Scientific Research Publishing

Journal of Applied Mathematics and Physics, 2019, 7, 431-475
http://www.scirp.org/journal/jamp
ISSN Online: 2327-4379
ISSN Print: 2327-4352

The Physics of an Absolute Reference System

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How to cite this paper: Patrinos, K. (2019) The Physics of an Absolute Reference System. *Journal of Applied Mathematics and Physics*, **7**, 431-475.
https://doi.org/10.4236/jamp.2019.73033

Received: February 1, 2019
Accepted: March 5, 2019
Published: March 8, 2019

Abstract

The hypothesis of the absolute reference system, unlike the existing physics theories, is not based on the concept of relativity (that is, it is not based on a relativistic description like Galileo's relativity or Einstein's theory of relativity). The absolute reference system is the framework of material in which any activity in the universe has begun. Also, each inertial reference system is accompanied by a peculiar electromagnetic wave due to the structure of matter. The physics of the absolute system of reference is based on three basic principles. The first of these principles is that the electromagnetic field quantitative estimates are made in the inertial reference system of the source of the electromagnetic field. The second principle is that the basic constituent of matter is "bound photons", which make up the internal structure of the elementary particles. The third principle is that the framework of material of an inertial system undergoes a contraction of length which is a real physical contraction and a corresponding real change in "time flow", not due to the geometry of space-time, but is due to the internal operation of the micro-structure of matter. These principles have the effect of changing the relativistic physical magnitudes, such as velocity, momentum and kinetic energy, into physical magnitudes described as absolute. This theory is consistent with experimental data so far and provides satisfactory answers to physics problems such as dark matter, particle physics experiments to confirm the dynamics, interpretation of experimental results of measurement of neutrinos velocity that are incompatible with the relativity, and magnetic induction experiments which are not explained by the classical electromagnetic theory.

Keywords

Electromagnetic Field and Photons, Neutrino Velocity, Dark Matter, Particle Structure, Aether

1. Introduction

The introduced hypothesis in the present study is the existence of an absolute reference system (something like the known as the "aether reference system", which was considered at the beginning of the 20th century as an incorrect assumption after the Michelson-Morley experiment, ref. [1], chapter 2). We will see in the next section that (based on the relevant conditions set out in the same section) it is not possible, according to this hypothesis to locate the absolute reference system by implementing this experiment. Also at the present work, is considered as a basic criterion of correctness of a theory the agreement between the theoretical results and all the experimental data so far.

We will examine physical phenomena and experiments carried out in an inertial system of reference[1] (possibly in a laboratory in the land reference system), based on the introduced hypothesis of the absolute reference system. This consideration gives a confirmation of the theoretical results relative to the corresponding experimental data, as will be seen below[2].

2. Electromagnetism

The present consideration of electromagnetic equations, is based on the existence of an absolute reference system. Based on Faraday's induction law[3], we will see how the equations of Maxwell's electromagnetic theory are formulated. The system of units, used in this section, is the international (MKSA), as opposed to the reference literature where the system used is Gaussian.

The theoretical analysis in this chapter concerns the study of electromagnetic phenomena, which are observed in an inertial reference system, the frame of reference of electromagnetic interactions, based on the hypothesis of the absolute reference system. The space-time position $(\boldsymbol{r},t)$ refers to the position $\boldsymbol{r}$ of an elementary surface moving at a velocity of $\boldsymbol{u}=\mathrm{d}\boldsymbol{r}/\mathrm{d}t$ relative to the inertial reference system of the physical arrangement which causes the electric and/or magnetic field at the time *t*, where the velocity $\boldsymbol{u}$ and time *t* are measured with the clock and the physical measure of length of the inertial reference system of the experimental setup. This assumption leads to a universality in the formulation of these equations. The resulting expressions for the electric and magnetic fields are independent of the observer reference system, since they depend only on the reference system of the source of electromagnetic field.

2.1. The Electric Field

We first consider a space in which there is a non-homogeneous magnetic field $\boldsymbol{B}(\boldsymbol{r},t)$, which is created by a physical arrangement in the inertial reference system of the laboratory. This magnetic field, generally, is changing in time. The

[1]As an inertial reference system, we consider a reference system with an adapted Cartesian coordinate system, which is moving at constant speed with respect to the absolute reference system, but which includes a physical body and is also characterized by the corresponding "contraction coefficient" of length and time, as shown in the theoretical analysis set out in the following sections.

[2]About experimental confirmation of particle dynamics from the point of view of the hypothesis of absolute reference system see reference [2], Sections 1.3, 2.4 and 3.9.

[3]Reference [3], paragraph **6.1**, **Faraday's Law of Induction**.

elementary magnetic flux $\mathrm{d}\Phi_{mag}$, passing through an elementary surface $\mathrm{d}s$ moving with a velocity $\boldsymbol{u}$, measured with the measuring instruments of the laboratory, is:

$$\mathrm{d}\Phi_{mag} = \boldsymbol{B}(\boldsymbol{r},t)\cdot\hat{\boldsymbol{n}}\mathrm{d}s \tag{2.1}$$

where $\hat{\boldsymbol{n}}$ is the unit normal vector.

The instantaneous rate of change of the elementary magnetic flux through the elementary surface $\mathrm{d}s$, which is obtained using the clock of the inertial reference system of the laboratory, is:

$$\frac{\mathrm{d}}{\mathrm{d}t}\left(\mathrm{d}\Phi_{mag}\right) = \frac{\mathrm{d}\boldsymbol{B}(\boldsymbol{r},t)}{\mathrm{d}t}\cdot\hat{\boldsymbol{n}}\mathrm{d}s \tag{2.2}$$

provided that $\hat{\boldsymbol{n}}$ is independent of space and time, due to its fixed orientation, if there is no rotation. In such a rotation we will refer in the subsection 2.7.

The total instantaneous rate of change of the magnetic flux, through a surface S (which moves with a velocity $\boldsymbol{u}$, without deforming or rotating), at a moment t, always according to the laboratory clock, will be:

$$\frac{\mathrm{d}\Phi_{mag}}{\mathrm{d}t} = \int_S \frac{\mathrm{d}}{\mathrm{d}t}\left(\mathrm{d}\Phi_{mag}\right) = \int_S \frac{\mathrm{d}\boldsymbol{B}(\boldsymbol{r},t)}{\mathrm{d}t}\cdot\hat{\boldsymbol{n}}\mathrm{d}s \tag{2.3}$$

We assume that the surface S is surrounded by the closed curve C. The induced electromotive force along the closed C curve is:

$$E_C = \oint_C \frac{\mathrm{d}W_C}{e} \tag{2.4}$$

where $\mathrm{d}W_C$ is the elementary work of moving the charged particle at a distance $\mathrm{d}\ell$. The calculated electromotive force, at the given moment t, in the inertial reference system of the laboratory and according to the clock of the same reference system, along the C curve, is given by the following relation:

$$E_C = \oint_C \boldsymbol{E}(\boldsymbol{r},t)\cdot\mathrm{d}\ell = -\frac{\mathrm{d}\Phi_{mag}}{\mathrm{d}t} = -\int_S \frac{\mathrm{d}\boldsymbol{B}(\boldsymbol{r},t)}{\mathrm{d}t}\cdot\hat{\boldsymbol{n}}\mathrm{d}s \tag{2.5}$$

where $\boldsymbol{E}(\boldsymbol{r},t)$ the electric field as a function of time and position. Using the Stokes theorem we get a generalized relation for the electric and the magnetic field:

$$\nabla\times\boldsymbol{E} = -\frac{\mathrm{d}\boldsymbol{B}}{\mathrm{d}t} \tag{2.6}$$

Since $\boldsymbol{u} = \mathrm{d}\boldsymbol{r}/\mathrm{d}t$ we get:

$$\frac{\mathrm{d}\boldsymbol{B}(\boldsymbol{r},t)}{\mathrm{d}t} = (\boldsymbol{u}\cdot\nabla)\boldsymbol{B}(\boldsymbol{r},t) + \frac{\partial\boldsymbol{B}(\boldsymbol{r},t)}{\partial t} \tag{2.7}$$

moreover:

$$\nabla\times(\boldsymbol{u}\times\boldsymbol{B}) = -(\boldsymbol{u}\cdot\nabla)\boldsymbol{B} + \boldsymbol{u}(\nabla\cdot\boldsymbol{B}) \tag{2.8}$$

Undoubtedly on any randomly closed surface S, at a given moment t, the total magnetic flux that permeates this surface is zero (that is, $\oint_S \boldsymbol{B}(\boldsymbol{r},t)\cdot\hat{\boldsymbol{n}}\mathrm{d}s = 0$), therefore $\nabla\cdot\boldsymbol{B} = 0$ and this is consistent with the known expression:

$$\boldsymbol{B} = \nabla \times \boldsymbol{A} \tag{2.9}$$

The resulting differential equation takes the form of:

$$\nabla \times \boldsymbol{E} = \nabla \times (\boldsymbol{u} \times \boldsymbol{B}) - \frac{\partial \boldsymbol{B}}{\partial t} \tag{2.10}$$

According to the last two relations, the expression for the electric field is:

$$\boldsymbol{E} = -\nabla \phi - \frac{\partial \boldsymbol{A}}{\partial t} + \boldsymbol{u} \times \boldsymbol{B} \tag{2.11}$$

The quantity ϕ is a scalar electric potential, which can also be derived from any existing distribution of electric charge in the space, corresponding to a volume charge density ρ, at a particular spacetime position $(\boldsymbol{r}, t)$.

2.2. The Magnetic Field

We assume here the existence of a non-homogeneous and time-varying electric field $\boldsymbol{E}(\boldsymbol{r}, t)$, produced by a physical arrangement in the inertial reference system of the laboratory. The elementary electrical flow $\mathrm{d}\Phi_{elec}$, passing through an elementary surface $\mathrm{d}s$ moving at a velocity $\boldsymbol{u}$, measured with the measuring instruments of the laboratory, is:

$$\mathrm{d}\Phi_{elec} = \boldsymbol{D}(\boldsymbol{r}, t) \cdot \hat{\boldsymbol{n}} \mathrm{d}s \tag{2.12}$$

where $\hat{\boldsymbol{n}}$ the unit normal vector, $\boldsymbol{D} = \epsilon_0 \boldsymbol{E}$, and ϵ_0 the vacuum dielectric constant. The instantaneous rate of change of the elementary electric flux through the elementary surface $\mathrm{d}s$ is:

$$\frac{\mathrm{d}}{\mathrm{d}t}(\mathrm{d}\Phi_{elec}) = \frac{\mathrm{d}\boldsymbol{D}(\boldsymbol{r}, t)}{\mathrm{d}t} \cdot \hat{\boldsymbol{n}} \mathrm{d}s \tag{2.13}$$

and therefore in analogy to the calculation of the electromotive force previously defined in the preceding section, we define the magnetomotive force $\oint \boldsymbol{H} \cdot \mathrm{d}\ell$ as the instantaneous rate of change of the electric flux, according to the following relation:

$$\oint_C \boldsymbol{H} \cdot \mathrm{d}\ell = \frac{\mathrm{d}\Phi_{elec}}{\mathrm{d}t} = \epsilon_0 \int_S \frac{\mathrm{d}\boldsymbol{E}}{\mathrm{d}t} \cdot \hat{\boldsymbol{n}} \mathrm{d}s \tag{2.14}$$

From this relation, and also the known expressions $\boldsymbol{B} = \mu_0 \boldsymbol{H}$ and $\epsilon_0 \mu_0 = 1/c^2$, we get the following generalized relation for magnetic and electric field:

$$\nabla \times \boldsymbol{B} = \frac{1}{c^2} \frac{\mathrm{d}\boldsymbol{E}}{\mathrm{d}t} \tag{2.15}$$

while for the total derivative of electric field:

$$\frac{\mathrm{d}\boldsymbol{E}}{\mathrm{d}t} = \boldsymbol{u}(\nabla \cdot \boldsymbol{E}) - \nabla \times (\boldsymbol{u} \times \boldsymbol{E}) + \frac{\partial \boldsymbol{E}}{\partial t} \tag{2.16}$$

Taking into account the relations $\nabla \cdot \boldsymbol{E} = \rho/\epsilon_0$ and $\boldsymbol{j} = \rho \boldsymbol{u}$ (ρ is the charge density per unit volume, $\boldsymbol{j}$ is the current density), we get the differential equation:

$$\nabla\times\boldsymbol{B}=\mu_0\boldsymbol{j}-\frac{1}{c^2}\nabla\times(\boldsymbol{u}\times\boldsymbol{E})+\frac{1}{c^2}\frac{\partial\boldsymbol{E}}{\partial t}\tag{2.17}$$

The dot product of ∇ and each member of last equation, give us the equation of continuity:

$$\nabla\cdot\boldsymbol{j}+\frac{\partial\rho}{\partial t}=0\tag{2.18}$$

2.3. Correlation with Maxwell Equations

As can be seen from the Equations (2.6) and (2.15) the electric field can be attributed as a rate of change of the magnetic field and vice versa. But there is something that differentiates this image. The expression (2.11) for the electric field includes the term $-\nabla\phi$, which is attributed to the existence of electric charge. A corresponding term does not exist in the expression (2.17), except for the term $\mu_0\boldsymbol{j}$, which is attributable to electric charge movement and there is no magnetic monopole (that is, there is no a net "magnetic charge"). Therefore, the primary field is electric, while the magnetic field is generated by the changing electric field, or by the motion relative to the source of the electric field.

Also, from the Equations (2.6) and (2.15), the following differential equations for the electric and magnetic field arise:

$$\nabla\times(\nabla\times\boldsymbol{E})+\frac{1}{c^2}\frac{\mathrm{d}^2\boldsymbol{E}}{\mathrm{d}t^2}=0\tag{2.19}$$

$$\nabla\times(\nabla\times\boldsymbol{B})+\frac{1}{c^2}\frac{\mathrm{d}^2\boldsymbol{B}}{\mathrm{d}t^2}=0\tag{2.20}$$

In a random but stable position $\boldsymbol{r}$, that is $\mathrm{d}\boldsymbol{r}/\mathrm{d}t=0$, if there is no electric charge in that position, which means $\nabla\cdot\boldsymbol{E}=0$, the last two relations result in the following wave equations[4]:

$$\nabla^2\boldsymbol{E}-\frac{1}{c^2}\frac{\partial^2\boldsymbol{E}}{\partial t^2}=0\tag{2.21}$$

$$\nabla^2\boldsymbol{B}-\frac{1}{c^2}\frac{\partial^2\boldsymbol{B}}{\partial t^2}=0\tag{2.22}$$

A more elegant form for the expressions of electric and magnetic field arises by defining two quantities of electric and magnetic field $\boldsymbol{E}_M$ and $\boldsymbol{B}_M$ which are the Maxwell's classical expressions for the electric and the magnetic field[5], according to the following equations:

$$\boldsymbol{E}_M=-\nabla\phi-\frac{\partial\boldsymbol{A}}{\partial t}\tag{2.23}$$

$$\nabla\times\boldsymbol{B}_M=\mu_0\boldsymbol{j}+\frac{1}{c^2}\frac{\partial\boldsymbol{E}}{\partial t}\tag{2.24}$$

[4]The corresponding equations for a medium which is homogeneous are in reference [4], paragraph **1.2, THE WAVE EQUATION AND THE VELOCITY OF LITE** (Equation (7)).

[5]Ref. [3], paragraph **6.3**, **Maxwell's Displacement Current, Maxwell Equations** and paragraph **6.4**, **Vector and Scalar Potentials**.

Using the last two equations, we get the following expressions:

$$\boldsymbol{E} = \boldsymbol{E}_M + \boldsymbol{u} \times \boldsymbol{B} \tag{2.25}$$

$$\boldsymbol{B} = \boldsymbol{B}_M - \frac{1}{c^2}\boldsymbol{u} \times \boldsymbol{E} \tag{2.26}$$

Considering that the symbol $\parallel$ refers to component of electric or magnetic field which is parallel to the velocity $\boldsymbol{u}$, while the symbol $\perp$ refers to component which is perpendicular to the velocity $\boldsymbol{u}$, and that $\gamma = \left(1 - \boldsymbol{u}^2/c^2\right)^{-1/2}$, the following expressions for the electric and magnetic field are taken:

$$\boldsymbol{E}_\parallel = \boldsymbol{E}_{M\parallel} \tag{2.27}$$

$$\boldsymbol{E}_\perp = \gamma^2 \left(\boldsymbol{E}_{M\perp} + \boldsymbol{u} \times \boldsymbol{B}_M\right) \tag{2.28}$$

$$\boldsymbol{B}_\parallel = \boldsymbol{B}_{M\parallel} \tag{2.29}$$

$$\boldsymbol{B}_\perp = \gamma^2 \left(\boldsymbol{B}_{M\perp} - \frac{1}{c^2}\boldsymbol{u} \times \boldsymbol{E}_M\right) \tag{2.30}$$

It is clear that the electromagnetic field expressions $\boldsymbol{E}$, $\boldsymbol{B}$ and $\boldsymbol{E}_M$, $\boldsymbol{B}_M$ differ because the expressions of $\boldsymbol{E}$, $\boldsymbol{B}$ depend on the velocity $\boldsymbol{u}$, *i.e.* they include the kinematic terms $\boldsymbol{u} \times \boldsymbol{B}_M$, $-\frac{1}{c^2}\boldsymbol{u} \times \boldsymbol{E}_M$, and the factor γ^2, while the expressions of $\boldsymbol{E}_M$, $\boldsymbol{B}_M$ are not dependent on the velocity $\boldsymbol{u}$ and are the corresponding expressions for a charged particle that is being in the inertial system of the source of the electromagnetic field, that is $\boldsymbol{u} = 0$.

