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Einstein's Mistake: The Non-Objectivity of Spacetime Distortion

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Abstract

Pseudotachyonic Relativity (PtR) implicates the reality of negative energies and of two opposite time-flows in the Universe. Neither Newton's law of gravity neither General Relativity have been formulated taking these possibilities into account. Contrastively, however, both theories embrace the mathematical possibility of temporal reversal but not directly of negative energies. The concept of co-particles provides the foundations of a generic field theory on basis of positive and negative energies. Its basic propositions are summarized here. Newton's law of gravity is analysed and generalized to negative masses. Finally, some reflections on relativistic accelerated frames are brought forth, with a relevant conclusion: Einstein made a mistake when he pushed the equivalence between gravity and accelerated frames too far, establishing the reality of the curvature of spacetime. It seems that he took the effect as the cause. According to PtR, gravity is caused by mediator particles (gravitons or co-gravitons), exchanging energy and momentum and generating either attractive or repulsive fields; matter is pro-reactive to these fields, co-matter anti-reactive. As a result, from the point of view of accelerated frames, spacetime seems to be curved in symmetrical ways for matter and co-matter. That means, spacetime distortion is not an objective feature of the Universe: the force is real, the distortion is just appearance.
Keywords: Special relativity; Pseudotachyonic relativity; Negative energy; Reversed time; Gravity; Spacetime structure.

1. Introduction

What is gravity and how does it work? This has been a fundamental question for a long time, from long before Newton's discomfort with the mysterious "action at a distance" that his Law seems to imply. This is still a fundamental question.

Since Einstein's formulation of General Relativity (GR), numerous but unsuccessful efforts have been made to conciliate it with Quantum Physics. If gravity is a distortion of spacetime, how does it spread? How to describe this field in terms of mediator particles – gravitons – if spacetime itself is modified by their trail, in fact, by their own existence? Moreover, what is the role of mediator particles in mediating "fictitious forces"?

The theory of Pseudotachyonic Relativity (PtR), a seemingly coherent variant of Special Relativity applied to the 'faster than light'Luís Dias Ferreira [1] brings forward the reality of negative energies and the coexistence of two time flows in the Universe. In short, a *tachyon* (a particle theoretically moving faster than light) may only be detected – or, generally, interact with bradyonic particles – as a 'slower than light' *co-particle*, with negative energy and a 'reverted history'. This also applies to massless particles, as photons (in this case corresponding to *co-photons*, with the same velocity *c*). This co-particle concept reminds the original Dirac's *negative-energy electron*, but it seems that it is not the same thing, neither its conjugated *antiparticle* [2].

It is then possible to understand fields of forces as generated by mediators with either positive or negative energy; this corresponds to repulsive or attractive fields, respectively [3]. On the other hand, co-particles react negatively to forces: they accelerate in the opposite sense. We will review these hypotheses ahead. But then, there is a conflict with GR, which claims all objects to follow paths in a spacetime warped by the sources of gravitational fields. If so, there should not be any difference between a particle and a homologous co-particle submitted to them. But there is.

Remark that Newton's and Coulomb's laws are similar. Why then should their fundamental mechanics be so different in nature? Especially when one comes to know that there are also opposite gravitational 'charges'. This issue ceases to puzzle as soon as one understands the hypothesis that in fact the respective fields are generated, propagate and cause effects in a similar way, expressed by the same formula for mediators' density (related to Gauss's flux) and Compton scattering. Building his GR theory, Einstein replaced Newtonian's forces of gravity by the curvature of spacetime by matter/energy. However, reasoning about gravity as a force – on a concept of 'mediator particles' extended to co-particles – one arrives to the inevitable conclusion that gravity and antigravity correspond to opposite distortions; further, that matter and co-matter (and also, maybe, antimatter) react in an opposite way to these supposed distortions. That is, the curvature is not a geometrical property of spacetime itself, it is not but a relative, non-objective, effect on accelerated material frames (in a wide sense) caused by gravitational forces.

