extended electron of size λ_c cannot display the required scattering radius [17].

c. Gravitational stress much larger than electromagnetic stress

The gravitational self-stress is 46 orders of magnitude larger than the electromagnetic self-stress. This means that - although the gravitational force between two electrons is 44 orders of magnitude smaller than the electrostatic force - in the microscopic domain the gravitational stress plays a crucial role when the electrostatic and magnetostatic stresses are almost in equilibrium.

d. Logarithmic singularity for infinitely thin ring

If the small radius tends to zero ($r \to 0$) the same logarithmic singularity of quantum electrodynamics is obtained. This notable coincidence has been overlooked where Jackson compares this quantum singularity with the classical singularity; he *a priori* assumes that the classical electron must be spherical [2].

e. Well described by equivalent mechanical models

As in any stationary old classical model, the angular momentum is of electromagnetic origin and there is no mass movement. Anyhow, an approximate equivalent mechanical model can be constructed to compute spin by assuming that a uniform slender ring of mass m and large radius R rotates at angular speed ω_0 about its axis of symmetry. This equivalent mechanical rotational model allows the angular momentum to be computed as if it were from mechanical origin ($S = \omega_0 Rm$), with an error below 0.5%. The equivalent moment of inertia of the ring is $I = mR^2$ and its mechanical rotational energy is $W = I\omega_0 = mR^2\omega_0$ which differs less than 0.5 % from the magnetostatic self energy of the electromagnetic model.

III. The Unnecessary Photons

A. The Photoelectric Effect

The fact is that an electron illuminated by an electromagnetic wave of angular frequency ω acquires a kinetic energy $W_k = \hbar\omega$ where $h = 2\pi\hbar$ is Planck's constant.

Physic students are taught that there is no classical interpretation for this effect, and so the quantum interpretation must prevail; the electromagnetic wave is made of particles called photons, each one of energy $W_p = \hbar\omega$, the point electron is somehow able to absorb a photon and acquire a kinetic energy $W_k = W_p$ [18, 19].

In 1905, when Einstein put forward his prize winning heuristic principle, the magnetic moment and the angular momentum (spin) of the electron had not yet been discovered. When these two experimental facts are considered together, an old classical interpretation of the photoelectric effect naturally arises.

The first fact is that the electron has angular momentum. The old classical theory assumes that this moment is of purely electromagnetic origin, but for approximate computational purposes it employs equivalent mechanical rotational models. In the correct-spin mechanical model, a ring of radius $\lambda_c / 2$ rotates at angular frequency $\omega_0 = 2m_e c^2 / \hbar$ in a plane that is perpendicular to the magnetic moment vector $\mathbf{M}$, about an axis that will be labeled as z. The moment of inertia about this axis is $I_{zz} = \hbar / 2\omega_0$. The conditions of electromagnetic stability preclude axially symmetric solutions, so to introduce the required asymmetry in electron structure, the center of mass of the particle will be assumed to lie at a certain distance smaller than λ_c from its intrinsic axis of rotation.

The second fact is that the electron has a magnetic moment. This vector $\mathbf{M}$ must align itself with the magnetic field of the wave, so the external torque on the particle vanishes, in the same way as the magnetic needle of a compass aligns with the magnetic field of the earth. The magnetic field of the wave oscillates at angular frequency ω, so the magnetic moment vector $\mathbf{M}$ of the electron will be forced to rotate at this same frequency in a plane that contains this vector. The extended electron must rotate at frequency ω about an external axis named y, that does not intersect the charged region, otherwise its rotation will generate a second harmonic of the wave frequency; a phenomena that has not been observed. To avoid second harmonics, it is assumed that the center of charge of the electron is separated at a distance greater than λ_c from this external axis of rotation.

To model the interaction between the intrinsic and external rotations, we assume that the electron must revolve about two perpendicular axes, the equivalent rotational energy associated to the product of inertia I_{yz} about the y and z axes is:

$$W_{yz} = I_{yz}\omega\omega_0$$

The existence of a product of inertia is supported by the lack of symmetry of the electron particle - its center of mass may be at a certain distance from the intrinsic rotational axis - and by the requirement that the rotation forced by the wave is about an axis external to the particle. This rotational energy has the required dependence on ω, so we assume that it represents the energy gained by the extended electron, due to the interaction of its intrinsic angular moment with the rotational movement induced by the wave. As a first guess we assume that the product of inertia is of the order of the equivalent mechanical moment of inertia of the correct spin ring model ($I_{yz} \sim \hbar / 2\omega_0$) so we obtain $W_{yz} \sim \hbar\omega / 2$.