2.4. Electromagnetic Field and Photons

For an elementary photonic electromagnetic wave the solution of the Equation (2.21) for the electric field of a photon is in the form:

$$\boldsymbol{E}_{ph} = \boldsymbol{E}_{ph0} \mathrm{e}^{i(\boldsymbol{k} \cdot \boldsymbol{r} - \omega t)} \tag{2.31}$$

where $\boldsymbol{k}$ is the wave vector and $\boldsymbol{E}_{ph0}$ the amplitude vector of the photon electric field. If we consider that Z axis of a Cartesian coordinate system is in the direction of the vector $\boldsymbol{k}$, then the electric field can divided into two components, namely the x component and the y component:

$$\boldsymbol{E}_{phx} = \boldsymbol{E}_{ph0x} \mathrm{e}^{i(kz - \omega t + \delta)}$$

$$\boldsymbol{E}_{phy} = \boldsymbol{E}_{ph0y} \mathrm{e}^{i(kz - \omega t)}$$

where the amplitudes and the relative phase δ between the two components are initially arbitrarily defined. For example if $\delta = 0$ the polarization is linear, while if $\delta = \pi/2$ and $\boldsymbol{E}_{ph0x} = \boldsymbol{E}_{ph0y}$ the polarization is circular (see [5], chapter **3**, paragraph **3.6.2 The electromagnetic Field and Photons**).

In a Coulomb field derived from an elementary charged particle, the motion of the photons that are force carriers of electrostatic interactions must be identical for all photons. We define as quantities with index i the quantities which correspond to a photonic wavelength λ_i. Also, we consider that the radial component of the speed of photonic quanta, with respect to a Cartesian coordinate system whose axis of origin is at the center of mass of the above-mentioned elementary particle, is $u = \mathrm{d}r/\mathrm{d}t$, and their emission rate, for a wavelength λ_i, is constant and equal to:

$$R_i = \frac{\mathrm{d}N_i}{\mathrm{d}\Omega \mathrm{d}t} \tag{2.32}$$

where $\mathrm{d}N_i$ is the number of photons of wavelength λ_i, in a differential solid angle $\mathrm{d}\Omega$, in a differential time period $\mathrm{d}t$. We define the constant quantity η_i equal to $\mathrm{d}N_i/(\mathrm{d}r\mathrm{d}\Omega) = R_i/u$. The density of the photonic quanta, for a particular wavelength λ_i, in a differential volume $\mathrm{d}V$ is:

$$\rho_i = \frac{\mathrm{d}N_i}{\mathrm{d}V} = \frac{\mathrm{d}N_i}{r^2 \mathrm{d}r\mathrm{d}\Omega} = \frac{\eta_i}{r^2} \tag{2.33}$$

We now assume that in a fixed small volume δV, for a particular wavelength λ_i, there are δN_i photons that are force carriers of electrostatic interactions. The wave vector, for each photonic quantum, is equal to $\boldsymbol{k}_i$, and the corresponding photonic quantum mass is equal to m_{ph_i}.

Because of the spherical symmetry, the total electric field is in the radial direction. We define the quantity $E_{ph0_{ri}}$ as the radial component of the amplitude vector of the photon electric field. The sum of all elementary electric fields in volume δV, for a particular wavelength $\lambda_i = 2\pi/k_i$, is given by the equation:

$$E_{s_i} = E_{ph0_{ri}} \sum_{j=1}^{\delta N_i} \mathrm{e}^{i(\boldsymbol{k}_i \cdot \boldsymbol{r} - \omega_i t + \delta_j)} = \delta N_i E_{ph0_r} \mathrm{e}^{i(\boldsymbol{k}_i \cdot \boldsymbol{r} - \omega_i t + \delta)} \tag{2.34}$$

where $\mathrm{e}^{i\delta} = \left(\sum_{j=1}^{\delta N_i} \mathrm{e}^{i\delta_j}\right)/\delta N_i$.

Therefore, the electric field E_i at one point, for a particular wavelength λ_i, will be given by the relation:

$$E_i = A\rho_i E_{ph0_{ri}} \mathrm{e}^{i(\boldsymbol{k}_i \cdot \boldsymbol{r} - \omega_i t + \delta)} \tag{2.35}$$

where A is a constant quantity. The real part of the electric field E_i is

$$E_{i,r} = A\rho_i E_{ph0_{ri}} \cos(\boldsymbol{k}_i \cdot \boldsymbol{r} - \omega_i t + \delta) \tag{2.36}$$

The effective value $E_{i,ef}$ of the electric field E_i, that comes from the time-mean-value of the quantity $E_{i,r}^2$, is given by the equation:

$$E_{i,ef} = \frac{1}{\sqrt{2}} A\rho_i E_{ph0_{ri}} \tag{2.37}$$

We assume that a photonic quantum occupies a volume equal to v_{ph_i}. Therefore, the density $\mathcal{E}$ of the transmitted kinetic energy[6] of the photonic quantum is equal to $(\hbar k_{r_i})^2/(2m_{ph_i} v_{ph_i})$, where k_{r_i} is the radial component of $\boldsymbol{k}_i$. According to the known relation $\mathcal{E} = (1/2)\epsilon_0 E_{ph0_{ri}}^2$ we get

$$E_{ph0_{ri}} = \frac{\hbar k_{r_i}}{\sqrt{\epsilon_0 m_{ph_i} v_{ph_i}}} \tag{2.38}$$

where ϵ_0 is the dielectric constant of the vacuum. Since the magnitude of the

[6]On photonic momentum and energy we will refer in detail in Section 4.

radial component of the wave vector is $k_{r_i} = \boldsymbol{k}_i \cdot \boldsymbol{r}/r$, the total electric field for a particular wavelength $\lambda_i = 2\pi/k_i$ is given by the equation:

$$E_i = g_i \frac{\boldsymbol{k}_i \cdot \boldsymbol{r}}{r^3} \mathrm{e}^{i(\boldsymbol{k}_i \cdot \boldsymbol{r} - \omega_i t + \delta)} \tag{2.39}$$

where g_i is a constant quantity, and is given by the relation:

$$g_i = \frac{A\eta_i \hbar}{\sqrt{2\epsilon_0 m_{ph_i} v_{ph_i}}} \tag{2.40}$$

The total electric field is:

$$E = \sum_i E_i \tag{2.41}$$

To see under what conditions this last expression of the total electric field is a solution of the Equation (2.21), we have to calculate the quantity $\nabla^2 E_i - \frac{1}{c^2}\frac{\partial^2 E_i}{\partial t^2}$. For a particular wavelength $\lambda = 2\pi/k$ the corresponding electric field is:

$$E_\lambda = g \frac{\boldsymbol{k} \cdot \boldsymbol{r}}{r^3} \mathrm{e}^{i(\boldsymbol{k} \cdot \boldsymbol{r} - \omega t + \delta)} \tag{2.42}$$

and the resulting relations are:

$$\nabla^2 E_\lambda = g\left(-\frac{6i(\boldsymbol{k} \cdot \boldsymbol{r})^2}{r^5} + \frac{2ik^2}{r^3}\right)\mathrm{e}^{i(\boldsymbol{k} \cdot \boldsymbol{r} - \omega t + \delta)} - k^2 E_\lambda$$

$$-\frac{1}{c^2}\frac{\partial^2 E_\lambda}{\partial t^2} = \frac{\omega^2}{c^2} E_\lambda$$

Therefore since $k^2 = \omega^2/c^2$ and according to relation 2.21 we get the equality $3(\boldsymbol{k} \cdot \boldsymbol{r})^2 = (kr)^2$. So, by defining $\boldsymbol{k} = \boldsymbol{k}_r + \boldsymbol{k}_v$ and $k_r = |\boldsymbol{k}_r|$, $k_v = |\boldsymbol{k}_v|$, where $\boldsymbol{k}_r$ is the radial component of $\boldsymbol{k}$ and $\boldsymbol{k}_v$ is the perpendicular to the radial component, the k_v is related to k_r as follows:

$$k_v = \sqrt{2} k_r \tag{2.43}$$

The interpretation of this result is that the motion of a photonic quantum, that is a force carrier, in the Coulomb field is a synthesis of two motions, one of which is radial and one perpendicular to it. Therefore, since the component of photon momentum, which is perpendicular to the radial component of motion, is equal to $\hbar\boldsymbol{k}_v$, there is a corresponding angular momentum. Because of the spherical symmetry, the vector of resultant angular momentum is parallel to the direction of radial component of motion. Therefore the motion of the photonic quantum is a helical motion with its axis parallel to the radial component of motion, with momentum equal to $\hbar\boldsymbol{k}$, and velocity equal to the speed of light in the vacuum *c*. Also, the angular frequency ω is divided into two angular frequencies, one that corresponds to the radial motion equal to ω_r, and another that corresponds to the circular motion equal to ω_v. The frequency that corresponds to the circular motion leads to a stationary wave.

We define as u the radial component of the velocity and as v the vertical component. So, according to the above, taking into account the relations

$c=|\boldsymbol{u}+\boldsymbol{v}|$, $k^2=k_r^2+k_v^2$, $k_r u=\omega_r$, $k_v v=\omega_v$, the following relations will apply:

$$k=\sqrt{3}k_r=\sqrt{\frac{3}{2}}k_v$$
$$\omega_v=2\omega_r \tag{2.44}$$
$$c=\sqrt{3}u=\sqrt{\frac{3}{2}}v$$

This whole picture is no other than that of a bound photon, which is referred to as the smallest elementary particle[7] and constitutes the smallest structural element of matter. The bound photon has a velocity of u and contributes to the radial component of the electric field, which is the Coulomb field. This elementary particle is also the force carrier of electromagnetic interactions.

2.4.1. Contraction of Length and Time

Let us examine an example, where we assume that the previous mentioned bound photon is a part of a particle, and that the orbit of the particle has the shape of a closed orbit in space, with respect to a coordinate system $\boldsymbol{X}YZ$ in the absolute reference system. Also we assume that, in a second case, in addition to the previous orbit, the particle appears to be moving with respect to the absolute reference system, with an extra constant velocity $\boldsymbol{u}$ parallel to the X axis. The moving particle in the second case, defines an inertial system of reference to which is fitted a coordinate system $\boldsymbol{X'Y'Z'}$.

We will calculate the total passage time of the photon through the closed orbit in the first case and the corresponding total time when it has acquired an extra velocity $\boldsymbol{u}$ with respect to the absolute reference system. We consider that the geometric shape and dimensions of the closed orbit in the second case contracts in the direction of the velocity $\boldsymbol{u}$ with respect to that of the absolute reference system, according to the Lorentz's contraction. A differential segment $\mathrm{d}\ell_0$ of the closed orbit of the bound photon (in the first case) in the absolute reference system ($\boldsymbol{X}YZ$) and a corresponding differential segment $\mathrm{d}\ell$ (in the second case) in the inertial reference system ($\boldsymbol{X'Y'Z'}$) will be correlated as follows:

$$\mathrm{d}\ell_0^2=\mathrm{d}\ell^2\left(\sin^2\theta+\gamma^2\cos^2\theta\right) \tag{2.45}$$

were $\gamma=\left(1-u^2/c^2\right)^{-1/2}$. The corresponding differential length $\mathrm{d}\ell'$ of the path of the bound photon, in the second case, as shown in the absolute reference system, will be:

$$\mathrm{d}\ell'=\mathrm{d}\ell+\boldsymbol{u}\mathrm{d}\tau \tag{2.46}$$

where $\mathrm{d}\tau$ is the differential time of the moving of the photon along the differential distance $\mathrm{d}\ell'$, measured by a clock in the absolute reference system. According to the relation (2.46) we will have:

$$\mathrm{d}\ell'^2=\mathrm{d}\ell^2+u^2\mathrm{d}\tau^2+2u\mathrm{d}\ell\mathrm{d}\tau\cos\theta \tag{2.47}$$

[7]Concerning the structure of the bound photons, an extensive reference is made to the subsection 4.1.

Since the photon has been moved at a distance $\mathrm{d}\ell'$, in the time interval $\mathrm{d}\tau$, and the measurement is done in the absolute reference system, according to the relation $\mathrm{d}\tau = \mathrm{d}\ell'/c$ the last equation takes the form:

$$\mathrm{d}\ell' = \gamma^2 \frac{u}{c} \mathrm{d}\ell \cos\theta + \gamma \mathrm{d}\ell \sqrt{\sin^2\theta + \gamma^2 \cos^2\theta} \tag{2.48}$$

In these circumstances, the closed integral of the first term of the second member of the previous equation will be $\oint \gamma^2 \frac{u}{c} \mathrm{d}\ell \cos\theta = 0$, so the calculated time is:

$$T = \frac{\gamma}{c} \oint \mathrm{d}\ell \sqrt{\sin^2\theta + \gamma^2 \cos^2\theta} \tag{2.49}$$

The corresponding calculated time, in the absolute reference system (in the first case), is:

$$T_0 = \frac{1}{c} \oint \mathrm{d}\ell_0 \tag{2.50}$$

From the last relation and relation (2.49), the total time for moving of the bound photon through the closed orbit in the second case, is:

$$T = \frac{\gamma}{c} \oint \mathrm{d}\ell_0 \tag{2.51}$$

The resulting correlation between the estimated total times is:

$$T = \gamma T_0 \tag{2.52}$$

According to hypothesis of absolute reference system all particles have bound-photons as structural components and they exhibit wave behavior. The contraction of length is accompanied by this wave behavior. As can be seen from the preceding example of calculating the total time for moving of the bound photon through a closed orbit, if we transfer this image to the structural elements of the particles, then the physical contraction of length and time will entirely occur in the inertial reference system.

But there is one substance, the aether, which has the property of an elastic medium which is distributed in the universe. Matter and energy owe their existence to this elastic behavior of this substance. In particular, photons, electromagnetic waves and fields are oscillations which propagate in this substance, and its elasticity is the cause of photon capture within the particle space, such as an elastic membrane oscillating at various points in coordination. Therefore, since the particles are composed of bound photons, they are included in this oscillating elastic medium.

However, the contraction of length is not perceived by an observer of an inertial frame of reference, due to the corresponding contraction of the natural measure of length. Considering as the unit of time the calculated time of the closed trajectory of the previous example, since the clock of the inertial system will operate at a corresponding slower rate, the speed of a bound photon in the vacuum is again measured equal to the known value c.

This result is also used in the next subsection where the Doppler effect is being considered. Also, the movement of the "bound photons", which are structural elements of the particles, is a synthesis of the transporting movements (due to the move of the particles), and internal motions (in the inner particle space). These internal motions are considered as closed trajectories in the corresponding inertial frame of reference.

It is obvious that such a closed trajectory of a photon is inconceivable in modern physics, but such a kind of trajectory is not at all observable (since the only observable photons are the "free photons", which are propagated in a straight line).

Since the rate of operation of time gauges in the inertial reference system of our example is γ times slower, this will result in a slowing of energy exchanges of the particles with the environment, resulting in longer life spans of these particles. The contraction rule will also apply to a photon emitted by a source in the inertial reference system, but also to a field. Also, a clock in the absolute reference system will show γ times more time than a clock on the inertial frame of reference, provided that the two clocks were initially synchronized and we then correlate their indications at any time[8].

Therefore, according to all the above, the actual contraction, in which the contraction factor is γ, relates not only to matter but also to the fields. The image of the dynamic lines of an electric field of an elementary electric charge located in the inertial frame of reference, for an observer in the absolute reference system, will be an image that resulting from contraction. However, for the observer in this inertial system, the image of the electric field remains unchanged, as if it has not been contracted, since the physical measure of length is contracted, according to the same contraction factor γ. The locations and distances that are estimated during observation of a physical phenomenon are determined with the physical measure of length of his inertial system, so no contraction is observed. Under these conditions, *all physical phenomena apply to any inertial frame of reference*, *without taking into account or perceiving physical contraction in these inertial systems*.

Therefore, all inertial frames of reference are equivalent in terms of all physical phenomena. For example, the Michelson-Morley experiment[9] will give the same results to any inertial reference system, thus excluding the possibility of measuring Earth's speed with respect to the absolute reference system, using this method.

The equivalence of all reference systems here is not due to space-time transformations, such as the Lorentz or Galileo transformations, but to the structure

[8]The relativity of simultaneity, and the special theory of relativity in the whole, is not taken into account here, since our initial assumption is based on the existence of an absolute reference system. We accept here that two simultaneous events in a reference system will be simultaneous in any other reference system.

[9]Ref. [1], chapter 2 **Perplexities in the propagation of light**, **PRELUDE TO THE MICHELSON-MORLEY EXPERIMENT** and chapter 3 **Einstein and the Lorentz-Einstein transformations**, **PREAMBLE: THE CONTRACTION HYPOTHESIS**.

of matter and to purely physical causes as are described in this section and in the following sections.