In this unpretentious paper, I present some simple but sustainable ideas to discuss the following questions:

• Why are both classical and relativistic mechanics fundamentally invariant with respect to time reversal? Why is that, physically, when the 'time arrow' appears to be a crucial characteristic of reality?

• If there are two 'time arrows', that is, two time-flows in the Universe, do they interact? It seems they do, and constantly.

• Why is the speed of light in vacuum an absolute in Relativity and a limit to velocities?

• Do tachyons exist and, if so, how do they appear to us? The answer is: co-particles and subluminal co-velocities (thus avoiding causality violation).

• Do massive objects really curve spacetime? Or is curvature an appearance, as I sustain here?

• Does antimatter "fall upwards"? Does antigravity exist? The answer is yes, at least concerning the so-called *co-matter* (a close relative of or perhaps the same as antimatter).

• If repulsive gravity exists, how does it fit in Newton's or Einstein's theories?

• Do we receive radiation from stars in the future, as well as from the past? Probably yes, in the case of co-material and anti-material stars.

• What is an inertial frame of coordinates and what is its real and deep relationship with the fundamental structure of spacetime? Is it just a convenient abstraction, a momentary 'local frame' between frames in a warped spacetime? Or does Minkowski's plane geometry correspond to the fundamental structure of the world?

2. Theory Review

2.1. Pseudotachyonic Relativity

In an article published in 2016 [2] I made a summary of some precedent propositions contained in the theory of Pseudotachyonic Relativity (PtR) [1],[3], [4], which is advisable to resume here in its fundamental outlines, such as the Lorentz pseudotachyonic standard transformations,

$$\begin{cases} t^* = \frac{x/c-\beta t}{\alpha} \\ x^* = \frac{x\beta - ct}{\alpha} \\ y^* = y \\ z^* = z \end{cases} \quad \text{in which} \quad \alpha = \sqrt{\beta^2-1}, \ \text{for } \beta = \frac{v}{c} > 1\,, \qquad (1)$$

and the corresponding notion of a **co-particle** as the result of the detection of a tachyonic particle. If v is the tachyonic velocity of the particle, then its subluminal co-velocity $\hat{v}$ is collinear with it and given by

$$\hat{v} = \frac{c^2}{v}\,, \qquad (2)$$

which is the velocity of the associated co-particle and of the **pseudotachyonic frame** S^* corresponding to the transformations table above. Remark that $\hat{\beta} = 1/\beta$. The transformation of energy and momentum is given by

$$\begin{cases} E^* = \frac{p_x c - E\beta}{\alpha} \\ p_x^* = \frac{p_x\beta - E/c}{\alpha} \\ p_y^* = p_y \\ p_z^* = p_z\,. \end{cases} \qquad (3)$$

If the movement is parallel to the xx axis ($p_y = p_z = 0$), this equation system reduces to

$$\begin{cases} E^* = \frac{pc-E\beta}{\alpha} \\ p^* = \frac{p\beta - E/c}{\alpha} \end{cases} \quad \text{and, identically,} \quad \begin{cases} E = \frac{p^*c-E^*\beta}{\alpha} \\ p = \frac{p^*\beta - E^*/c}{\alpha}\,. \end{cases} \qquad (4)$$

The most remarkable feature of PtR is the reversion of time and energy:

$$\begin{cases} t^* = -t' \\ \mathbf{x}^* = \mathbf{x}' \end{cases} \quad \text{and} \quad \begin{cases} E^* = -E' \\ \mathbf{p}^* = \mathbf{p}', \end{cases} \qquad (5)$$

if S' is the so-called **paraframe** of S^*, that is, the usual bradyonic frame moving with velocity $\hat{v} = c^2/v$. Negative energies include the kinetic energy of a co-particle; as a matter of fact, if m_0^* is the rest mass of its homologous particle (suppose $m_0^* > 0$), then:

$$E = -\frac{\beta}{\alpha}E_0^*; \quad m = -\frac{\beta}{\alpha}m_0^*; \quad E_k = \left(1 - \frac{1}{\sqrt{1-(\hat{v}/c)^2}}\right)m_0^* c^2\,. \qquad (6)$$

Intrinsically, this means that the proper energy and the proper mass of a *particle* **P** and of its *homologous co-particle* $\widehat{\mathbf{P}}$ have positive values for the first and negative ones for the second but exactly the same in modulus. Remark that **P** and $\widehat{\mathbf{P}}$ are, in the fact, the same particle, the difference between them being nothing but a relativistic effect.