In view of this later result we heuristically assume that the product of inertia is twice the moment of inertia of the correct-spin ring model ($I_{yz} \approx \hbar / \omega_0$) and that the rotational energy associated to this product is totally transformed into kinetic energy when the rotating electron elastically bounces in an obstacle. With these two later assumptions we obtain:

$$W_k = I_{yz}\omega\omega_0 = \hbar\omega$$

To estimate the product of inertia, the mass of the extended electron can be considered to be concentrated at a point that coincides with its center of mass. For example, if this point lies at a distance $\lambda_c / 3$ from its intrinsic z axis and at a distance $3\lambda_c$ from the external y axis, then we obtain $I_{yz} = m_e \lambda_c^2 = \hbar / \omega_0$ and the required value is obtained.

The old classical interpretation of the photoelectric effect is that the electron performs a rotational movement at frequency ω due the force exerted by the magnetic field of the wave on the magnetic moment of the particle. The cross interaction between this forced rotational movement at frequency ω and the intrinsic rotation of the charge at frequency ω_0 - required to assure the stability of the particle - generates a rotational energy $\hbar \cdot \omega$ that is transformed into kinetic energy.

Wher and Richards were wrong when - together with many other authors - they stated without proof that Maxwell's equations fail to account for the photoelectric effect. [18]

B. The Compton Effect

The fact is that when X rays of wavelength λ are scattered at angle θ by materials, a beam of secondary radiation at a frequency $\lambda' = \lambda + \lambda_c(1 - \cos\theta)$ is observed.

The quantum interpretation assumes that the electromagnetic wave is made of particles called photons each one of energy $W_p = \hbar\omega$, so the interaction between the electron and the wave can be modeled mechanically as an elastic collision between an electron and a photon. [18-20]

The old classical interpretation follows Compton [20] in his classical description of the effect that bears his name; it assumes that scattering electrons submerged in an electromagnetic wave of wavelength λ acquire a velocity υ along the direction of propagation of the wave given by $\upsilon / c = 1/(1 + \lambda / \lambda_c)$.

When the equation for the Doppler Effect is considered, the predicted wavelength shift of the secondary scattered radiation is $\lambda' = \lambda + \lambda_c(1 - \cos\theta)$. The observed phenomena are predicted without further assumptions. Compton gives both interpretations in the same prize winning paper, but to compute the intensity of the scattered radiation he uses the classical interpretation, not the quantum interpretation. [20]

Bolles was wrong when he stated - as many other physics authors did - that electrodynamics cannot explain the Compton effect [21]. All these authors do not seem to have been aware of the contents of Compton's paper on the subject. [20]

C. Radiated Spectra of the Hydrogen Atom

The hydrogen spectrum is well described by Bohr's mechanical model of the atom where a point electron circles about the proton, in radial equilibrium between the centrifugal and the electrostatic forces. This mechanical model gave a good prediction of the frequency of the spectral lines, but it violated Maxwell's equations [18,19]. Although in the end this model was not good enough for quantum physics, it is nowadays presented as sufficient evidence to condemn Maxwell's equations in the microscopic domain. Those who follow this weak line of reasoning have overlooked the fact that in Bohr's model the point electron - which is absurd in classical terms - can be replaced by a ring electron; the same equation for radial equilibrium holds, and the same final results are obtained without violating Maxwell's equations.

Hawking is wrong when he states - as many other physics authors do - that classical electrodynamics fails because it is violated by Bohr's model [22]. All these authors do not seem to be aware of Allen's proposal to replace in Bohr's model the point electron by a ring electron [9].

The fact is that when the electron changes between two states that differ in energy by amount $\hbar\omega$, a spectral line of frequency ω is observed. The quantum interpretation is that a photon of energy $\hbar\omega$ is generated; the old classical interpretation is that an extended electromagnetic particle briefly oscillates at frequency ω and generates an electromagnetic pulse of frequency ω.

IV. The Unnecessary Problems

A. Lorentz Transformations and Special Relativity

Lorentz's transformations for the parameters (m, M, S) of an electron moving at a speed υ with respect to an absolute reference frame are well known [23]. All these transformations are automatically satisfied by any electromagnetic electron model, as long as isotropic contraction is assumed; that is; all electron dimensions are reduced by the factor $\sqrt{1 - \upsilon^2 / c^2}$, not just that dimension in the direction of movement.