2.4.2. The Charge and the Force Carrier of Electromagnetic Interactions

The scope of this subsection is the quantification of charge of a particle and the study of microstructure and operation of the force carrier. According to the relations 2.37 and 2.38 the effective electric field, for a particular wavelength λ_i, is

$$E_{i,ef} = \frac{A\hbar}{r^2}\frac{\eta_i k_{r_i}}{\sqrt{2\epsilon_0 m_{ph_i} v_{ph_i}}} \tag{2.53}$$

Therefore, the Coulomb field is given by the relation:

$$\frac{q}{4\pi\epsilon_0 r^2} = \frac{A\hbar}{r^2}\sum_i \frac{\eta_i k_{r_i}}{\sqrt{2\epsilon_0 m_{ph_i} v_{ph_i}}} \tag{2.54}$$

and the charge q of the above mentioned particle is

$$q = 4\pi A\hbar \sum_i n_i k_{r_i}\sqrt{\frac{\epsilon_0}{2m_{ph_i} v_{ph_i}}} \tag{2.55}$$

Since $k_{r_i}/u = k_i/c$ and $\eta_i = R_i/u$, the following relation is derived for the electric charge:

$$q = \frac{4\pi A\hbar}{c}\sum_i R_i k_i \sqrt{\frac{\epsilon_0}{2m_{ph_i} v_{ph_i}}} \tag{2.56}$$

If $\mathrm{d}N_{tot_i}$ is the total number of emitted photonic quanta that come from the charge q in time $\mathrm{d}t$, then the emission rate R_i can be given by the equation:

$$R_i = \frac{\mathrm{d}N_i}{\mathrm{d}\Omega \mathrm{d}t} = \frac{\mathrm{d}N_{tot_i}}{4\pi \mathrm{d}t} \tag{2.57}$$

Therefore, the charge is given by the equation:

$$q = \frac{A\hbar}{c}\sum_i k_i \frac{\mathrm{d}N_{tot_i}}{\mathrm{d}t}\sqrt{\frac{\epsilon_0}{2m_{ph_i} v_{ph_i}}} \tag{2.58}$$

According to the last equation, the electric charge of the elementary particle is independent of the inertial reference system to which it belongs and is at rest with respect to it.

However, a charged particle belonging to an inertial system of reference moving at a velocity of $\boldsymbol{v}$ with respect to the inertial reference system of the laboratory, will have electric charge less than that measured in the reference system to which it belongs. This is due to the fact that the emission rate of the photonic quanta, that comes from a charged particle moving at a velocity of $\boldsymbol{v}$ with respect to the laboratory, when it is measured with the clock of the laboratory, is less than the corresponding rate of emission that comes from the charge that is at rest in the laboratory. In particular a differential time interval $\mathrm{d}t$ measured by the clock of the laboratory, in accordance with the clock of the moving charged particle is equal to $\mathrm{d}t_v = \mathrm{d}t/\gamma_v$, where $\gamma_v = \left(1-\boldsymbol{v}^2/c^2\right)^{-1/2}$. The number of photonic quanta emitted by the moving charged particle is denoted by

$\mathrm{d}N_{tot,\boldsymbol{v}_i}$, while the number of photonic quanta emitted by the charged particle which is at rest in the laboratory is denoted by $\mathrm{d}N_{tot_i}$. If the rate that comes from charged particle moving at a velocity of $\boldsymbol{v}$ with respect to the laboratory, which is measured with the clock of the laboratory, is denoted by $R_{i_{\boldsymbol{v}}}$ and the rate that comes from the charge that is at rest in the laboratory, which is also measured with the laboratory clock, is denoted by R_i, using the relation 2.57 the following relation is obtained:

$$\frac{R_{i_{\boldsymbol{v}}}}{R_i} = \frac{\dfrac{\mathrm{d}N_{tot,\boldsymbol{v}_i}}{4\pi \mathrm{d}t}}{\dfrac{\mathrm{d}N_{tot_i}}{4\pi \mathrm{d}t}} = \frac{\mathrm{d}N_{tot,\boldsymbol{v}_i}}{\mathrm{d}N_{tot_i}} = \frac{1}{\gamma_{\boldsymbol{v}}} \tag{2.59}$$

since $R_i = \dfrac{\mathrm{d}N_{tot,\boldsymbol{v}_i}}{4\pi \mathrm{d}t_{\boldsymbol{v}}} = \dfrac{\mathrm{d}N_{tot_i}}{4\pi \mathrm{d}t}$. Therefore, we obtain the following relation for the electric charge:

$$\frac{q_{\boldsymbol{v}}}{q} = \frac{1}{\gamma_{\boldsymbol{v}}} \tag{2.60}$$

where $q_{\boldsymbol{v}}$ is the charge moving at a velocity of $\boldsymbol{v}$ with respect to the laboratory, and q is the charge that is at rest in the laboratory. Therefore, a supposed electric field $\boldsymbol{E}$ in the laboratory reference system exerts a force on the charge $q_{\boldsymbol{v}}$, given by the equation:

$$\boldsymbol{F} = q_{\boldsymbol{v}} \boldsymbol{E} = \frac{q}{\gamma_{\boldsymbol{v}}} \boldsymbol{E} \tag{2.61}$$

Now, for a photonic quantum which is a force carrier, we will denote the radial angular momentum by $\boldsymbol{L}_r$. Also, we will denote the radial momentum by $\boldsymbol{p}_r$. Based on the above, the vectors $\boldsymbol{L}_r$ and $\boldsymbol{p}_r$ are given by the equations $\boldsymbol{L}_r = \hbar \boldsymbol{r}_v \times \boldsymbol{k}_v$ and $\boldsymbol{p}_r = \hbar \boldsymbol{k}_r$, and their magnitudes are $L_r = \hbar r_v k_v$ and $p_r = \hbar k_r$ respectively. If the sign of quantity $\boldsymbol{L}_r \cdot \boldsymbol{p}_r / (L_r p_r)$ is positive, then the photonic quantum comes from a positive charge, and if it is negative, then it comes from a negative charge, that is, the rotational motion of the photonic quantum is clockwise in the field of a positive charge and anticlockwise in the field of a negative charge.

Two charged particles interact through the exchange of the aforementioned photonic quanta. A photonic quantum derived from a positive charge can be absorbed by another positively charged particle, with simultaneous momentum transfer equal to $\hbar k_r$. Therefore the force in this case is repulsive. The same photonic quantum can be initially absorbed by a negatively charged particle, but immediately afterwards it is emitted together with a released photon of the same wavelength, in the direction of motion of the original photonic quantum. In this case, the initially transmitted momentum due to absorption is equal to $\hbar k_r$, but an opposite momentum equal to $-2\hbar k_r$, due to the emission, must be added. Therefore the total momentum is negative, equal to $-\hbar k_r$, and the force in this case is attractive, but the absolute value of this force is equal to the absolute value of the aforementioned repulsive force.

2.5. Charge in the Electromagnetic Field

We will examine now, as an example, the Lagrangian function of a charged particle moving within an electromagnetic field, at a velocity that is far less than the velocity of light in the vacuum. In this case the Lagrangian function is, in its general form, $\mathcal{L} = T - V(\boldsymbol{r}, \dot{\boldsymbol{r}}, t) = (1/2) m\dot{\boldsymbol{r}}^2 - V(\boldsymbol{r}, \dot{\boldsymbol{r}}, t)$, where $\dot{\boldsymbol{r}} = \mathrm{d}\boldsymbol{r}/\mathrm{d}t$ is the velocity of the charged particle relative to the reference laboratory system (that is, in this case, relative to the inertial reference system of the source of the electromagnetic field), T and V is the kinetic and dynamic energy of the charged particle respectively, and t is the time measured by the clock of the laboratory reference system. The Lagrangian equation is:

$$m\ddot{\boldsymbol{r}} - \frac{\mathrm{d}}{\mathrm{d}t}\frac{\partial V}{\partial \dot{\boldsymbol{r}}} + \nabla V = 0 \tag{2.62}$$

On the basis of the relationship (2.6) the electric field is $\boldsymbol{E} = -\nabla\phi - \mathrm{d}\boldsymbol{A}/\mathrm{d}t$, where $\boldsymbol{A}$ is the potential of magnetic field, and therefore the force exerted on the charged particle is:

$$\boldsymbol{F} = m\ddot{\boldsymbol{r}} = e\boldsymbol{E} = -e\nabla\phi - e\frac{\mathrm{d}\boldsymbol{A}}{\mathrm{d}t} \tag{2.63}$$

where e is the charge of the particle. In order to be the last two relations in agreement, the equation $\partial V/\partial \dot{\boldsymbol{r}} = -e\boldsymbol{A}$ must be valid. The resulting for the dynamic energy relation is:

$$V = -e\dot{\boldsymbol{r}} \cdot \boldsymbol{A} + f(\boldsymbol{r}, t) \tag{2.64}$$

where $f(\boldsymbol{r}, t)$ is a scalar quantity, which depends on location and time, but not on the velocity $\dot{\boldsymbol{r}}$. By replacing this expression of dynamic energy in the Lagrange equation, and using the identities:

$$(\dot{\boldsymbol{r}} \cdot \nabla)\boldsymbol{A} = \nabla(\dot{\boldsymbol{r}} \cdot \boldsymbol{A}) - \dot{\boldsymbol{r}} \times (\nabla \times \boldsymbol{A})$$

$$\frac{\mathrm{d}}{\mathrm{d}t} = \dot{\boldsymbol{r}} \cdot \nabla + \frac{\partial}{\partial t}$$

is obtained the following equation:

$$m\ddot{\boldsymbol{r}} = -\nabla f(\boldsymbol{r}, t) + e\dot{\boldsymbol{r}} \times \boldsymbol{B} - e\frac{\partial \boldsymbol{A}}{\partial t} \tag{2.65}$$

Also because of the relations $\boldsymbol{E} = -\nabla\phi + \dot{\boldsymbol{r}} \times \boldsymbol{B} - \partial\boldsymbol{A}/\partial t$ and (2.63), the scalar quantity $f(\boldsymbol{r}, t)$ can be considered equal to $e\phi$. Therefore, dynamic energy is defined as:

$$V = e\phi - e\dot{\boldsymbol{r}} \cdot \boldsymbol{A} \tag{2.66}$$

while the Lagrangian takes the form:

$$L = \frac{1}{2}m\dot{\boldsymbol{r}}^2 - e\phi + e\dot{\boldsymbol{r}} \cdot \boldsymbol{A} \tag{2.67}$$

We will then examine a special case of moving a charged particle perpendicular to the dynamic lines of a magnetic field. In this case the Maxwell expressions for magnetic field and magnetic potential are determined according to the subsection 2.3 by the equations $\boldsymbol{B}=\gamma^2\boldsymbol{B}_M$ and $\boldsymbol{A}=\gamma^2\boldsymbol{A}_M$, where $\gamma=\left(1-\boldsymbol{u}^2/c^2\right)^{-1/2}$, $\boldsymbol{u}=\mathrm{d}\boldsymbol{r}/\mathrm{d}\tau$, $\dot{\boldsymbol{r}}=\mathrm{d}\boldsymbol{r}/\mathrm{d}t$ and τ,t are the times according to the clocks of the laboratory and of the frame of the charged particle respectively. So $\mathrm{d}\tau=\gamma\mathrm{d}t$. Also the charge e is replaced by e/γ. We suppose that there is no electrical potential (that is $\nabla\phi=0$). The term of the time changing of magnetic potential is expressed as follows:

$$-\frac{e}{\gamma}\frac{\mathrm{d}\gamma^2\boldsymbol{A}_M}{\gamma\mathrm{d}t}=-e\frac{\mathrm{d}\boldsymbol{A}_M}{\mathrm{d}t}$$

so, because:

$$\frac{\mathrm{d}}{\mathrm{d}t}\frac{\partial V}{\partial\dot{\boldsymbol{r}}}=\frac{\mathrm{d}}{\mathrm{d}t}\left(-e\boldsymbol{A}_M\right)$$

the dynamic energy becomes $V=-e\dot{\boldsymbol{r}}\cdot\boldsymbol{A}_M$. By replacing this term of dynamic energy in the Lagrangian, we get the following equation of motion:

$$m\ddot{\boldsymbol{r}}=-e\frac{\mathrm{d}\boldsymbol{A}_M}{\mathrm{d}t}+e\nabla\left(\dot{\boldsymbol{r}}\cdot\boldsymbol{A}_M\right)=e\dot{\boldsymbol{r}}\times\boldsymbol{B}_M-e\frac{\partial\boldsymbol{A}_M}{\partial t}$$

and the Lagrange's equation is:

$$\mathcal{L}=\frac{1}{2}m\dot{\boldsymbol{r}}^2+e\dot{\boldsymbol{r}}\cdot\boldsymbol{A}_M=\frac{1}{2}m\gamma^2\boldsymbol{u}^2+e\gamma\boldsymbol{u}\cdot\boldsymbol{A}_M \tag{2.68}$$

2.6. Radiating Power

Based on the previous electromagnetic field equations, we will calculate the electromagnetic power radiated through a closed surface.

Dot-multiplying each member of the vector Equations (2.6) and (2.15) by the vectors $\boldsymbol{B}$ and $\boldsymbol{E}$ respectively, will give us the equation:

$$\nabla\cdot\left(\boldsymbol{E}\times\boldsymbol{H}\right)+\frac{1}{2}\frac{\mathrm{d}}{\mathrm{d}t}\left(\mu_0H^2+\epsilon_0E^2\right)=0 \tag{2.69}$$

where we have taken into account the equality $\boldsymbol{B}=\mu_0\boldsymbol{H}$.

We now assume that a V volume is involved in the movement at a speed $\boldsymbol{u}$ and enclosed by the closed surface S. A volume integral over V of the members of the last equation, using the Gauss theorem and the relation $\mathrm{d}/\mathrm{d}t=\boldsymbol{u}\cdot\nabla+\partial/\partial t$, will give us the equation:

$$\oint_S\left(\boldsymbol{E}\times\boldsymbol{H}\right)\cdot\hat{\boldsymbol{n}}\mathrm{d}S+\frac{1}{2}\left(\boldsymbol{u}\cdot\nabla\right)\int_V\left(\mu_0H^2+\epsilon_0E^2\right)\mathrm{d}V+\frac{1}{2}\frac{\partial}{\partial t}\int_V\left(\mu_0H^2+\epsilon_0E^2\right)\mathrm{d}V=0$$

After some algebraic calculations in the second term of the first member of this equation, we get the following equation:

$$\begin{aligned}&\oint_S\left(\boldsymbol{E}\times\boldsymbol{H}\right)\cdot\hat{\boldsymbol{n}}dS+\int_V\boldsymbol{j}\cdot\boldsymbol{E}\mathrm{d}V-\mu_0\int_V\boldsymbol{H}\cdot\left(\nabla\times\left(\boldsymbol{u}\times\boldsymbol{H}\right)\right)\mathrm{d}V\\&-\epsilon_0\int_V\boldsymbol{E}\cdot\left(\nabla\times\left(\boldsymbol{u}\times\boldsymbol{E}\right)\right)\mathrm{d}V+\frac{1}{2}\frac{\partial}{\partial t}\int_V\left(\mu_0H^2+\epsilon_0E^2\right)\mathrm{d}V=0\end{aligned} \tag{2.70}$$

This result differs from that derived from Maxwell's classical (unmodified) equations (that is the Poynting's theorem[10]), which can be formulated as follows:

$$\oint_S (\boldsymbol{E}\times\boldsymbol{H})\cdot\hat{\boldsymbol{n}}\mathrm{d}S+\int_V \boldsymbol{j}\cdot\boldsymbol{E}\mathrm{d}V+\frac{1}{2}\frac{\partial}{\partial t}\int_V\left(\mu_0 H^2+\epsilon_0 E^2\right)\mathrm{d}V=0 \tag{2.71}$$

The difference in relations 2.70 and 2.71 are two additional terms, namely the third and the fourth term of the first member of the Equation (2.70). These terms are due to the movement of the charged particle at a speed of $\boldsymbol{u}$ in the electromagnetic field within the said volume V.

But this difference overturns the known collapse image of the classical atom, according to the Equation (2.71), where an electron moving around the nucleus cannot follow a constant energy periodic path, but the energy loss due to radiation (due to the acceleration of the electron[11]), will result in a helical path to the nucleus, leading to a fall of electron to him. This overturn is because all energy which is lost through the surface S, is regained due to the existence of the two additional terms of the Equation (2.70).

This can be easily understood using a simple example. Suppose an electron tends to move cyclic around the kernel. Then the terms $\int_V \boldsymbol{j}\cdot\boldsymbol{E}\mathrm{d}V$ and $\frac{1}{2}\frac{\partial}{\partial t}\int_V\left(\mu_0 H^2+\epsilon_0 E^2\right)\mathrm{d}V$ of the Equation (2.70) are zeroed, since the $\boldsymbol{j}$ is perpendicular to $\boldsymbol{E}$ and is nonexistent a change of electromagnetic energy within the said volume V. Therefore:

$$\oint_S (\boldsymbol{E}\times\boldsymbol{H})\cdot\hat{\boldsymbol{n}}\mathrm{d}S-\mu_0\int_V \boldsymbol{H}\cdot\left(\nabla\times(\boldsymbol{u}\times\boldsymbol{H})\right)\mathrm{d}V-\epsilon_0\int_V \boldsymbol{E}\cdot\left(\nabla\times(\boldsymbol{u}\times\boldsymbol{E})\right)\mathrm{d}V=0 \tag{2.72}$$

Under these conditions, the electron continues to move into the proton's Coulomb electric field along a circular path around it.

2.7. Rotating Charged Particle

In order to compute the electric field and the force exerted on an elementary charged particle, due to its transporting motion, and also because of the spin, within a magnetic field, we consider a differential surface $\mathrm{d}s$, perpendicular to the instantaneous direction of motion, which performs a transportation movement and at the same time performs rotational motion about the Z axis of a Cartesian coordinate system XYZ, inside the magnetic field. We also consider that the unit vector $\hat{\boldsymbol{n}}$ is perpendicular to the previous differential surface $\mathrm{d}s$, and is rotated about the Z axis, and therefore is time dependent.

According to these conditions, the rate of change of magnetic flux through the elementary surface $\mathrm{d}s$ will be:

$$\frac{\mathrm{d}}{\mathrm{d}t}\left(\mathrm{d}\Phi(\boldsymbol{r},t)\right)=\frac{\mathrm{d}}{\mathrm{d}t}\left(\boldsymbol{B}(\boldsymbol{r},t)\cdot\hat{\boldsymbol{n}}\right)\mathrm{d}s \tag{2.73}$$

We define, in the inertial reference system of the Cartesian system coordinate XYZ, the following matrices:

[10]Ref. [3], paragraph **6.8**, **Poynting's Theorem and Conservation of Energy and Momentum for a system of Charged Particles and Electromagnetic Fields**.