It is of primordial importance to note that:

Co-particles – even massless ones – have this remarkable dynamic characteristic: their velocity vector $\boldsymbol{u}$ *and the corresponding momentum vector* $\boldsymbol{p}$ *have opposite orientations.*

Hence, *if we push a co-particle forward, it will go backwards*; and this is a crucial feature regarding the behaviour of co-particles in interactions, including any kind of field, such as the gravitational field, as I pointed out in Luís Dias Ferreira [3].

The reversion of time, measured in bradyonic and pseudotachyonic frames of coordinates, which is quite evident in the length contraction and time dilation phenomena

$$\begin{cases} \Delta x = \frac{\alpha}{\beta}\Delta x^* \quad \Rightarrow \quad \Delta x = \sqrt{1-(1/\beta)^2}\,\Delta x^* \\ \Delta t = -\frac{\beta}{\alpha}\Delta t^* \quad \Rightarrow \quad \Delta t = -\frac{1}{\sqrt{1-(1/\beta)^2}}\Delta t^* \end{cases} \qquad (7)$$

[that is, $\Delta x^* = \Delta x'$ and $\Delta t^* = -\Delta t'$], clearly reveals the coexistence of **two opposite time-flows in Nature**, an extraordinary and full of consequences feature of the Universe [4].

Another reversion in PtR transformations lies in the anti-invariance of electric charge:

$$\mathbf{e}^* = -\mathbf{e}\,; \tag{8}$$

so, a particle and its homologous co-particle display opposite charges.

Now, a moving subluminal particle, with velocity v, has a *De Broglie wave* associated (the result of an "internal periodic phenomenon"), which propagates in the same sense and with a phase velocity u_φ given by

$$u_\varphi = \frac{\omega}{k} = \frac{mc^2}{mv} = \hat{v}.$$

This is a tachyonic velocity. PtR not only allows to give a real physical signification to the wave, it also teaches that it may only be detected with the associated velocity $\hat{u}_\varphi = c^2/\hat{v} = v$, this is, the velocity of the particle itself. This conclusion is quite enlightening and suggests that particle and wave are indeed two different although intimately associated things. Moreover, remark that one may write Einstein's mass-energy equivalence as

$$E = mv\hat{v}$$

and this represents the energy of the particle (and of the wave) as a product of its mass by the velocities of both the particle and the wave.

2.2. Antibradyonic Relativity

As it is known, particles with negative energy were seriously introduced in Physics by Paul Dirac (the negative-energy electron), though he soon found out a clever way to replace them by conjugate positive energies. And this has been done ever since, concerning what is called *antimatter*. Nevertheless, the disturbing problem of the negative-energy electron still stands in the shadow. For several discrepancies, anyway, it seemed to me that Dirac's positron or even his negative-energy electron was not the same as the PtR negative-energy electron. On the other hand, since PtR result is a 'natural' extension of Relativity, presenting positive or negative solutions as two *aspects* of a single entity, the same should happen with Dirac's negative-energy solution: it should correspond to a relativistic transformation of that same entity.

We obtain a satisfactory answer following (and correcting) [2]: after analysing Dirac's theory of the electron, I suggested that 'his' **prime-antiparticle** (by this I mean the negative-energy solution with positive mass for his equation, not the *antiparticle* resulting from a conjugation method), corresponds to a relativistic **antibradyonic transformation**:

$$\begin{cases} t^\bullet = \frac{vx/c^2 - t}{\sqrt{1-\beta^2}} \\ x^\bullet = \frac{vt - x}{\sqrt{1-\beta^2}} \\ y^\bullet = -y \\ z^\bullet = -z, \end{cases} \tag{9}$$