According to this old classical interpretation, in scattering experiments the effective scattering radius is reduced by the factor $\sqrt{1 - \upsilon^2 / c^2}$. The current upper limit for this radius ($< 10^{-18}$ m) was measured with an energy of 29 GeV, and the mass of the electron at rest is 0.51 MeV, so a reduction factor of $m_e(\upsilon) / m_e(0) \approx 56863$ is expected. Considering isotropic contraction, the current upper limit for the effective scattering radius of the old classical particle at rest is ~ 6×10^{-13} m.

Special relativity assumes point observers and applicability of the free space solution for a spherical wave in the presence of an observer [24]. Both assumptions are invalid; there is no observer that can be fitted into a mathematical point, and, in the presence of any real observer, the free space solution is not applicable. The equations of special relativity may be applicable in an immaterial world with point observers devoid of charge, but not in the real world where the most elementary observer is an extended charged particle whose largest dimension is of order $2\lambda_c$.

B. Planck's Radiation Law and the Discontinuity of the Energy Distribution

Blackbody radiation is well described by a law deducted through a series of steps. The only step that contradicts old classical physics is the assumption that the energy of an oscillator that oscillates at a frequency ω can take only discrete values of $\hbar\omega$. This assumption is stated as "An oscillator that oscillates at a frequency ω can take only a discrete set of possible energy values $\hbar\omega$, $2\hbar\omega$, $3\hbar\omega$, $4\hbar\omega$, ... *et cetera.*" [18,19]

The old classical interpretation to be presented assumes instead that due to sub-harmonic radiation, those oscillators that contribute to radiation at frequency ω, can have energy values that are integer multiples of $\hbar\omega$. The old classical assumption is stated as "The oscillators that radiate at a frequency ω have possible energy values $\hbar\omega$, $2\hbar\omega$, $3\hbar\omega$, $4\hbar\omega$, ... *et cetera.*"

The quantum interpretation assumes that a radiator that is oscillating at a mechanical frequency ω will only radiate at frequency ω. Under this perspective, it is forced to conclude that any electron that oscillates at frequency ω must take energy levels that are equal to an integer multiple of $\hbar\omega$, to contribute to radiation at frequency ω. [18,19]

The old classical interpretation assumes instead that an electron with rotational energy $\hbar\omega$ that oscillates at angular frequency ω takes a period $T_1 = 2\pi / \omega$ to execute is fundamental cycle. Within the blackbody enclosure, this electron will be exposed to the whole range of radiated wavelengths, and will execute synchronous oscillation at those particular frequencies whose periods are an integer multiple of its fundamental period $T_n = nT_1$. Any electron that oscillates at fundamental frequency ω, under the action of external fields will also oscillate at lower frequencies ω / n, radiating therefore at a discrete range of frequencies ω, $\omega / 2$, $\omega / 3$, $\omega / 4$,... *et cetera.*

The energy radiated by the blackbody enclosure at a certain frequency ω should consider all the possible oscillators that can spectrally contribute; this includes the fundamental harmonic of those oscillators that rotate at a frequency ω, the second sub-harmonic of those oscillators that rotate at a frequency 2ω, the third sub-harmonic of those oscillators that rotate a frequency 3ω, *et cetera.*

From the old-classical point of view, only those oscillators that have certain discrete $n\hbar\omega$ energy values will contribute to the radiation at a given frequency ω. This is almost identical to the quantum interpretation, but in this old classical picture the oscillators can attain a continuum of energy values $\hbar\omega$ by oscillating at any possible frequency ω; there are no prohibited energy levels. The illogical assumption of discrete energy levels is totally unnecessary, being replaced by the more logical assumption of sub-harmonic radiation, without affecting the derivation of the law.

Wher and Richards were wrong when - together with many other authors - they stated without proof that Maxwell's equations fail to account for blackbody radiation [18].

C. The Missing Quarter of Electromagnetic Mass

The problem of the missing quarter of electromagnetic mass is unnecessary in the context of the old classical theory; it is peculiar to the physically absurd spherical electron model [2]. The redefinition of electromagnetic momentum by Rohrlich [4] to solve this problem is as unnecessary as the problem that it attempts to solve; it has been resisted in the work of Boyer. [25]

D. Wave Particle Duality

The problem of the wave particle duality is peculiar to the assumption of a point particle [18,19]; when an extended flexible particle is considered, this duality is unnecessary. Bostick gives a graphical example of how an extended electron goes through two slits at the same time [12].