[11]Ref. [3], paragraph **14.2**, **Total Power Radiated by an Accelerated Charge-Larmor's Formula and Its Relativistic Generalization**, Equation (14.22).

$$\left(B\right)=\begin{pmatrix}B_x\\B_y\\B_z\end{pmatrix}$$

$$\left(\boldsymbol{e}\right)=\begin{pmatrix}\hat{\boldsymbol{i}}\\\hat{\boldsymbol{j}}\\\hat{\boldsymbol{k}}\end{pmatrix}$$

$$\left(n\right)=\begin{pmatrix}n_x\\n_y\\n_z\end{pmatrix}$$

and because $n_z=0$, we get the following equations:

$$\hat{\boldsymbol{n}}=n_x\hat{\boldsymbol{i}}+n_y\hat{\boldsymbol{j}},\ \boldsymbol{B}=B_x\hat{\boldsymbol{i}}+B_y\hat{\boldsymbol{j}}+B_z\hat{\boldsymbol{k}}$$

where B_x,B_y,B_z are the Cartesian components of the magnetic field and $\hat{\boldsymbol{i}},\hat{\boldsymbol{j}},\hat{\boldsymbol{k}}$ are the time-independent unit vectors, whereas the elements of the matrix (n) are the time-dependent cartesian components of the rotated unit vector $\hat{\boldsymbol{n}}$.

In the rotating coordinate system $X'Y'Z'$ of the unit vector $\hat{\boldsymbol{n}}$, with the axes Z and Z' coinciding, the planes XY and $X'Y'$ to be parallel, and the origins O and O' be identically, we define respectively:

$$\left(\boldsymbol{e}'\right)=\begin{pmatrix}\hat{\boldsymbol{i}}'\\\hat{\boldsymbol{j}}'\\\hat{\boldsymbol{k}}'\end{pmatrix}$$

$$\left(n'\right)=\begin{pmatrix}n'_x\\n'_y\\n'_z\end{pmatrix}$$

and since $n'_z=0$ the following equation is obtained:

$$\hat{\boldsymbol{n}}'=n'_x\hat{\boldsymbol{i}}'+n'_y\hat{\boldsymbol{j}}'$$

where the unit vectors $\hat{\boldsymbol{i}}',\hat{\boldsymbol{j}}'$ of the matrix $\left(\boldsymbol{e}'\right)$ depend on time, while the components of the matrix $\left(n'\right)$ are independent of time.

The relation between the rotating and non-rotating Cartesian unit vectors is:

$$\begin{pmatrix}\hat{\boldsymbol{i}}\\\hat{\boldsymbol{j}}\\\hat{\boldsymbol{k}}\end{pmatrix}=\begin{pmatrix}\hat{\boldsymbol{i}}\cdot\hat{\boldsymbol{i}}' & \hat{\boldsymbol{i}}\cdot\hat{\boldsymbol{j}}' & \hat{\boldsymbol{i}}\cdot\hat{\boldsymbol{k}}'\\\hat{\boldsymbol{j}}\cdot\hat{\boldsymbol{i}}' & \hat{\boldsymbol{j}}\cdot\hat{\boldsymbol{j}}' & \hat{\boldsymbol{j}}\cdot\hat{\boldsymbol{k}}'\\\hat{\boldsymbol{k}}\cdot\hat{\boldsymbol{i}}' & \hat{\boldsymbol{k}}\cdot\hat{\boldsymbol{j}}' & \hat{\boldsymbol{k}}\cdot\hat{\boldsymbol{k}}'\end{pmatrix}\cdot\begin{pmatrix}\hat{\boldsymbol{i}}'\\\hat{\boldsymbol{j}}'\\\hat{\boldsymbol{k}}'\end{pmatrix}$$

and therefore the time-dependent rotation matrix is:

$$R=\begin{pmatrix}\hat{\boldsymbol{i}}\cdot\hat{\boldsymbol{i}}' & \hat{\boldsymbol{i}}\cdot\hat{\boldsymbol{j}}' & \hat{\boldsymbol{i}}\cdot\hat{\boldsymbol{k}}'\\\hat{\boldsymbol{j}}\cdot\hat{\boldsymbol{i}}' & \hat{\boldsymbol{j}}\cdot\hat{\boldsymbol{j}}' & \hat{\boldsymbol{j}}\cdot\hat{\boldsymbol{k}}'\\\hat{\boldsymbol{k}}\cdot\hat{\boldsymbol{i}}' & \hat{\boldsymbol{k}}\cdot\hat{\boldsymbol{j}}' & \hat{\boldsymbol{k}}\cdot\hat{\boldsymbol{k}}'\end{pmatrix}$$

Taking all these into account, the following equations are obtained:

$$(n) = R(n')$$
$$\boldsymbol{B}\cdot\hat{\boldsymbol{n}} = (B)^{\mathrm{T}} R(n')$$

The rate of change of differential magnetic flux is:

$$\frac{\mathrm{d}}{\mathrm{d}t}(\mathrm{d}\Phi) = \frac{\mathrm{d}}{\mathrm{d}t}(\boldsymbol{B}\cdot\hat{\boldsymbol{n}})\mathrm{d}s = \frac{\mathrm{d}\boldsymbol{B}}{\mathrm{d}t}\cdot\hat{\boldsymbol{n}}\mathrm{d}s + \boldsymbol{B}\cdot\frac{\mathrm{d}\hat{\boldsymbol{n}}}{\mathrm{d}t}\mathrm{d}s \tag{2.74}$$

The term $\frac{\mathrm{d}\boldsymbol{B}}{\mathrm{d}t}\cdot\hat{\boldsymbol{n}}\mathrm{d}s$ is the rate of flow change due to the transportation moving. The last term, which is due to the spin of charged particle q, is obtained by the relation:

$$\boldsymbol{B}\cdot\frac{\mathrm{d}\hat{\boldsymbol{n}}}{\mathrm{d}t}\mathrm{d}s = (B)^{\mathrm{T}}\frac{\mathrm{d}R}{\mathrm{d}t}(n')\mathrm{d}s \tag{2.75}$$

Because of this spin of the charged particle q about the axis of rotation Z of the XYZ coordinate system, the rotation matrix R is:

$$R = \begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

where θ the angle of rotation. The time-derivative of the spin matrix is calculated as:

$$\frac{\mathrm{d}R}{\mathrm{d}t} = \dot{\theta}\begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\cdot\begin{pmatrix} \cos\theta & -\sin\theta & 0 \\ \sin\theta & \cos\theta & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

The term of change of the differential magnetic flux due to the spin of the charged particle q, will be:

$$(B)^{\mathrm{T}}\frac{\mathrm{d}R}{\mathrm{d}t}(n')\mathrm{d}s = \dot{\theta}\begin{pmatrix} B_x & B_y & B_z \end{pmatrix}\cdot\begin{pmatrix} 0 & -1 & 0 \\ 1 & 0 & 0 \\ 0 & 0 & 0 \end{pmatrix}\cdot\begin{pmatrix} n_x \\ n_y \\ 0 \end{pmatrix}\mathrm{d}s$$

and by inserting the unit matrix $I = (\hat{\boldsymbol{e}})\cdot(\hat{\boldsymbol{e}})^{\mathrm{T}}$ in the previous relation, the term due to the spin becomes:

$$(B)^{\mathrm{T}}\frac{\mathrm{d}R}{\mathrm{d}t}(n')\mathrm{d}s = \dot{\theta}\begin{pmatrix} B_y & -B_x & 0 \end{pmatrix}\cdot\begin{pmatrix} \hat{\boldsymbol{i}} \\ \hat{\boldsymbol{j}} \\ \hat{\boldsymbol{k}} \end{pmatrix}\cdot\begin{pmatrix} \hat{\boldsymbol{i}} & \hat{\boldsymbol{j}} & \hat{\boldsymbol{k}} \end{pmatrix}\cdot\begin{pmatrix} n_x \\ n_y \\ 0 \end{pmatrix}\mathrm{d}s$$

so:

$$\boldsymbol{B}\cdot\frac{\mathrm{d}\hat{\boldsymbol{n}}}{\mathrm{d}t}\mathrm{d}s = \dot{\theta}\left(B_y\hat{\boldsymbol{i}} - B_x\hat{\boldsymbol{j}}\right)\cdot\hat{\boldsymbol{n}}\mathrm{d}s = -\dot{\theta}\left(\hat{\boldsymbol{k}}\times\boldsymbol{B}\right)\cdot\hat{\boldsymbol{n}}\mathrm{d}s \tag{2.76}$$

Including the term of the transportation move, since the angular velocity due to the spin is $\omega = \dot{\theta}\boldsymbol{k}$, with the help of the Stokes theorem, the following equation is obtained:

$$\nabla\times\boldsymbol{E}(\boldsymbol{r},t) = -\frac{\mathrm{d}\boldsymbol{B}(\boldsymbol{r},t)}{\mathrm{d}t} + \omega\times\boldsymbol{B}(\boldsymbol{r},t) \tag{2.77}$$

According to the previously described, regarding the calculation of the electric field, in the 2.1 section, the last equation becomes:

$$\nabla \times \boldsymbol{E} = \nabla \times (\boldsymbol{u} \times \boldsymbol{B}) - \frac{\partial \boldsymbol{B}}{\partial t} + \omega \times \boldsymbol{B} \tag{2.78}$$

Since, as we will see in the next section, the rotating charged particle interacts with the magnetic field as a magnetic dipole, in the final state, that is in equilibrium, the vectors of the angular velocity and the magnetic field will be parallelized. Therefore the final relation for the electric field is given by the Equation (2.11).

2.8. Gyromagnetic Ratio

We will calculate in this section the dynamic energy and the gyromagnetic ratio of a charged particle, spinning into a magnetic field $\boldsymbol{B}$. This magnetic field is independent of time. The force that causes the torque of the magnetic dipole resulting from the rotation of a differential portion of the charged particle, that is the rotation of a differential charge which is equal to $\mathrm{d}q_\ell$, will come from the term $\boldsymbol{u} \times \boldsymbol{B}$ of the electric field. We assume that $\mathrm{d}q_\ell$ is a differential part of the charge, measured with the laboratory instruments. If $\mathrm{d}q$ is the corresponding value measured in the momentarily inertial reference system of the differential part of the charged particle, then $\mathrm{d}q_\ell = \mathrm{d}q/\gamma$, where $\gamma = \left(1 - \boldsymbol{u}^2/c^2\right)^{-1/2}$. Since $\boldsymbol{u} = \omega \times \boldsymbol{r}$ and the differential force is $\mathrm{d}\boldsymbol{F} = \mathrm{d}q_\ell (\omega \times \boldsymbol{r}) \times \boldsymbol{B} = \mathrm{d}q_\ell \left(\boldsymbol{r}(\omega \cdot \boldsymbol{B}) - \omega(\boldsymbol{r} \cdot \boldsymbol{B})\right)$, the differential torsion moment will be:

$$\mathrm{d}\boldsymbol{M} = \boldsymbol{r} \times \mathrm{d}\boldsymbol{F} = -\mathrm{d}q_\ell \boldsymbol{r} \times \omega(\boldsymbol{r} \cdot \boldsymbol{B}) \tag{2.79}$$

Therefore, for a differential part of the charged particle to be in equilibrium, the differential torque must be zeroed and this occurs when the position vector $\boldsymbol{r}$ of the differential portion of the charged particle is perpendicular to the magnetic field $\boldsymbol{B}$, so the $\boldsymbol{r}$ will be at the plane of the circular path of the corresponding differential mass $\mathrm{d}m$, so that the vectors of angular velocity and magnetic field to be parallel. In this case, we select the magnetic field to be parallel to the Z axis of a Cartesian coordinate system, so it to be equal to $\boldsymbol{B} = B\hat{\boldsymbol{k}}$, and also $B = f(z)B_o$, where B_o is a constant magnetic field value. The position vector $\boldsymbol{r}$ will then be at the XY level, *i.e.* $\boldsymbol{r} = r\hat{\boldsymbol{u}}_r = x\hat{\boldsymbol{i}} + y\hat{\boldsymbol{j}}$. Also the term $\boldsymbol{u} \times \boldsymbol{B}$ is equal to $\boldsymbol{r}(\omega \cdot \boldsymbol{B})$, and the corresponding differential of the force is:

$$\mathrm{d}\boldsymbol{F} = \mathrm{d}q_\ell \omega r \left(\hat{\boldsymbol{k}} \cdot \boldsymbol{B}\right) \hat{\boldsymbol{u}}_r = \mathrm{d}q_\ell \omega r B \hat{\boldsymbol{u}}_r \tag{2.80}$$

This force quantity plays the role of centripetal force. Since the velocity $\boldsymbol{u}$ is perpendicular to the magnetic field, we can verify the latter relationship by calculating this differential quantity of the force with the help of the relation 2.68, from which is obtained the dynamic energy of a charged particle in a magnetic field (subsection 2.5). For this particular magnetic field we will first prove the relation:

$$\boldsymbol{A} = \frac{1}{2} \boldsymbol{B} \times \boldsymbol{r} \tag{2.81}$$

where $\boldsymbol{A}$ the magnetic vector potential. We will use the identity $\nabla\times(\boldsymbol{B}\times\boldsymbol{r})=(\boldsymbol{r}\cdot\nabla)\boldsymbol{B}-\boldsymbol{r}(\nabla\cdot\boldsymbol{B})-(\boldsymbol{B}\cdot\nabla)\boldsymbol{r}+\boldsymbol{B}(\nabla\cdot\boldsymbol{r})$. The terms of the second member of this identity are:

$$(\boldsymbol{r}\cdot\nabla)\boldsymbol{B}=\left(x\frac{\partial}{\partial x}+y\frac{\partial}{\partial y}\right)f(z)B_o\hat{\boldsymbol{k}}=0$$

$$-\boldsymbol{r}(\nabla\cdot\boldsymbol{B})=0$$

$$-(\boldsymbol{B}\cdot\nabla)\boldsymbol{r}=-B\frac{\partial}{\partial z}\left(x\hat{\boldsymbol{i}}+y\hat{\boldsymbol{j}}\right)=0$$

$$\boldsymbol{B}(\nabla\cdot\boldsymbol{r})=2\boldsymbol{B}$$

So the magnetic potential[12] is $\nabla\times(\boldsymbol{B}\times\boldsymbol{r})=2\boldsymbol{B}=2\nabla\times\boldsymbol{A}$, that is $\boldsymbol{A}=\frac{1}{2}(\boldsymbol{B}\times\boldsymbol{r})$.

In this case, the term of differential dynamic energy of the rotating differential part of charged particle, within the magnetic field $\boldsymbol{B}_M$, will be:

$$\mathrm{d}\mathcal{V}=-\frac{1}{2}\gamma\mathrm{d}q\boldsymbol{u}\cdot(\boldsymbol{B}_M\times\boldsymbol{r})=-\frac{1}{2}\frac{\mathrm{d}q}{\mathrm{d}m}\boldsymbol{B}_M\cdot(\boldsymbol{r}\times\gamma\mathrm{d}m\boldsymbol{u}) \tag{2.82}$$

The differential angular momentum of the rotating differential mass $\mathrm{d}m$ is $\mathrm{d}\boldsymbol{L}=\boldsymbol{r}\times\gamma\mathrm{d}m\boldsymbol{u}$, so the term of the differential dynamic energy becomes:

$$\mathrm{d}\mathcal{V}=-\frac{1}{2}\frac{\mathrm{d}q}{\mathrm{d}m}\boldsymbol{B}_M\cdot\mathrm{d}\boldsymbol{L} \tag{2.83}$$

Since the position vector $\boldsymbol{r}$ is perpendicular to angular velocity ω, we obtain the equation $\boldsymbol{r}\times(\omega\times\boldsymbol{r})=\omega(\boldsymbol{r}\cdot\boldsymbol{r})-\boldsymbol{r}(\boldsymbol{r}\cdot\omega)=\omega r^2$. The previous relation becomes:

$$\mathrm{d}\mathcal{V}=-\frac{1}{2}\gamma\mathrm{d}q\omega r^2B_M \tag{2.84}$$

In the subsection 2.5 is referenced that τ,t are the times according to the clocks of the laboratory and of the frame of the charged particle respectively. So $\mathrm{d}\tau=\gamma\mathrm{d}t$. Now we denote by θ the angle resulting from the relation $\omega=\mathrm{d}\theta/\mathrm{d}\tau$. Also we denote by $\dot{\theta}$ the time derivative $\mathrm{d}\theta/\mathrm{d}t$. So $\dot{\theta}=\gamma\omega$, and the differential term of the force resulting from this differential dynamic energy will be:

$$\mathrm{d}\boldsymbol{F}=-\nabla\mathrm{d}\mathcal{V}=-\frac{\partial(\mathrm{d}\mathcal{V})}{\partial r}\hat{\boldsymbol{u}}_r=\mathrm{d}q\dot{\theta}rB_M\hat{\boldsymbol{u}}_r \tag{2.85}$$

and by making the substitutions $B_M=B/\gamma^2$, $\mathrm{d}q=\gamma\mathrm{d}q_\ell$, and $\dot{\theta}=\gamma\omega$ we really get the relation 2.80.