From where do this transformation come from? In [5] Albert Einstein deduces the standard Lorentz transformations as follows:

$$\begin{cases} t' = \varphi(v)\dfrac{t - vx/c^2}{\sqrt{1-\beta^2}} \\ x' = \varphi(v)\dfrac{x - vt}{\sqrt{1-\beta^2}} \\ y' = \varphi(v)y \\ z' = \varphi(v)z, \end{cases}$$

where $\varphi(v)$ is a function of the velocity v. Based on a simple reasoning he concludes that it must be

$$\varphi(v)\varphi(-v) = 1.$$

Then, he considers a rod moving in S' aligned with the $y'y'$ axis, with length $\Delta y' = l$, which in S gives $\Delta y = l/\varphi(v)$; for symmetry reasons, the length of a rod moving perpendicularly to its axis does not depend on the *direction* of its movement, and so

$$\frac{l}{\varphi(v)} = \frac{l}{\varphi(-v)} \quad \text{or} \quad \varphi(v) = \varphi(-v);$$

hence he finally concludes that $\varphi(v) = 1$, thus resulting the well known Lorentz transformations. However, remark that one may also conclude for $\varphi(v) = -1$. This implicates a reversion of time but remains a valid hypothesis since PtR teach us that time naturally flows in opposite directions in the Universe; and, on the other hand, that in each frame of coordinates the reality of *both alignments* of time is a requirement for the interaction of mutually pseudotachyonic frames to exist; shouldn't the *anti-time nature* manifest and this relationship would be impossible: there would be anything else but 'straight' matter and the World would be impossible (because, as we will see, the variety of aspects for 'particles' appears to be essential in the reality and behavior of force fields and their correspondent interactions). So, making $\varphi(v) = -1$, we get the transformation table (9).

Though involving a time reversion, this is not the same as a pseudotachyonic transformation. It represents an **antibradyonic frame** $S^\bullet$, a *bradyonic frame going back in time*, with all coordinates reversed compared to the usual bradyonic one, S', with the same velocity v, which we will call once again its 'paraframe':

$$t^\bullet = -t' \quad x^\bullet = -x' \quad y^\bullet = -y' \quad z^\bullet = -z'.$$

Naturally, then, $\mathbf{u}^\bullet = \mathbf{u}'$ and $\mathbf{a}^\bullet = -\mathbf{a}'$. However, for the energy-momentum 4-vector, the option corresponding to the negative Hamiltonian used by Dirac in his equation for the electron obliges to consider the covariant form $\mathbf{E}^\bullet_\mu = \left(iE^\bullet/c\,, -p^\bullet_x\,, -p^\bullet_y\,, -p^\bullet_z\right)$ instead of the contravariant. It introduces, in the case of this quadrivector, the option for the dual base instead of the 'natural' base of the spacetime quadrivector $x^{\mu\bullet} = (ict^\bullet, x^\bullet, y^\bullet, z^\bullet)$, with the following result:

$$\begin{cases} E^\bullet = \frac{vp_x - E}{\sqrt{1-v^2/c^2}} \\ p_x^\bullet = \frac{p_x - vE/c^2}{\sqrt{1-v^2/c^2}} \\ p_y^\bullet = p_y \\ p_z^\bullet = p_z. \end{cases} \quad (10)$$

Remark that

$$\begin{cases} E^\bullet = -E' \\ \mathbf{p}^\bullet = \mathbf{p}'. \end{cases} \quad (11)$$

But then, $\mathbf{p}^\bullet = m^\bullet \mathbf{u}^\bullet = m^\bullet \mathbf{u}'$ and $\mathbf{p}' = m'\mathbf{u}'$ implicates that

$$m^\bullet = m' = \frac{m_0}{\sqrt{1-v^2/c^2}}. \quad (12)$$

As a consequence, since $E^\bullet = -E' = -m'c^2$, we get

$$E^\bullet = -m^\bullet c^2, \quad (13)$$

and this is precisely Dirac's equation for his negative-energy solution, clearly suggesting that this solution refers to an antibradyonic Lorentz transformation. In fact, there's no doubt about it since we may prove that electric charge is invariant under antibradyonic transformation: $e^\bullet = e$. This means that, in Dirac's case, a negative-energy electron has the same negative charge as the electron.