E. Radiation Reaction and Runaway Solutions

The weird assumption of a point particle avoids the problem of the electron structure. When this structure is neglected in the computation of radiation reaction, this automatically leads to weird predictions like the runaway solutions and the violation of causality [2]. When a structure is assumed for the particle, these weird solutions disappear [26]. All the problems obtained due to the point particle assumption are unnecessary; they are Nature's indications that there is a price to be paid for avoiding the necessary problem of the electron structure.

V. Conclusion

Nietzche defined truth as those set of beliefs that are necessary for the preservation of the species. To preserve the ambiguous uncertainty of modern physics it is necessary to reject the logical order of classical physics in the microscopic domain. To preserve old classical physics it is necessary to ignore the weird interpretations of modern physics, and then look with new eyes the raw facts of microscopic phenomena. Table 1 compares the alternative interpretations that modern and old classical physics have to offer to some of the observed facts that have been here considered.

Table 1.
Comparison of Modern and Old Classical Interpretations

Observed facts	Modern interpretation	Old classical interpretation
Electron is stable	Electron is a mathematical point with no structure	Electron has an extended structure in equilibrium
Spherical electron model has many defects	Classical electro-dynamics can not describe the electron	Spherical model is unsuitable to describe the electron
Magnetic moment of electron is $\frac{1}{2}e\lambda_c c$	Electron rotates at speed c on circle of radius λ_c [17]	Charge rotates at speed c within region of radius $\sim\lambda_c$
Electron scattering radius is below 10^{-18} m	Electron is a mathematical point with no structure	Electron of radius $\sim\lambda_c$ has scattering radius $<10^{-18}$ m
Photoeletric effect	Electron absorbs photon of energy $\hbar\omega$	Electron acquires rotational energy $\hbar\omega$
Compton's effect	Electron collides elastically with a photon	Moving electron radiates according to doppler effect
Bohr's model predicts hydrogen spectra	Maxwell's equations are violated by point electron	Maxwell's equations are not violated by ring electron
Hydrogen line spectra at frequency ω	Electron jump generates photon of frequency ω	Electron structure oscillates at frequency ω
Lorentz transformations	Space and time are relative	Moving electrons undergo isotropic contraction
Planck's radiation law	Oscillators can have only discrete energy levels	Oscillators radiate at some discrete wavelengths
Electron behaves both as a particle and as a wave	Electron is dual: can be either a point or a wave	Electron has an extended flexible structure

The revenge of old classical physics against modern physics is not complete; it has just begun. It will be over when one of the following two conditions about the old classical nonlinear equations is rigorously demonstrated:

A. They do not predict the observed properties of isolated elementary particles. This will be an honorable death for old classical physics in the microscopic domain.

B. They predict the observed properties of isolated elementary particles. This will be the joyous rebirth of old classical physics in the microscopic domain.

This paper attempts to cleanse the name of old classical physics and show that this little-known science deserves more respect and further research before a final conclusion about its capability in the microscopic domain can be firmly established. If some readers are persuaded to contribute to this research - or at least to look with a more classical attitude at microscopic phenomena - the objective of this paper has been achieved.

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CORRESPONDENCE

Light Speed Constant. . .(Isn't it?) (cont. from p. 82)

Adhering to principles usually produces better theories, such as occurs in [1]. As Somerset Maugham once said, "The most useful thing about a principle is that it can always be sacrificed to expediency". This is not acceptable in Science, yet SRT apparently found it very useful.

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Action-Reaction in Electrodynamics

This note calls attention to the fact that the reaction effect that a moving electron has on a magnetic field was never considered in the analysis that concludes that mass increases with velocity.

I have been reviewing Walter Kaufmann's experiments of over 100 years ago, which were used as a basis for Einstein's mass increase with velocity assertion. [1] There is nothing wrong with the experiments, but the analysis of them seemed to have excluded the fact that an electron moving in a static magnetic field reduces the force of the magnetic field. It is action-reaction all over again. The field acts on the electron, and the electron acts back on the field, effectively reducing its strength. [2] A weakened field has a contraction factor that has to be applied to it.

Let us first write the equation from SRT

$$B_0 er / v = m_0 \Big/ \sqrt{1 - v^2 / c^2} \qquad (1)$$

According to Carroll [2], the magnetic field has to be diminished by a factor $(1 - v^2 / c^2)$ on account of reaction, so we apply this factor to both sides of the Eq. (1), Cont. on page 97