We will then calculate the dynamic energy of the rotating charged particle of charge q and mass m, within the above-mentioned magnetic field $\boldsymbol{B}_M$. We denote the charge density as $\rho_q(\boldsymbol{r})$, and the mass density as $\rho_m(\boldsymbol{r})$. This calcu-

[12]For a homogeneous magnetic field $\boldsymbol{B}$ (that is, with a fixed value $\boldsymbol{B}$) the same relation arises, because the terms of the second member of the above mentioned identity are: $(\boldsymbol{r}\cdot\nabla)\boldsymbol{B}=0$, $-\boldsymbol{r}(\nabla\cdot\boldsymbol{B})=0$, $-(\boldsymbol{B}\cdot\nabla)\boldsymbol{r}=-\boldsymbol{B}$, $\boldsymbol{B}(\nabla\cdot\boldsymbol{r})=3\boldsymbol{B}$, that is $\nabla\times(\boldsymbol{B}\times\boldsymbol{r})=2\boldsymbol{B}$.

lation is done integrating the equation 2.84 over the volume V. If the volume V is considered to be too small (in the case of an elementary particle it tends to be almost a point), the magnetic field $\boldsymbol{B}_M$ can be considered to be approximately constant within this volume. Under these conditions, this dynamic energy will be:

$$\mathcal{V} = -\frac{1}{2}\omega B_M \int_V \gamma \rho_q r^2 \mathrm{d}V$$

We now define a numerical constant equal to:

$$g_q = \frac{\int_V \gamma \rho_q r^2 \mathrm{d}V}{(q/V)\int_V \gamma r^2 \mathrm{d}V}$$

so, the dynamic energy can be written as:

$$\mathcal{V} = -\frac{g_q q \omega B_M}{2V}\int_V \gamma r^2 \mathrm{d}V$$

We define a new numerical constant:

$$g_m = \frac{\int_V \gamma \rho_m r^2 \mathrm{d}V}{(m/V)\int_V \gamma r^2 \mathrm{d}V} = \frac{L/\omega}{(m/V)\int_V \gamma r^2 \mathrm{d}V}$$

where L is the angular momentum. In this case, the equality $\int_V \gamma r^2 \mathrm{d}V = (L/\omega)/(g_m m/V)$ arises and therefore the dynamic energy becomes:

$$\mathcal{V} = -\frac{1}{2}\frac{g_q}{g_m}\frac{q}{m}B_M L \tag{2.86}$$

The numerical constant $g = g_q/g_m$ is the well known gyromagnetic factor and the quantity $g(q/2m)$ is the calculated gyromagnetic ratio. Given that the quantity $\mu = g(q/2m)\boldsymbol{L}$ is the magnetic dipole moment, the calculated dynamic energy is expressed by the relation:

$$\mathcal{V} = -\mu \cdot \boldsymbol{B}_M \tag{2.87}$$

This calculation of the dynamic energy due to the spinning of a charged particle within a magnetic field is more simple for an elementary particle such as the electron, since the charge density and mass density can in this case be roughly constant inside the space that occupies the particle, with the result that the gyromagnetic factor is approximately equal to the unit. For the proton, due to the inhomogeneous mass (much larger than the electron mass) and the inhomogeneous charge, since it consists of three smaller charged particles (quarks), it is expected to have a gyromagnetic factor not equal to unit.

According to the subsection 3.5 for relatively low rotational speeds, compared to the speed of light in the vacuum (that is $(\omega\rho/c) \ll 1$), the rotational kinetic energy is approximately equal to $E_{kin} = (1/2)\omega L$, where ω is the angular velocity and L is the angular momentum of the rotating particle. For a rotating electron, according to the hypothesis of the absolute reference system, kinetic energy is equal to $(1/2)\hbar\omega$. Therefore, in a homogeneous magnetic field, the angular momentum eigenvalues are equal to $\pm\hbar$, depending on the direction of the angular velocity, resulting from the spin orientation in the magnetic field, ie for example spin up or spin down, and the corresponding quantum number is equal to 1, that is an integer, as in the orbital angular momentum, instead of the quantum number of 1/2 of modern physics. Assuming that X_{up} is the wave function of the clockwise rotation of the electron, and X_{down} the wave function of the counterclockwise rotation of the electron, then we get $LX_{up} = \hbar X_{up}$ and $LX_{down} = -\hbar X_{down}$ respectively. Therefore, assuming a homogeneous magnetic field *B*, in an electron beam, moving perpendicular to the magnetic field lines, an energy difference $\Delta\mathcal{V}$, due to the spin-magnetic field interaction (Stern-Gerlach Experiment[13]), is added, and is obtained by the following equation:

$$\Delta\mathcal{V} = \pm\frac{1}{2}\frac{ge}{m_e}B_M\hbar \tag{2.88}$$

The measured experimental value of *g*, since the spin quantum number associated with the spin angular momentum is taken as equal to $s = 1/2$, according to the National Institute of Standards and Technology U.S. Department of Commerce is equal to $2.00231930436182 \pm 2.6\times10^{-13}$. Therefore, the corresponding experimental value of *g*, according to the hypothesis of the absolute reference system, will be approximately equal to half of that value, that is approximately equal to 1.00115965218091, since, in this case, the spin quantum number associated with the spin angular momentum is equal to $s = 1$.

The quantity:

$$\mu_B = \frac{e\hbar}{2m_e} \tag{2.89}$$

is the Bohr magneton, that is equal to $\mu_B = -9.284764620(57)\times10^{-24}\ \mathrm{J/T}$. Therefore the previous energy difference is:

$$\Delta\mathcal{V} = \pm g\mu_B B_M \tag{2.90}$$

3. Dynamics

A basic consideration in this section, according to the hypothesis of the absolute reference system, is that the mass remains unchanged in any reference system, inertial or non-inertial. This means that, unlike the theory of relativity, the mass does not depend on the kinetic state of the body in the reference system in which it is observed. Also, physical quantities estimates, such as power and energy, differ from corresponding estimates based on modern physics.

3.1. Momentum and Force

We will begin with measurements in the inertial reference system of a laboratory. A particle is in the $\boldsymbol{r}$ position of a XYZ coordinate system, while at the same time a force F acts on it due to the existence of a field. We assume that initially

[13]Gerlach, W.; Stern, O. (1922). "Der experimentelle Nachweis der Richtungsquantelung im Magnetfeld". Zeitschrift fur Physik. 9: 349-352.

the particle was stationary in the inertial reference system of the laboratory and that it reached position $\boldsymbol{r}$ under the influence of force F over a period of time τ. Let us also assume that the same particle, located at the position $\boldsymbol{r}$, moves at a velocity $\boldsymbol{u} = \mathrm{d}\boldsymbol{r}/\mathrm{d}\tau$. According to Newtonian dynamics, the momentum of the particle is:

$$\boldsymbol{p}_a = m\frac{\mathrm{d}\boldsymbol{r}}{\mathrm{d}\tau} = m\boldsymbol{u} \tag{3.1}$$

In a differential time $\mathrm{d}\tau$, the velocity of the particle will be changed by an amount $\mathrm{d}\boldsymbol{u}$. If m is the mass of the particle, then the calculated force in the inertial reference system of the laboratory is:

$$\boldsymbol{F}_a = m\frac{\mathrm{d}}{\mathrm{d}\tau}\frac{\mathrm{d}\boldsymbol{r}}{\mathrm{d}\tau} \tag{3.2}$$

But this way of calculation is not a correct way of calculating the momentum and the force of the particle, if we want to be consistent with the hypothesis of the absolute reference system. In calculating the force exerted on the particle by the existence of the aforementioned field, the time of the momentarily inertial reference system of the particle and not the time of the inertial reference system of the laboratory must be taken into account. This is comprehended when examining the force exerted by the interactions (in particular the frequencies of the interaction photons) in the relation (4.5), in the Section 4.

According to the above, the correlation of the differential times corresponding to the above-mentioned differential velocity $\mathrm{d}\boldsymbol{u}$, will be $\mathrm{d}\tau = \gamma \mathrm{d}t$, where $\mathrm{d}\tau$ is the differential time according to the clock of the inertial (or absolute) reference system and $\mathrm{d}t$ is the corresponding differential time according to the clock of the reference system of the particle (which is considered as momentarily inertial). More generally, *the quantitative estimation of physical quantities, such as the momentum and energy of a particle as well as the force exerted thereon, is made by using the physical measure of length of the inertial (or absolute) reference system in which the field exists, and with the clock of the reference system of the particle*. Under these conditions, the instantaneous momentum of the particle, measured with the clock of its reference system and the physical measure of length of the inertial (or absolute) reference system, is:

$$\boldsymbol{p} = m\frac{\mathrm{d}\boldsymbol{r}}{\mathrm{d}t} = m\gamma\frac{\mathrm{d}\boldsymbol{r}}{\mathrm{d}\tau} = m\gamma\boldsymbol{u} \tag{3.3}$$

while the force exerted on the particle will be:

$$\boldsymbol{F} = m\frac{\mathrm{d}}{\mathrm{d}t}\frac{\mathrm{d}\boldsymbol{r}}{\mathrm{d}t} = m\gamma\frac{\mathrm{d}}{\mathrm{d}\tau}\left(\gamma\frac{\mathrm{d}\boldsymbol{r}}{\mathrm{d}\tau}\right) \tag{3.4}$$

where $\gamma = \left(1 - u^2/c^2\right)^{-1/2}$.

If we want to evaluate the force by using the clock and the physical meter of length of the inertial system of the laboratory, so that we are consistent with Galileo's relativity, according to which the physical magnitude measurements are made by the length measure and the clock of the inertial system the observer's reference, we should define the differential change of momentum as $\mathrm{d}\boldsymbol{p}_\ell = \gamma \mathrm{d}\boldsymbol{p}$. According to the corresponding definition of force it will be $\boldsymbol{F} = \mathrm{d}\boldsymbol{p}_\ell / \mathrm{d}\tau$, and for a particle initially stationary in the laboratory, which acquires speed $\boldsymbol{u}$ under the influence of force $\boldsymbol{F}$, the momentum will be defined as $\boldsymbol{p}_\ell = \int_0^u \gamma \left(\mathrm{d}\boldsymbol{p} / \mathrm{d}\boldsymbol{u} \right) \mathrm{d}\boldsymbol{u}$, instead of being defined as $\boldsymbol{p} = m\gamma\boldsymbol{u}$, as would be according to the hypothesis of the absolute reference system. *But the hypothesis of the absolute reference system is different from Galileo's relativity, and generally differs from any relativistic description of natural laws*, and therefore we will not deal with such descriptions here.

Considering that $\|$ refers to components of physical quantities parallel to the velocity $\boldsymbol{u}$, while $\perp$ perpendicular, we can express the force as a sum of a parallel and a vertical component, as follows:

$$\boldsymbol{F} = m\gamma^4 \left(\frac{\mathrm{d}^2\boldsymbol{r}}{\mathrm{d}\tau^2} \right)_{\|} + m\gamma^2 \left(\frac{\mathrm{d}^2\boldsymbol{r}}{\mathrm{d}\tau^2} \right)_{\perp} \tag{3.5}$$

An example that can help in understanding the last relation is to assume that a charged particle enters at a velocity $\boldsymbol{u}$ within a magnetic field produced by a natural magnet stationary in the inertial reference system of the laboratory. If q is the charge, then the force exerted on the particle, based on the relations 2.27, 2.28 and 2.61, will be:

$$\boldsymbol{F} = q'\boldsymbol{E} = q\left(\boldsymbol{E}_{M\perp} + \boldsymbol{u} \times \boldsymbol{B}_M \right)\gamma + \frac{q}{\gamma}\boldsymbol{E}_{M\|} \tag{3.6}$$

If there is no electric field in the same position of the inertial reference system of the laboratory, that is $\boldsymbol{E}_M = 0$, then:

$$\boldsymbol{F} = m\gamma^2 \frac{\mathrm{d}^2\boldsymbol{r}}{\mathrm{d}\tau^2} = q\left(\boldsymbol{u} \times \boldsymbol{B}_M \right)\gamma \tag{3.7}$$

The equation of motion of the particle in the inertial reference system of the laboratory is:

$$m\gamma \frac{\mathrm{d}^2\boldsymbol{r}}{\mathrm{d}\tau^2} = q\left(\boldsymbol{u} \times \boldsymbol{B}_M \right) \tag{3.8}$$

Having measured the charge e with the Millikan method, measuring the mass of the charged particle can be achieved using the previous relation 3.8. The correctness of this relation has been tested with fairly good accuracy in the Rogers experiment (cf. [6]).

Another example is the Coulomb interaction of two charged particles, where q_1 and q_2 are the magnitudes of the two charges. According to the equation 2.61, if we denote by p_1, p_2 the momentums of the two particles, and $\mathrm{d}t_1$, $\mathrm{d}t_2$, $\mathrm{d}t_\ell$ as their differential times in the reference systems of the two particles and the laboratory respectively, provided that the particle movements are in one dimension and originate only from the interaction between them, then the equations of motion are:

$$\frac{\mathrm{d}p_1}{\mathrm{d}t_1} = \frac{\mathrm{d}p_2}{\mathrm{d}t_2} = k_{el} \frac{q_1 q_2}{\gamma_1 \gamma_2 r^2}$$

where $p_1 = m_1\gamma_1 u_1$, $p_2 = m_2\gamma_2 u_2$, $\gamma_1 = \left(1-u_1^2/c^2\right)^{-1/2}$, $\gamma_2 = \left(1-u_2^2/c^2\right)^{-1/2}$, and the two charged particles are separated by a distance *r*. Therefore, since $\mathrm{d}t_\ell = \gamma_1 \mathrm{d}t_1 = \gamma_2 \mathrm{d}t_2$, the interaction forces of the two particles are equal and are expressed with the relations:

$$F = \frac{\gamma_1 \mathrm{d}p_1}{\mathrm{d}t_\ell} = \frac{\gamma_2 \mathrm{d}p_2}{\mathrm{d}t_\ell} = k_{el}\frac{q_1 q_2}{\gamma_1\gamma_2 r^2}$$

3.2. Angular Momentum

The calculated angular momentum of an elementary mass in position $\boldsymbol{r}$ of an inertial reference system, with respect to a Cartesian coordinate system, will be:

$$\boldsymbol{L} = \boldsymbol{r}\times\boldsymbol{p} \tag{3.9}$$

where $\boldsymbol{p}$ is the momentum of the particle. The total angular momentum of a plurality of N particles is calculated:

$$\sum_{i=1}^{N}\boldsymbol{L}_i = \sum_{i=1}^{N}\boldsymbol{r}_i\times\boldsymbol{p}_i \tag{3.10}$$

3.3. Energy and Calculation of the Work Done by a Force

Let us now deal with the work done by a force that is exerted on a particle. We assume that the particle is initially immobile in the inertial reference system of the laboratory and that by the action of the force $\boldsymbol{F}$, whose origin source is also immobile in the inertial reference system of the laboratory, it has acquired a velocity $\boldsymbol{u} = \mathrm{d}\boldsymbol{r}/\mathrm{d}\tau$, measured with the clock of the inertial reference system of the laboratory. The work done by the force is:

$$E = \int_0^u \boldsymbol{F}\cdot\mathrm{d}\boldsymbol{r} \tag{3.11}$$

Based on the above, the work done by the force is calculated:

$$E = \frac{1}{2}m\gamma^2c^2 - \frac{1}{2}mc^2 \tag{3.12}$$

The two terms of the second member of the last equation are the kinetic energies of the particle. At the initial time (where $\tau = 0$ and $\boldsymbol{u} = 0$) the kinetic energy is equal to $\frac{1}{2}mc^2$, while at the final time τ is equal to $\frac{1}{2}m\gamma^2c^2$. These kinetic energies, however, are not those described by Newtonian mechanics, nor by modern physics[14], but they are internal kinetic energies of the particle having to do with the internal movements of the structural components of the particle. According to the previous section, these structural components are "bound photons".

Also, if the velocity of the particle in the inertial reference system of the laboratory is $\boldsymbol{u}$, then the same velocity measured with the clock of its reference system is $\gamma\boldsymbol{u}$, so the corresponding total kinetic energy will be

[14]Ref. [1], chapter 1 **Departures from Newtonian dynamics**, **ENERGY, MOMENTUM, AND MASS**.

$E_{kin} = \frac{1}{2}mc^2 + \frac{1}{2}m(\gamma\boldsymbol{u})^2 = \frac{1}{2}m(\gamma c)^2$. We will come back to this way of calculating kinetic energy in the next section.

From the last relation (3.12), the resulting work done by the force, which is equal to the "transport kinetic energy" of the particle, is:

$$E = \frac{1}{2}m\gamma^2u^2 \tag{3.13}$$

The corresponding work done by the force calculated with the clock of the inertial reference system of the laboratory (*i.e.* according to Newtonian physics) is:

$$E_a = \int_0^u \boldsymbol{F}_a \cdot \mathrm{d}\boldsymbol{r} = \frac{1}{2}mu^2 \tag{3.14}$$

The latter relation is expected since the velocity of the particle, measured with the clock of the inertial reference system of the laboratory, is γ times lower than the instantaneous velocity measured with the clock of reference system of the particle and the natural measure length of the inertial reference system of the laboratory. However, this way of calculating the kinetic energy of the particle is incorrect according to the hypothesis of the absolute reference system, because, as we have already mentioned earlier and referred to in Section 4, the only correct method of calculating the energy is done on counting the time with a clock of the reference system of the particle.