Now, since either a co-particle or its prime-antiparticle correspond to relativistic transformations, I finally suggested that, together with their homologous "particle" and "co-prime-antiparticle", they aren't but four **aspects** of a single entity, which I call their **archeparticle** or **matrix-particle**. Concerning the electron, one may also conclude that each of the four aspects verifies Dirac's equation,

$$[p_0 - \alpha_1 p_1 - \alpha_2 p_2 - \alpha_3 p_3 - \alpha_m mc]\psi = 0,$$

and that they relate to the four components of the spinor ψ.

Note that the brief analysis pointed out above, concerning the quadrivector $\mathbf{E}_\mu^\bullet$, suggests that the two aspects, *prime-antiparticle* and *co-particle*, may indeed correspond to a single one, evaluated in a natural base and its dual base. Whatever it is, I also established in Luís Dias Ferreira [2] the fundamental statement that, keeping in mind the necessary coexistence of two time-flows in any reference frame:

The sign for the energy of a particle (massive or not) in whatever frame of coordinates relates to the alignment $(+)$ *or the anti-alignment* $(-)$ *of this particle towards positive time-flow in that frame.*

This – I wrote – is quite plausible in view of the relation between energy and frequency established by Planck and generalized by de Broglie: $E = h\nu$ (an equation valid in whatever frame of coordinates); positive or negative energies respectively correspond to positive or negative frequencies. Essentially:

There is a direct link between the sign of energy and the arrow of time. In 'our' material world, it is because of its positive energy that a particle goes forward in time; that is, for each particle (massive or not), in every moment, the sign of energy establishes the past and the future.

Now, if this corresponds to reality, all issues concerning fields of forces, hence gravity, must eventually take these *aspects* and their interactions into account. Moreover, one needs to understand the profound consequences of the co-existence of two opposite time flows; and of the interactions between them, which, following the ideas for force fields proposed ahead, are taking place... all the time!

2.3. The Mystery of Time Reversal

A big mystery in both classical and relativistic mechanics lies in the fact that their equations are fundamentally invariant with respect to time reversal. One aspect of this mathematical invariance are the various conservation principles, for energy, linear impulse, etc.: these physical entities remain exactly the same 'after' and 'before' a collision or any other mechanical interaction, which in fact means that 'after' and 'before' may permute. But why is that, physically, if time reversal does not seem to occur in Nature, the 'time arrow' appearing as a crucial characteristic of reality?

Thermodynamics apart, for now, an explanation for this mystery is to be found in the relation between material and co-material (or antibradyonic) frames of coordinates. We just saw that time appears inverted from one to another. Now, because of their equivalence – none is better than the other – physics must be the same for both. That is, on the one hand, processes must be described by time-invariant equations; on the other hand, for instance, the total energy involved in an interaction must remain the same because 'after' and 'before' is interchangeable.

Because of the relevance of this issue to the following analysis, let us examine three simple situations:

1. Consider the rough experiment of throwing a stone in the air vertically from the earth. According to Newton's mechanics, despising the air resistance, the behaviour of the stone (concerning space, time and velocity), going up or coming down, is perfectly symmetrical.

This elementary result and others shouldn't be thoughtlessly considered as obvious; on the contrary, they veil a perfect treasure. The conclusion is that the stone behave as well in an inverted time-flow. But, according to PtR, the experiment seen in a pseudotachyonic paraframe consists on a co-stone going up in the air from a co-earth and returning to it. What the invariance of Newton's equations say is that the co-stone behaves exactly like the stone in a similar experiment. And this is absolutely satisfying because of the equivalence of material and co-material frames; shouldn't it be so and this equivalence wouldn't exist, causing a serious damage to the theory of Relativity.