A particle, initially immobilized in the inertial reference system of the laboratory, that has acquired a velocity $\dot{\boldsymbol{r}} = \mathrm{d}\boldsymbol{r}/\mathrm{d}t = \gamma\boldsymbol{u}$, measured with the clock of the reference system of the particle, under the influence of a field whose origin source is also at rest in the inertial reference system of the laboratory, has dynamic energy $U(\boldsymbol{r})$. The equation of motion of the particle results from the Lagrange equation:

$$\frac{\mathrm{d}}{\mathrm{d}t}\frac{\partial\mathcal{L}}{\partial\dot{\boldsymbol{r}}} - \frac{\partial\mathcal{L}}{\partial\boldsymbol{r}} = 0 \tag{3.15}$$

where $\mathcal{L} = T(\dot{\boldsymbol{r}}) - U(\boldsymbol{r})$ is the Lagrange function for the particle under the given conditions, $T(\dot{\boldsymbol{r}})$ is the kinetic energy, which is $T = (1/2)m\gamma^2u^2$. Since the force derived from this field is $\boldsymbol{F} = -\nabla U(\boldsymbol{r}) = -\mathrm{d}U/\mathrm{d}\boldsymbol{r}$ [15], the last equation can be written:

$$\boldsymbol{F} = \frac{\mathrm{d}}{\mathrm{d}t}\frac{\partial\mathcal{L}}{\partial\dot{\boldsymbol{r}}} \tag{3.16}$$

Based on the relation $\partial\mathcal{L}/\partial\dot{\boldsymbol{r}} = \partial T/\partial(\gamma\boldsymbol{u}) = m\gamma\boldsymbol{u}$, the resulting force is:

$$\boldsymbol{F} = \gamma\frac{\mathrm{d}}{\mathrm{d}\tau}\left(m\gamma\frac{\mathrm{d}\boldsymbol{r}}{\mathrm{d}\tau}\right) \tag{3.17}$$

which is the same as that of the relation (3.4) for the force, as expected. Since the total kinetic energy (including internal kinetic energy) of the particle, as above, is $(1/2)m\gamma^2c^2$, a more general Lagrange function is $\mathcal{L}_{tot} = (1/2)m\gamma^2c^2 - U(\boldsymbol{r})$. This Lagrange function differs from the previous one by a constant (since

[15] See reference [7], CHAPTER 1, Section **1-1**, **MECHANICS OF A PARTICLE**, Equations (1-16).

$\mathcal{L}_{tot} = \mathcal{L} + (1/2)mc^2$), so the Lagrange equation does not differ from the previous one. Therefore, following the same methodology as before, the resulting expression for the force is again the same as that of the relation (3.4).

3.4. Correlation of Expressions for the Energy

As mentioned in the previous subsection, the total kinetic energy of a body at rest, with a mass *m*, and at a velocity $\boldsymbol{u}$ with respect to the inertial reference system of the laboratory (and thus with a contraction coefficient $\gamma = (1 - \boldsymbol{u}^2/c^2)^{-1/2}$), is calculated:

$$E_{abs} = \frac{1}{2}m\gamma^2 c^2 = \frac{1}{2}m\gamma^2 \boldsymbol{u}^2 + \frac{1}{2}mc^2 = \frac{\boldsymbol{p}^2}{2m} + \frac{1}{2}mc^2 \tag{3.18}$$

where $\boldsymbol{p} = m\gamma\boldsymbol{u}$ the momentum of that body. Multiplying the second and last member of the previous equation with the quantity $2mc^2$ gives the equation:

$$(m\gamma c^2)^2 = \boldsymbol{p}^2 c^2 + m^2 c^4 \tag{3.19}$$

Since the total relativistic energy E_{rel} of an inertial body is equal to the quantity $m\gamma c^2$, and the rest mass of the body does not differ in the theory of relativity and in the hypothesis of the absolute reference system, the latter relation is that which is given and from special theory of relativity. That is, this relation applies to both these considerations. Finally, the correlation between expressions for the total energy of a body at rest gives:

$$E_{abs} = \frac{E_{rel}^2}{2mc^2} \tag{3.20}$$

According to the last equation, the relativistic energy is[16]:

$$E_{rel} = \pm\sqrt{2mc^2 E_{abs}} = \pm\sqrt{\boldsymbol{p}^2 c^2 + m^2 c^4} \tag{3.21}$$

so, negative energy values also appear. As mentioned earlier, in order to give an explanation of this, Dirac[17] formulated the theory that the vacuum is not the absolute nothing, but it is an infinite sea of negative energy of electrons, protons, neutrinos, neutrons and all other particles with spin 1/2.

This paradoxical result of existence of negative energies is invalidated when the energy is expressed according to the hypothesis of the absolute reference system, since the quantity E_{abs} is proportional to the square of relativistic energy E_{rel}, while the vacuum of Dirac, of the infinite sea of negative energy, is replaced by aether as a means of propagating electromagnetic radiation.

From a physical point of view, it is much easier for someone to accept that the assumed vacuum is occupied by the aether as a means of propagation of electromagnetic radiation, rather than accepting that it is a sea of particles with neg-

[16]Relative references can easily be found by the reader in all relativistic quantum mechanics books, for example in the book **"RELATIVISTIC QUANTUM THEORY"**, **L. D. LANDAU & E. M. LIFSHITZ**, §11, **Particles and antiparticles**, p.33.

[17]The reader can see the relevant reference [8], chapter 2 *Single-Particle relativistic wave equations*, paragraph **2.4 Prediction of antiparticles** and reference [9], *Fourteenth Lecture*, **INTERPRETATIONS OF NEGATIVE ENERGY STATES**.

ative energies. This theory, which is predicted by the solution of the Dirac equation, leads us to a mathematical description of the universe, apparently different from the corresponding classical physical description that existed until the end of the nineteenth century.

An additional observation is that when the amount E_{rel} is maintained, that is the energy in the relativistic form, then the quantity E_{abs}, that is the energy according to the hypothesis of the absolute reference system is also preserved, and vice versa. Therefore, the use of relation 3.19, in some problems of quantum electrodynamics, is not in any divergence of views, relative to the corresponding calculations from the point of view of the hypothesis of the absolute reference system, except that the energy in the relativistic description, is proportional to the square root of the corresponding energy of the hypothesis of the absolute reference system.

However, with respect to the wave equation used instead of the Schrodinger equation, in the corresponding equation[18] the only difference is the fixed factor $\frac{1}{2}$ in the energy operator, that is instead of $i\hbar\frac{\partial}{\partial t}$ it is $\frac{i\hbar}{2}\frac{\partial}{\partial t}$.

3.5. The Kinetic Energy of a Rotating Body

According to the definition of angular momentum, a body with a density $D(\boldsymbol{r})$, which rotates at a fairly high angular velocity ω and occupies volume *V*, will have an angular momentum equal to:

$$L = \int_V D\gamma_\rho \omega\rho^2 \mathrm{d}V \tag{3.22}$$

where ρ is the distance of the differential mass $\mathrm{d}m = D\mathrm{d}V$ from the axis of rotation and $\gamma_\rho = \left(1-(\omega\rho)^2\right)^{-1/2}$. The kinetic energy of this rotating body is:

$$E_{kin} = \frac{1}{2}\int_V D\gamma_\rho^2 \omega^2\rho^2 \mathrm{d}V \tag{3.23}$$

It is obvious that even in the case of constant angular velocity the classical relation $E_{kin} = \frac{1}{2}L\omega$ is not applies. Instead, the inequality $E_{kin} > \frac{1}{2}L\omega$ applies and will of course converge to equality at low angular speeds ($(\omega\rho/c) \ll 1$), in which case $\gamma_\rho^2 \simeq \gamma_\rho \simeq 1$.

4. Introduction to Particle Mechanics

We will use as a basic relation for the energy of the "free photon" in the laboratory reference system:

$$E_{ph} = h\nu \tag{4.1}$$

[18]As mentioned in the book **"RELATIVISTIC QUANTUM THEORY"**, **L. D. LANDAU & E. M. LIFSHITZ**, $10, **The wave equation for particles with spin zero**, p.31, $p^2 - m^2 = 0$, Equation (10.5) (O. Klein, V. A. Fock, 1926). The explicit form of this equation is $-\partial_\mu\partial^\mu\psi \equiv \left(-\frac{\partial^2}{\partial t^2} + \Delta\right)\psi = m^2\psi$, Equation (10.6).

where ν is the frequency of the photon and h is the Planck constant. Also the same photon will have a linear momentum p_{ph} equal to:

$$p_{ph} = \frac{h\nu}{c} \tag{4.2}$$

which is measured experimentally, with fairly good accuracy (about 2%) by Gerlach and Golsen in 1923, as radiation pressure. This phenomenon comes from the transfer of kinetic energy from these photon energy packets to the target. The mechanical analogue of this pressure is that in which small masses equal to $h\nu/c^2$ moving at velocity c create upon their experimental target the measured radiation pressure. Taking this into account and according to the hypothesis of the absolute reference system, the transmitted kinetic energy from a photon of energy $E_{ph} = h\nu$, will be equal to:

$$T_{ph} = \frac{1}{2} m_{\iota\sigma} c^2 = \frac{1}{2} h\nu \tag{4.3}$$

where $m_{\iota\sigma} = h\nu/c^2$. Therefore, when a free photon of low energy, is absorbed by a particle (e.g., an electron), an amount of kinetic energy equal to $(1/2)h\nu$ is transferred thereto. In this case, when absorbed a number of N photons from a particle, the totally transferred kinetic energy will be:

$$T = \frac{1}{2} h \sum_{i=1}^{N} \nu_i = \frac{1}{2} h\nu_q \tag{4.4}$$

where ν_i the frequency of the photon i and therefore the amount $\nu_q = \sum_{i=1}^{N} \nu_i$ is the sum of the frequencies of all the absorbed photons by the particle.

This whole hypothesis, regarding the transport of kinetic energy from low-energy photons, demonstrates the fact that the force exerted on the particle should be measured by the clock of the particle reference system. This results from the relation:

$$T_{ph} = F\delta x = \frac{1}{2} h\nu \tag{4.5}$$

where δx is a differential displacement due to the force F and the transfer of kinetic energy of a photon $T_{ph} = (1/2)h\nu$. It seems that the amount of $F\delta x$ that is the elemental work of force F is equal to $(1/2)h\nu$, but the frequency ν should certainly be measured with the reference system clock of the particle on which this force exerted.

We will also take into account our initial assumption that elementary particles constitute from photons. As mentioned in the previous section, the internal energy of a particle immobile relative to the laboratory reference system (using the measure of length and the clock of the laboratory) will be equal to $(1/2)mc^2$. This is the kinetic energy of all the bound photons that constitute the whole particle mass. If the sum of the frequencies of these photons is equal to ν_σ then the kinetic energy for a free particle is equal to $(1/2)mc^2 = (1/2)h\nu_\sigma$. The resulting relation of mass-energy equivalence will be:

$$mc^2 = h\nu_\sigma \tag{4.6}$$

In this section we will deal only with elemental (photonic) electromagnetic plane-waves and not those, for example, which exhibit spherical symmetry, such as those in a Coulomb field, which are discussed in the subsection 2.4.

Let us assume now that a photon absorbed by the particle has a high energy $E_{ph} = h\nu$, that is, the frequency ν is included in the frequency spectrum of the "bound photons" forming the particulate mass. Then this absorption will result to increasing the kinetic energy of the particle and in addition creating a bound photon, with the energy given by the original free photon. The action-reaction principle, coupled with the relation 4.5, results in an even distribution of energy between the retardation of the original photon, equivalent to generating elementary mass, and increasing the velocity of the particle. In particular, the kinetic energy (equal to $(1/4)h\nu$) that will come from the half energy of the photon will be transferred to the particle (aggregate), while the other half is available to form an extra elementary mass of "bound photon", resulting from the equivalence relation $(1/2)m_{ph}c^2 = (1/4)h\nu$, equal to:

$$m_{ph} = \frac{h\nu}{2c^2} \tag{4.7}$$

Therefore, the frequency of the bound photon is half of the frequency of the initial photon absorbed by the particle and its internal kinetic energy is equal to $(1/2)m_{ph}c^2 = (1/4)h\nu$, measured with the clock of the frame of reference of the particle. Indeed, under these circumstances, the momentum transferred will be:

$$p_{ph} = m_{ph}c = \frac{h\nu}{2c} \tag{4.8}$$

And the transferred kinetic energy will be:

$$\frac{p_{ph}^2}{2m_{ph}} = \frac{1}{2}m_{ph}c^2 = \frac{1}{4}h\nu \tag{4.9}$$

which is the expected. The view of the existence of mass in an elemental photonic wave is the key to the explanation of the wave-particle duality, that is, every particle may be partly described in terms not only of particles, but also of waves.

If the velocity of a particle relative to the inertial frame of reference of the laboratory is equal to $\boldsymbol{u}$ (due, for example, to a linear accelerator of the laboratory), then the total kinetic energy of a photon bounded to it will be $E_{ph} = (1/2)h\nu'_{ph} = (1/2)m_{ph}\gamma^2c^2$ (where $\gamma = \left(1 - u^2/c^2\right)^{-1/2}$). This relation is derived from the corresponding relations mentioned in subsection 3.3. The mass of the photon in this case is determined by the relation $m_{ph} = h\nu'_{ph}\big/\left(\gamma^2c^2\right)$, that is, it is proportional to the amount $\nu'_{ph}\big/\gamma^2$. The mass of the "bound photon", when this is stationary in the laboratory reference system, it is calculated as $m_{ph} = h\nu_{ph}\big/c^2$. However, this mass remains constant and therefore the equality $\nu_{ph} = \nu'_{ph}\big/\gamma^2$ applies. The difference in frequency is due to the extra frequency added due to the increase in the kinetic energy of the "bound photon" while the measurement of this frequency is based on the time measurement according to the clock of the particle frame of reference. As mentioned before this is the correct way to measure the energy of the elements constituting the particle, that is, of the bound photons. This change in kinetic energy, according to the above, is expressed in the following relation:

$$\Delta E_{ph} = \frac{1}{2} h\left(\nu'_{ph} - \nu_{ph}\right) = \frac{1}{2} h\nu_{ph}\left(\gamma^2 - 1\right) = \frac{1}{2} m_{ph}\gamma^2 u^2 \tag{4.10}$$

The frequency equal to the difference $\nu'_{ph} - \nu_{ph}$ corresponds to an additional elementary photonic wave, which is accompanied by corresponding contraction of the path length of the particular bound photon. This contraction is done according to the corresponding contraction factor γ, in the direction of particle motion relative to the inertial reference system of the laboratory. This is the cause of the contraction of the whole matter of an inertial system, according to the contraction factor γ, in that direction, since we have assumed that the structure of all elementary particles, as well as of the electromagnetic interactions, is photonic.

Let us consider that ν_l is the frequency of this elementary photonic wave, measured by clock of the inertial reference system of the laboratory, and k is the corresponding wavenumber. The wavelength—and any length—is measured by the physical length meter of the lab reference system. Since the frequency of the examined photonic wave, with the clock of the frame of reference of the particle, is γ times higher than the frequency of the same photonic wave measured in the laboratory reference system, the corresponding kinetic energy will be:

$$E_{ph,kin} = \frac{1}{2} h\gamma\nu_l = \frac{1}{2} m_{ph}\gamma^2 u^2 \tag{4.11}$$

The momentum p_{ph} of the photonic particle, in the direction of the velocity u, according to the relation $E_{ph,kin} = (1/2) m_{ph}\gamma^2 u^2 = p_{ph}^2 / (2m_{ph})$, will be:

$$p_{ph} = \frac{2E_{ph,kin}}{\gamma u} = \frac{h\nu_l}{u} \tag{4.12}$$

and therefore, since in the laboratory reference system the quantity ν_l / u is equal to $k/(2\pi)$, the momentum is given by the relation:

$$p_{ph} = \hbar k = m_{ph}\gamma u \tag{4.13}$$

Summarizing we can say that *the mass of a body is the sum of the masses of all the bound photons from which it is composed, and is independent of the reference system of the body.*

4.1. The Structure of the Smallest Elementary Particle

As a first example, we will look at the assumption of a primordial particle accelerated to the absolute reference system. According to the mentioned in the subsection 2.4, the trajectory of the bound photon is a closed circular path in the particle reference system. There is an elemental electromagnetic wave that introduces a new frequency in this photon, which accompanies the transfer movement of the bound photon relative to the absolute reference system.

If $\nu_{ph,u}$ is the frequency of this elementary wave accompanying the transfer movement of the bound photon, measured with the clock of the reference system of the particle, the transfer kinetic energy of the bound photon according to the precedings and Section 3 will be equal to $(1/2)h\nu_{ph,u} = (1/2)m_{ph}\gamma^2u^2$, where $\gamma = \left(1-u^2/c^2\right)^{-1/2}$ the contraction factor and u the speed measured with the physical length meter and the clock of the absolute system. Therefore, the total kinetic energy of the bound photon is:

$$E_{ph,kin,tot} = \frac{1}{2}m_{ph}c^2 + \frac{1}{2}m_{ph}\gamma^2u^2 = \frac{1}{2}m_{ph}\gamma^2c^2 \tag{4.14}$$

It appears from the analysis so far that *the bound photons have two different kinds of frequencies, that is, the one kind of frequencies caused by their transfer motion, denoted here by* $\nu_{ph,u}$, *and the other kind of frequencies of the closed trajectories, denoted here by* $\nu_{ph,c}$, *which can be called mass frequencies, since these are proportional to the mass according to the relation* $m_{ph} = h\nu_{ph,c}/c^2$.

Now that we have a clearer picture of what is considered as microstructure of the smallest elementary particles, which are the bound photons, we can deeper into studying the contraction of length and time.

Let us assume that a particle moves at a constant velocity u with respect to an inertial reference system and that it acquired that velocity from a force internal to the frame of material defining the particular inertial system. The speed u is measured with the clock and the physical length meter of the inertial system. We also assume that this material frame of the inertial system moves at a constant velocity v with respect to the absolute reference system. The velocity v is measured by the physical length meter and the clock of the absolute reference system, and it comes from the action of an internal force in the absolute reference system.

An additional basic principle of the hypothesis of the absolute reference system is that *the way of correlation between the values of physical magnitudes in the absolute reference system and in an inertial system of reference does not differ from the corresponding correlation way in two inertial systems.*

We will calculate now the closed orbit times of a bound photon of the above-mentioned particle in three different reference systems.

If the times of the closed orbits of the above-mentioned bound photon in the reference system of the particle, in the above-mentioned inertial frame of reference, and in the absolute reference system respectively are T_u, T_v and T_0, the taken equations are $T_u = \gamma_u T_v$ and $T_v = \gamma_v T_0$, where $\gamma_u = \left(1-u^2/c^2\right)^{-1/2}$ and $\gamma_v = \left(1-v^2/c^2\right)^{-1/2}$. The correlation of the times T_u and T_0 is given by the relation:

$$T_u = \gamma_v \gamma_u T_0 \tag{4.15}$$

This result differentiates the concept of the inertial reference system as compared to the corresponding relativistic concept, which is related to the concept of relative movement. In the present case, according to the previous relation, the total contraction factor is equal to $\gamma_v\gamma_u$ and therefore does not come from the relative velocity, of our example, with respect to the absolute reference system but comes from the product of the two contraction factors. This mainly means that *the differentiation between two inertial systems of reference is not based on their relative velocity with respect to the absolute reference system but on the total contraction factor*. For example, two identical inertial particles that are relatively immobile to each other are differentiated from each other if they are characterized by different total contraction factors.

Substituting the previous correlation of inertial reference systems to a plurality n of inertial systems, the total contraction factor is equal to the quantity $\gamma_1\gamma_2\gamma_3\cdots\gamma_n$, whereby an inertial particle of the last inertial system will correspond to a total contraction factor equal to $\gamma_1\gamma_2\gamma_3\cdots\gamma_n\gamma$. The kinetic energy of the inertial mass of one of the bound photons that make up the entire mass of the particle is equal to:

$$\frac{1}{2}h\nu_{ph,c} = \frac{1}{2}m_{ph}c^2 \tag{4.16}$$

while kinetic energy, due to its transfer motion, is equal to:

$$\frac{1}{2}h\nu_{ph,u} = \frac{1}{2}m_{ph}\gamma_1^2\gamma_2^2\gamma_3^2\cdots\gamma_n^2\gamma^2u_0^2 \tag{4.17}$$

where $\gamma = \left(1-u^2/c^2\right)^{-1/2}$ is the partial contraction-factor of the inertial particle, u_0 its velocity measured with the physical measure of length of the last (with index n) inertial system, but with the clock of the absolute reference system, and $\nu_{ph,u}$ is the frequency due to its transfer motion, measured with the clock of the frame of reference of the particle. We also assume that u is the velocity due to the particle's transferring movement, measured with the measuring instruments of the last (with index n) inertial system, equal to:

$$u = \gamma_1\gamma_2\gamma_3\cdots\gamma_n u_0 \tag{4.18}$$

Therefore, the transport kinetic energy is equal to:

$$\frac{1}{2}h\nu_{ph,u} = \frac{1}{2}m_{ph}\gamma^2u^2$$

Total kinetic energy is equal to:

$$E_{ph,kin,tot} = \frac{1}{2}h\left(\nu_{ph,c}+\nu_{ph,u}\right) = \frac{1}{2}m_{ph}\gamma^2c^2 \tag{4.19}$$

If the above particle consists of a number of N bound photons, and m is its mass, then:

$$m = \sum_{i=1}^{N} m_{ph_i} \tag{4.20}$$

while total frequencies and energies are:

$$\nu_c = \sum_{i=1}^{N}\nu_{ph_i,c} \tag{4.21}$$

$$\nu_u = \sum_{i=1}^{N}\nu_{ph_i,u} \tag{4.22}$$

$$\frac{1}{2}\sum_{i=1}^{N} m_{ph_i} c^2 = \frac{1}{2} mc^2 \tag{4.23}$$

$$\frac{1}{2}\sum_{i=1}^{N} m_{ph_i} \gamma^2 u^2 = \frac{1}{2} m\gamma^2 u^2 \tag{4.24}$$

$$E_{kin,tot} = \frac{1}{2} h\left(\nu_c + \nu_u\right) = \frac{1}{2} m\gamma^2 c^2 \tag{4.25}$$

However, this total kinetic transport energy refers to the energy estimate in the last inertial system (with index n). The "universal transport kinetic energy" of the previous particle is the sum of all the kinetic transport energies, with respect to all inertial reference frames, including the absolute reference system, that is, the sum of:

$$E_{univ.} = \frac{1}{2} m\sum_{i=1}^{n} \gamma_i^2 u_i^2 + \frac{1}{2} m\gamma^2 u^2 \tag{4.26}$$

where u_i is the velocity measured by the length measure and clock of the inertial reference system which is denoted by an index $i-1$. If $i-1=0$, then the velocity measurement is done with the length and time measuring instruments of the absolute reference system. The quantity $\frac{1}{2} m\sum_{i=1}^{n} \gamma_i^2 u_i^2$ is the basic kinetic energy, that comes from the motion of the particle with respect to the n-th inertial system. If M is the total mass of the material frame of the n-th inertial reference system, then its basic kinetic energy is:

$$E_{in.sys.bas.,n} = \frac{1}{2} M\sum_{i=1}^{n} \gamma_i^2 u_i^2$$

If we denote by ν_i the frequency due to the corresponding term of kinetic transport energy, then according to the relation $\frac{1}{2} h\nu_i = \frac{1}{2} m\gamma_i^2 u_i^2$ the universal kinetic energy of the above particle is equal to:

$$E_{univ.} = \frac{1}{2} h\sum_{i=1}^{n} \nu_i + \frac{1}{2} h\nu_u \tag{4.27}$$

while the amount $\sum_{i=1}^{n} \nu_i$ is the sum of frequencies that are corresponds to the basic kinetic transport energy of the particle. We define as "basic frequency" ν_b this sum, that is $\nu_b = \sum_{i=1}^{n} \nu_i$, bypassing the fact that it is a sum of different (or not) frequencies.

Ultra-high energy cosmic particles such as those of the Auger phenomenon could indeed be due to the fact that they come from inertial systems with ultra-high basic kinetic energy particles, thus yielding the energy difference between them and the Earth's particles, due to interactions between them.

According to the introduction of the Section 4, the free photons exert radiation pressure on a fixed target corresponding to energy $\frac{1}{2} m_{\iota\sigma} c^2 = \frac{1}{2} h\nu$ and to the equivalent mass of the free photons $m_{\iota\sigma}$. In the last inertial system (which is the n-th inertial system) we mentioned earlier, in addition to the speed c of the light relative to a light source of the same system, we should also take into account the radiation pressure of the intermediate inertial systems (with indices $1,2,\cdots,n$) if the target of the light beam is, for example, in the absolute reference system. These kinetic energies and the corresponding frequencies are similar to those of the above-mentioned particle, that is, the basic energy, for a free photon emitted by a light source in the *n*-th inertial system, is:

$$E_{b_{ph}} = \frac{1}{2} m_{\iota\sigma} \sum_{i=1}^{n} \gamma_i^2 u_i^2 = \frac{1}{2} h\nu_{ph} \sum_{i=1}^{n} \frac{\gamma_i^2 u_i^2}{c^2} \quad (4.28)$$

and its basic frequency is expressed by the term $\nu_{ph} \sum_{i=1}^{n} \gamma_i^2 \left(u_i^2 / c^2 \right)$, where ν_{ph} is its frequency in the same inertial reference system. In the inertial system which is denoted by the index *i*, for example, the corresponding frequency is $\nu_{ph_i} = \nu_{ph} \gamma_i^2 \left(u_i^2 / c^2 \right)$, but the frequencies, denoted by the indices $i = 1,2,\cdots,n$, are not perceived by a natural observer of the reference system denoted by the index *n*, because the inertial frame material is moving along with the free photons with the same total contraction factor $\gamma_1\gamma_2\gamma_3\cdots\gamma_n$, and therefore cannot be the target of these individual photonic motions.

4.2. Doppler Effect

A complex problem, predominantly geometric, should be examined in this section, in order to study the Doppler effect. For this purpose we should use the ones mentioned in this chapter. In summary, it should be recalled in principle that the velocity of light in the vacuum is equal to the constant *c* when the light source is (and is observed) in the absolute reference system. Also, as we will see in the chapter on particle mechanics, apart from the physical contraction of the photonic tracks, it appears that the speed of the "free photons" has the same value *c*, when it is measured by the physical length meter and the clock of the inertial frame of reference of the light source, while when it is measured with the physical measure of length and the clock of the absolute reference system the velocity of the same photons in vacuum is being different from this constant *c*.

A more general case involving the Doppler effect is one in which an electromagnetic signal emitted periodically (a pulse transmitted per time unit), from some part of a galaxy, and is directed to Earth, where it is received. We will determine the relation of the two frequencies of the emission and taking of the signal, based on the hypothesis of absolute reference system. A relative reference is [1], chapter 5, **Relativistic Kinematics**, **MORE ABOUT DOPPLER EFFECTS**. The velocity of the source of the emitted electromagnetic signal to the absolute system is assumed to be equal to u_g, while Earth's velocity is u_Γ. We assume that the trajectory of the source (of the galaxy) with respect to the absolute reference system is *AB*, while the Earth's trajectory is CD (**Figure 1**).

The points *A*, *B*, *C*, *D* are not at the same level, but we consider the straight lines *AC* and *BD* parallel because of the large distance. Along these straight lines two consecutive electromagnetic signals are moving. The velocity of the electromagnetic signal with the physical measure of length and the clock of the absolute reference system, since the light velocity in the reference system of the

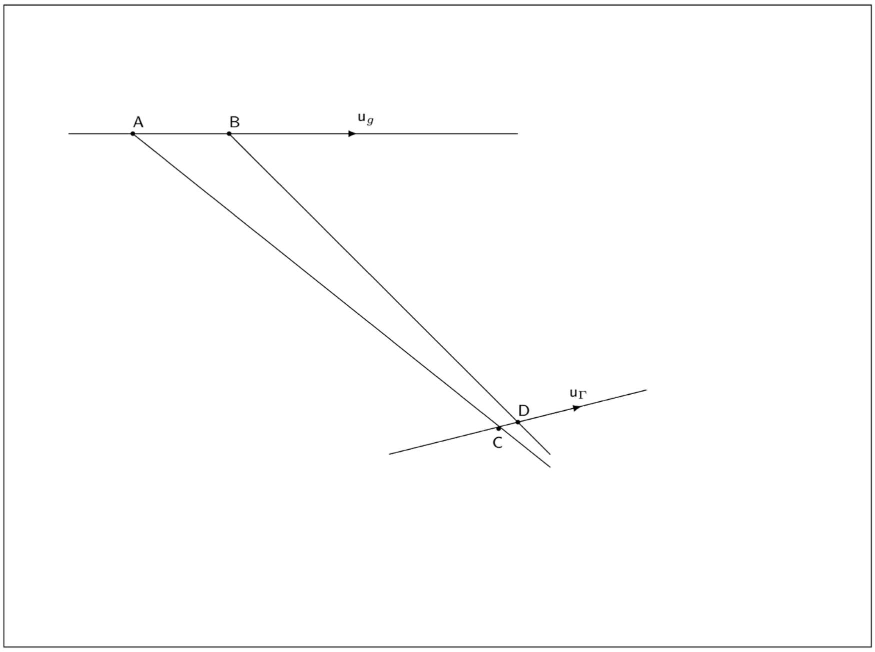

Figure 1. Broadcasting and receiving electromagnetic signals from a long distance in the point of view of absolute reference system. The trajectory of the source in the absolute reference system is the *AB* line, while the Earth's trajectory is the *CD* line. Two consecutive electromagnetic signals move along the lines *AC* and *BD*.

source is equal to the constant value *c*, and taking into account the time and length contractions, will be:

$$c_g = \sqrt{c^2 \sin^2 \chi / \gamma_g^2 + \left(c \cos \chi / \gamma_g^2 + u_g \right)^2} \tag{4.29}$$

where χ the angle formed by the direction of the electromagnetic signal, emitted by the source from point *A* to the reference system of the galaxy, with the line *A*?, *i.e.* without physical contraction in the direction of motion of the galaxy. Also u_g is the velocity of the galaxy in the absolute reference system, when it is measured with the physical length-measure and the clock of the absolute reference system. Considering this velocity as much greater than the respective velocities of the individual movements inside the galaxy, the contraction factor will be $\gamma_g = \left(1 - u_g^2 / c^2\right)^{-1/2}$.

Defining the times τ_Γ and τ_g as the time differences between the pulses from the Earth and the pulses from the source of electromagnetic signals respectively, as these times are measured with the clock of the absolute reference system, the following equation is taken:

$$\begin{aligned} \tau_\Gamma &= \tau_g - \left(AC/c_g - BD/c_g \right) \\ &= \tau_g - \left(u_g \tau_g \cos \phi - u_\Gamma \tau_\Gamma \cos \theta \right) / c_g \end{aligned} \tag{4.30}$$

where θ is the acute angle formed by the *AC* and *CD* lines of the shape and ϕ is the acute angle formed by the *AB* and *AC* lines in the absolute reference system. If t_Γ and t_g denote the time differences of the pulses with the clocks of the inertial reference systems of the Earth's and of the source of electromagnetic signals respectively, then the correlations between these and the previous time differences are $t_\Gamma = \tau_\Gamma / \gamma_\Gamma$ and $t_g = \tau_g / \gamma_g$, where $\gamma_\Gamma = \left(1 - u_\Gamma^2 / c^2\right)^{-1/2}$ and u_Γ the Earth's velocity with respect to the absolute reference system (with the physical measure of length and the clock of the absolute system). As mentioned before the velocity of the Earth inside our galaxy's frame of reference is considered as negligible, compared to our galaxy's velocity with respect to the absolute reference system. The measured frequencies of the pulses, in the Earth's reference system and in the galaxy's reference system respectively, are $\nu_\Gamma = 1/t_\Gamma$ and $\nu_g = 1/t_g$.

Finally, the correlation of the time differences and the frequencies of emission and reception of the electromagnetic signal, results in the relations:

$$\tau_\Gamma = \tau_g \frac{c_g - u_g \cos\phi}{c_g - u_\Gamma \cos\theta}$$

$$\nu_\Gamma = \nu_g \frac{\left(c_g - u_\Gamma \cos\theta\right)\gamma_\Gamma}{\left(c_g - u_g \cos\phi\right)\gamma_g} \tag{4.31}$$

This latter relation, which correlates the frequency of emission and reception of electromagnetic pulses (or the emission and reception of an electromagnetic wave in general) is clearly different from that of the special theory of relativity. An important remark is that the shift of the spectral lines towards the red or towards the violet depends on whether the quantity $u_\Gamma \cos\theta$ is greater or less than the quantity $u_g \cos\phi$, but also on the ratio γ_Γ / γ_g. The differentiation from the relativistic perception is that in this relation two velocities (the velocity of the galaxy and the velocity of the earth with respect to the absolute reference system) are taken into consideration, while in the corresponding relativistic relation for the Doppler effect, it is taken into account only the relative velocity of the galaxy with respect to the earth. So, the results from the use of the relativistic Doppler effect has to be reviewed on the basis of what has been described here, if we want to agree with the hypothesis of the absolute reference system.

The difference in estimated masses, derived from the use of two different methods such as those of Newtonian theory of gravity and brilliance of stars in conjunction with the corresponding shift to the red spectrum of galaxies, can only be explained by introducing the assumption of dark matter or by the modification of the universal law of gravitation. This assumption of the modificated Newtonian theory of gravity is introduced by Moti Milgrom from 1983 and is also supported by Jacob Bekenstein since 2004. According to the hypothesis of the absolute reference system, using the relation 4.31 this contradiction can be resolved. Therefore, neither the assumption of dark matter nor any other modification of the universal law of gravitation is needed to explain these celestial phenomena.

According to the observations of the rotation curves of spiral galaxies, stars with larger galactic orbits do not follow as expected in Kepler's third law. According to Kepler's third law, these stars should have smaller orbital velocities than those closest to the galactic center. What has been observed is that instead of being reduced to large rays, the orbital velocities remain constant. This finding has led to conclusions such as the existence of a dark matter composed of hypothetical particles, which do not emit or reflect enough electromagnetic radiation to be readily detectable, and supposed to cover the deficiency of the mass in order for these observations to be consistent with the Newton's theory of gravity.

All these findings, however, relate to the assessment of the speeds and, by extension, the masses based on the Doppler relativistic phenomenon. From the point of view of the absolute reference system, the relation for the displacement of the spectral lines and the corresponding change in the frequency of light coming from the stars that follow these galactic paths is the 4.31. The velocities that dominate the absolute reference system are not the individual stellar velocities in the inner space of the galaxies, but the velocities of the galaxies in the absolute reference system, because the stellar velocities (inside the galactic space) are much smaller than the velocities of the galaxies.

In the absolute reference system the circular galactic orbits of the stars, in conjunction with the movement of the galaxy, are helical, but the above-mentioned great difference in velocities makes these orbits almost straight lines and identical to the orbit of the galaxy. From this analysis we can conclude that the observed spectral stability of light coming from stars with different galactic paths is consistent with the hypothesis of the absolute reference system, and in this case the dark matter assumption does not need in order to justify these observations.

Another subject to be discussed is to solve cosmological problems according to newer observations and the corresponding explain of these problems with a newer physical theory[19], according to which the constant of the velocity of the light in the vacuum is not exactly constant. According to this theory the velocity of the light in vacuum has a value that depends on the time of the evolving universe, so the velocity of light coming from the early universe is much greater. From the point of view of the hypothesis of the absolute system of reference, it is obvious that the velocity of light coming from earlier phases of the evolutionary process of the universe is much greater, despite the fact that this velocity is equal to the known constant c when this velocity is measured in the reference system of the source of light. For example, the aforementioned velocity of light coming from the galaxy of our example, when it is measured in the Earth's reference system (with the Earth's physical measures of length and time), will have a value equal to:

$$c_\Gamma = \sqrt{c_g^2 \gamma_\Gamma^2 \sin^2 \chi_\Gamma + \left(c_g \gamma_\Gamma^2 \cos \chi_\Gamma \pm u_\Gamma\right)^2} \tag{4.32}$$

[19]**A time varying speed of light as a solution to cosmological puzzles**, Andreas Albrecht and Joao Magueijo, Theoretical Physics, The Blackett Laboratory, Imperial College, Prince Consort Road, London, SW7 2BZ, UK.

where χ_Γ is the angle formed by the direction of the electromagnetic signal emitted by the point A of the source of electromagnetic wave with the Earth's trajectory, with respect to the absolute reference system, whereas the double sign ± is used according to Earth's velocity direction.

In 1919 Hubble discovered that all external galaxies are moving away from us[20]. In calculating the speeds and distances of distant galaxies, initially, the relativistic Doppler effect had not been taken into account, and these velocities were calculated simply by using the function $c\Delta\lambda/\lambda$.

However, we will have to revise the results from the use of the relativistic Doppler effect according to what has been said so far, if we want to see the corresponding results from the point of view of the absolute reference system. In the Table 1 are listed the distances and velocities relative to the Earth of specific galaxies, based on a 1958 revised distance scale.

If the emitted pulses of the aforementioned example are emitted from an Earth satellite, then the phenomenon can be examined in the Earth reference system, so, the speed c_g is replaced to the constant c, the velocity u_Γ is equal with zero, the angle ϕ is formed by the direction of the pulse and the satellite velocity in the earth reference system, the velocity u_g substitutes the satellite velocity in the Earth's reference system and finally the two relations 4.31 result in the relations which are provided by the special theory of relativity.

4.3. The Fizeau Experiment

When entering a monochromatic light beam in a transparent container containing water in motion relative to the container and the whole experimental device, the initial velocity of the beam tends to initially vary due to the fluid movement, and then due to the refraction effect of the beam, which already has a differentiated speed, in the water.

Addressing the issue in this way is due to the concept of the inertial system according to the hypothesis of the absolute reference system. The experimental arrangement of Fizeau is in the land reference system, while the moving fluid, in this case water, is in an inertial reference system moving at a velocity v in relation to the Earth reference system. According to the absolute reference system hypothesis, each inertial reference system (together with the frame material) has an objective being, and it is not determined exclusively by the observer which is stationary (or not) with respect to that reference system, as provided by the corresponding relativistic description.

The source of the light beam, as well as the beam, are included in the same inertial reference frame. This means that the beam is part of the inertial system of the experimental array because of its "basic frequency", according to the relative definitions in the subsection 4.1. The moving water is in another inertial system moving at the velocity v with respect to the inertial beam source and therefore causes a variation of the initial velocity of the light beam that is equal to v/n,

[20]Ref. [1], chapter 5, **Relativistic Kinematics**, **The red shift of distant galaxies**.

Table 1. Distances and velocities of distant galaxies relative to the Earth, based on a 1958 revised distance scale.

Galaxies	Velocity ($\times 10^4$ km/sec)	Distance (light years)
Virgo	0.12	0.4×10^8
Ursa Major	1.40	5.0×10^8
Corona Borealis	2.14	7.0×10^8
Boötes	3.90	1.3×10^9
Hydra	6.10	2.0×10^9

where n is the refractive index of the water. Therefore, since the initial velocity of the beam in the air is approximately equal to the velocity of the light in the vacuum, for an observer in the inertial reference system of the moving water the final velocity of the beam will be equal to $\left(c \pm v/n\right)/n$, depending on its direction in relation to the direction of water movement, including the refraction effect when its velocity has already changed.

When the beam moves in the same direction as water, for an observer in the inertial system of the experimental device, the velocity of the beam within the moving water is:

$$u = \left(c - v/n\right)/n + v = c/n + \left(1 - \frac{1}{n^2}\right)v \tag{4.33}$$

When the water and beam directions are opposite:

$$u = \left(c + v/n\right)/n - v = c/n - \left(1 - \frac{1}{n^2}\right)v \tag{4.34}$$

The factor $f = 1 - 1/n^2$ is the known drag coefficient of Fresnel.

4.4. Speed of Light of a Moving Source

When the light passes into a medium, a continual process of absorption of the incident light and its reemission as secondary radiation by the medium takes place, and due to this effect the speed of the original source cannot be detected. This phenomenon is known as extinction[21] and for visible light, in order to accomplish, a thickness of about 10^{-5} cm of glass or 0.1 mm of air at atmospheric pressure is almost sufficient.

[21]**Experimental Evidence for the Second Postulate of Special Relativity**, J. G. Fox, Carnegie Institute of Technology, Pittsburgh, Pennsylvania, Citation: American Journal of Physics 30, 297 (1962), page 297, II. THE EXTINCTION THEOREM, … From the Thomson cross section for the scattering of light by an electron σ and the number of scattering electrons per unit volume n, one can estimate roughly the distance l in which the incident beam is attenuated. One must take into account the fact that the scattering electrons are oscillating in definite phase relations with one another. Many oscillate in phase and hence radiate in phase and absorb energy from the incident beam faster by a factor equal to the square of the number in phase. This may be taken to be roughly the square of the number of electrons in a length $\lambda/2\pi$ (λ = *the wavelength*) and is about 10^5 for condensed materials. Thus we obtain $l \simeq 1/\left(10^5 n\sigma\right)$. with $\sigma \simeq 6\times10^{-25}\ \text{cm}^2$ and $n \simeq 10^{23}/\text{cm}^3$, we obtain $l \simeq 10^{-4}$ cm. This is indeed a thin surface layer …

But according to the hypothesis of the absolute reference system, there is one more deeper cause that can cause an extinction effect and loss of the ability to determine the motion of the light source. According to the ones described in the subsection 4.1, the photons emitted have a "basic energy" and a corresponding "base frequency" derived from the reference system of the moving light source. Due to the scattering of the photons with the electrons of the optical medium from which they pass, the basic frequency and basic energy of the beam are equated with those of the electrons of the optical medium, yielding or gaining energy. This results in the photon beam moving at a velocity c/n with respect to the optical medium, where we denote by n the refractive index of the optical medium, and by c the velocity of light in the vacuum.

Such experiments[22], with high-frequency electromagnetic γ radiation derived from moving sources, were made to verify the second axiom of the special theory of relativity, of the stability of the light velocity, independent of the light source movement and the observer.

Also, according to the hypothesis of the absolute reference system, the beam originating from a rotating light source propagates at a speed determined not by the instantaneous velocity of the source but by the inertial system to which the light source is rotated. This is a basic requirement of the absolute system hypothesis and is described in detail in the section of electromagnetism. Therefore, experimental results[23] and observations[24] derived from rotatable electromagnetic radiation sources are in agreement with the hypothesis of the absolute reference system, although those experiments were performed to confirm the second

[22]Alvaeger F.J.M. Farley, J. Kjellman and I Wallin, Physics Letters 12, 260 (1964). Arkiv foer Fysik, Vol 31, pg 145 (1965). (Measured the speed of gamma rays from the decay of fast π^0 (0.99975 c) to be c with a resolution of 400 parts per million.) Sadeh, Phys. Rev. Lett. 10 no. 7 (1963), pg 271. (Measured the speed of the gammas emitted from e^+e^- annihilation (with center of mass v/c 0.5) to be c within 10%.) Filippas and Fox, Phys. Rev. 135 no. 4B (1964), pg B1071. (Measured the speed of gamma rays from the decay of fast π^0 (0.2 c) in an experiment specifically designed to avoid extinction effects.)

[23]Kantor, W., J. Opt. Soc. Amer., 52, 9, 978 (1962). James, J. F., and Sternberg, R. S., Nature, 197, 1192 (1963). Babcock and Bergmann, Journal Opt. Soc. Amer. Vol. 54, pg 147 (1964).(This repeat of Kantor's experiment in vacuum shows no significant variation in the speed of light affected by moving glass plates. Optical Extinction is not a problem. k < 0.02.) Rotz, F. B., Phys. Lett., 7, 4, 252 (1963). Beckmann, P., Dept. of Elect. Eng., Univ. of Colorado, Reprint (1964). Waddoups, R. O., Edwards, W. F., and Merrill, J. J., J. Opt. Soc. Amer., 55, 2, 142 (1965). Vysin, V., Phys. Lett., 8, 36 (1964). Datzeff, A. B., C.R. Acad. Sci., Paris, 17, 2, 121 (1964). Beckmann and Mandics, "Test of the Constancy of the Velocity of Electromagnetic Radiation in High Vacuum", Radio Science, 69D, no. 4, pg 623 (1965). (A direct experiment with coherent light reflected from a moving mirror was performed in vacuum better than 10^{-6} torr.)

[24]Comstock, Phys. Rev. 10 (1910), pg 267. DeSitter, Koninklijke Akademie van Wetenschappen, vol 15, part 2, pg 1297-1298 (1913). DeSitter, Koninklijke Akademie van Wetenschappen, vol 16, part 1, pg 395-396 (1913). DeSitter, Physik. Zeitschr. 14, 429, (1913) DeSitter, Physik. Zeitschr. 14, 1267, (1913) Zurhellen, Astr. Nachr. 198 (1914), pg 1. (Observations of binary stars. $k < 10^{-6}$. These are all subject to criticism due to Optical Extinction.) K. Brecher, "Is the Speed of Light Independent of the Velocity of the Source?", Phys. Rev. Lett. 39 1051-1054, 1236(E) (1977). (Uses observations of binary pulsars to put a limit on the source-velocity dependence of the speed of light. $k < 2\times10^{-9}$. Optical Extinction is not a problem here, because the high-energy X-rays used have an extinction length considerably longer than the distance to the sources.)

axiom of the special theory of relativity, about the stability of light velocity, such as the above experiments, that are referring to moving sources of γ radiation.

4.5. Terrestrial Sources According to the Hypothesis of the Absolute Reference System

The apparent velocity of light emitted by a source located in the inertial reference system of a laboratory, moving in parallel and in the same direction as the light beam at a velocity v with respect to the inertial system of observation is $u = l/t$, where u is the velocity measured by the inertial observation system and l, t is the length and the time measured by the physical measure of length and the clock of the same system. We assume that the measurements are made in the absolute vacuum, so that this velocity, when it is measured in the reference system of the source, to be equal to the velocity of the light in the vacuum, that is, to be equal to $c = \gamma^2 (l - vt)/t$, where $\gamma = (1 - v^2/c^2)^{-1/2}$. Therefore the velocity u is:

$$u = c/\gamma^2 + v \tag{4.35}$$

In the speed range v from 0 to c, the velocity u has a maximum value of $5c/4$ when the corresponding velocity value v is $c/2$. Experimental confirmation of this phenomenon is not simple. The simplest case would probably be the one of a particle in the place of the light source. For example, if from a particle, running at the laboratory at a speed close to half the speed of light in the vacuum, is emitted a photon that moves in the absolute vacuum at a velocity, measured by the physical measure of length and the clock of the frame of reference of the particle, very close to the speed of light in the vacuum, the velocity u could be measured equal to the amount $c + c/4$.

When the reference system of the light source, and the light beam move in the opposite direction, the velocity u is calculated with the relation:

$$u = c/\gamma^2 - v \tag{4.36}$$

In this case, the velocity u is zeroed when $v = (\sqrt{5} - 1)c/2 \simeq 0.618c$.

4.5.1. Experimental Confirmation

Since the creation of the absolute vacuum is practically impossible, the best way to implement such an experiment is through the production of neutrinos in a particle reaction, since these particles move at long distances without interactions.

The neutrinos produced are derived from protons accelerated in the European Center of Nuclear Research (CERN) accelerator (synchrotron), at speeds that are very close to the speed of light in the vacuum. Therefore, protons moving at such high velocities define an inertial reference system in which then the produced pions/kaons decay into muons and neutrinos, but only the neutrinos are finally allowed to pass through the muon detectors, while the hadrons also stop on a specific target.

The determination of proton velocity is based on the energy calibration according to the special theory of relativity. This is because both in terms of special theory of relativity and the view of the absolute reference system, the proton motion equation perpendicular to the dynamic lines of a homogeneous magnetic field, in the Gaussian system of units, is:

$$m\gamma \frac{\mathrm{d}\boldsymbol{v}}{\mathrm{d}t} = \frac{e}{c}\boldsymbol{v} \times \boldsymbol{B}$$

where m and e are the known values for the proton mass and charge respectively. Also $\boldsymbol{v}$ is the protons velocity within the magnetic field $\boldsymbol{B}$, and

$$\gamma = \left(1 - \boldsymbol{v}^2 / c^2\right)^{-1/2}.$$

If we assume that v is the velocity of the protons and u the velocity of the neutrinos then according to the previous relation $u = c/\gamma^2 + v$ arises:

$$\frac{u-c}{c} = \frac{v}{c} - \frac{v^2}{c^2} \tag{4.37}$$

The determination of the velocity v of the protons will therefore be made according to the kinetic energy relation of the special theory of relativity $E = m(\gamma - 1)c^2$, where $\gamma = \left(1 - v^2/c^2\right)^{-1/2}$.

The first terrestrial measurement of absolute transit time was carried out by the MINOS[25] research team in 2007 at Fermilab. To create neutrinos (the so-called NuMI beam) they used the Fermilab Main Injector, with which 120 GeV energy protons were directed to a graphite target. The produced mesons were decayed into muons—neutrinos 93% and muons—antineutrinos 6%, in a 675 meters long tunnel. The path time was determined by comparing arrival times at the nearby and distant MINOS detectors, that is, a 734 km path. The clocks of both stations were synchronized by the GPS and large optical fibers were used to transmit the signal.

Since the energy of the accelerated protons is 120 GeV, the ratio $(u-c)/c$ is calculated using the relation (4.37). The result of the calculation is:

$$\frac{u-c}{c} \simeq 3.05 \times 10^{-5}$$

which is in agreement with the corresponding experimental result.

Indeed, was measured an early neutrino arrival of approximately 126 ns. Thus, the relative speed difference was $(u-c)/c = (5.1 \pm 2.9) \times 10^{-5}$ (68% confidence limit). The main source of error in the experiment was the uncertainty in optical fiber delays. The statistical significance of this result was less than 1.8σ, thus it was not significant since 5σ is required to be accepted as a scientific discovery.

At the end of 2011 and early 2012, two new experiments were done, in order to be measured the velocity of neutrinos. The first one to be mentioned is that of the OPERA detector[26], while the second is what was done by the ICARUS re-

[25]**Measurement of neutrino velocity with the MINOS detectors and NuMI neutrino beam**, P. Adamson, C. Andreopoulos, K. E. Arms, … (The MINOS Collaboration)

[26]**Measurement of the neutrino velocity with the OPERA detector in the CNGS beam**, T. Adam, N. Agafonova, A. Aleksandrov, …, 12 Jul. 2012.

search team[27]. These experiments have contradictory results, when they examined from the point of view of the special theory of relativity, but viewed from the point of view of the hypothesis of the absolute reference system are in agreement.

The OPERA neutrino detector at LNGS is composed of two identical Super Modules, each consisting of an instrumented target section with a mass of about 625 tons followed by a magnetic muon spectrometre. Extensive information on the OPERA experiment is given in the reference "OPERA Collaboration, R. Acquafredda *et al.*, JINST 4 (2009) P04018". The CNGS beam is produced by accelerating protons to 400 GeV/c with the CERN Super Proton Synchrotron (SPS). Therefore the ratio $(u-c)/c$ is calculated:

$$\frac{u-c}{c}=2.7\times10^{-6}$$

which is in total agreement with the corresponding experimental result, that is equal to $(u-c)/c=\left(2.7\pm3.1(stat.)^{+3.4}_{-3.3}(sys.)\right)\times10^{-6}$.

The ICARUS experiment was carried out with the help of the Large Hadron Collider (LHC), since in the corresponding publication is stated: "The CNGS proton beam structure for the 2012 neutrino time of flight run is shown in **Figure 1**. It was based on LHC-like proton extractions, with a single extraction per SPS super-cycle (13.2 s), 4 batches per extraction separated by 300 ns, and 16 proton bunches per batch separated by 100 ns; each bunch had a narrow width of 4 ns FWHM (1.8 ns rms)."

At the end of 2011, the LHC had an operating break that would allow for a proton beam energy increase of 3.5 TeV to 4 TeV per beam. Therefore, the proton energy used in ICARUS is, during the period of implementation of the experiment, in the order of 3.5 TeV. In this case the ratio $(u-c)/c$ is calculated:

$$\frac{u-c}{c}=0.36\times10^{-7}$$

which is also in agreement with the corresponding experimental result, that is equal to $(u-c)/c=\left(0.4\pm2.8(stat.)\pm9.8(sys.)\right)\times10^{-7}$.

5. Conclusions

The hypothesis of the absolute reference system can be characterized as a "unified theory", since it is capable of interpreting the macrocosm and the microcosm. To sum up, the study so far, based on the hypothesis of the absolute reference system, concludes with the following conclusions:

1) Starting from the Faraday principle for the magnetic field, and extending this principle to the electric field, we get the Maxwell equations, with the coexistence of two additional kinetic terms like those of the special theory of relativity. These modified Maxwell equations give the solution to open issues of electromagnetism.

[27] **Precision measurement of the neutrino velocity with the ICARUS detector in the CNGS beam**, M. Antonello, B. Baiboussinov, P. Benetti, …, 26 Sep. 2012.

2) Due to the Doppler phenomenon modification according to the principles of the absolute reference system, there is no reason for the presence of dark matter.

3) In the study of neutrinos, derived from protons accelerated in a synchrotron, the theoretical calculation of neutrinos velocity based on the hypothesis of the absolute reference system is in agreement with the experimental results of neutrinos velocity measurements. These experimental results are in contrast to the special theory of relativity.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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