2. Take a co-electron $\hat{\mathbf{e}}$ immobile at $t_0 = 0$ and then submitted to the electrostatic field of an electron $\mathbf{e}$. According to Coulomb's law (to simplify), the co-electron approaches the electron, accelerating. In the electron's proper frame, for a great distance x_0 and a little time gap t, the co-electron behaves like the precedent falling stone and we may write:

$$\begin{cases} x = x_0 - \frac{1}{2}at^2 \\ u = -at \\ p = \hat{m}u. \end{cases}$$

As we have seen before, the mass $\hat{m}$ of the co-electron is negative and therefore its momentum $\mathbf{p}$ is opposite to its velocity $\mathbf{u}$.
In the co-electron's proper frame, charges are reversed; the co-electron becomes an electron and the former electron a co-electron:

$$\hat{\mathbf{e}} \rightarrow \mathbf{e} \quad ; \quad \mathbf{e} \rightarrow \hat{\mathbf{e}}.$$

Now, making in (1) $v \rightarrow \infty$ (so that $\hat{v} \rightarrow 0$), the pseudotachyonic transformation for the co-electron's proper frame S^* gives

$$\begin{cases} x^* = \lim\limits_{v\to\infty} \dfrac{x.\beta - ct}{\alpha} = \lim\limits_{v\to\infty} \dfrac{x - ct/\beta}{\sqrt{1 - 1/\beta^2}} = x \\ t^* = \lim\limits_{v\to\infty} \dfrac{x/c - \beta t}{\alpha} = \lim\limits_{v\to\infty} \dfrac{x/(\beta c) - t}{\sqrt{1 - 1/\beta^2}} = -t \end{cases} \Rightarrow \begin{cases} x^* = x_0 - \frac{1}{2}at^2 \\ t^* = -t; \end{cases}$$

this corresponds to time reversal. For the velocity u^* and the momentum p^*, we obtain

$$\begin{cases} u^* = \lim\limits_{v\to\infty} \dfrac{c^2 - uv}{v - u} = -u \\ p^* = \lim\limits_{v\to\infty} \dfrac{p.\beta - E/c}{\alpha} = p, \end{cases}$$

which means that the electron is moving away from the co-electron, beginning in time $t^* = -t$ with velocity $u^* = -u$, reducing velocity and finally stopping at time $t^* = 0$. This corresponds to the precedent stone going up; it is exactly what one should expect from an attractive electromagnetic interaction (with the co-electron as the source) and this, once again, shows that the invariance of physical laws, concerning time reversal, is coherent with the principle of equivalence.

3. Consider now the trajectory of an electron $\mathbf{e}_2$ moving in the electromagnetic field of another electron $\mathbf{e}_1$. In the proper frame of $\mathbf{e}_1$, the trajectory is the most distant branch of a hyperbola from the focus occupied by the source particle; the closest branch corresponds to a possible trajectory for a co-electron $\hat{\mathbf{e}}_3$ [6].

These trajectories remain the same if time is mathematically reversed, with the particles 2 and 3 simply reversing the sense of their movement. But, physically, this reversion means that the source $\hat{\mathbf{e}}_1$ is now a co-electron, $\hat{\mathbf{e}}_2$ a second co-electron and $\mathbf{e}_3$ an electron; and, also, that in these conditions the trajectories are the same.

There would be a huge contradiction if this wouldn't happen because it would contradict not only Coulomb's law but also the fundamental relativity of movement.

2.4. Bases for a Field Theory

Co-particles and antiparticles seem to be closely related aspects of a matrix-particle. Anyway, I will keep the further analysis only in the context of **particles** and **co-particles**, even if force fields may implicate all four aspects of matrix-mediators.

Yet, this is not a theory, just a review of some clues to it. PtR invites us to think about fields of forces on the basis of positive and negative energies. It goes as follows [3]: either electrostatic or gravitational interactions between two particles concern fields created by each one of them via specific *mediator particles*; photons or co-photons in the first case, gravitons or co-gravitons in the second. This implies the emission (or reception, in the case of co-particle sources) of mediators, with either positive or negative energy, which interact with target particles by exchanging energy and linear momentum. Concerning a given field, these mediators are all particles or co-particles of the same kind, with the same energy. If the mediator particles are *positive* (i.e. with positive energy), the field results repulsive; if the mediator particles are *negative* (co-particles, with negative energy), the field results attractive.

Take the electrostatic field created by an electron; one may admit that this field is due to the emission of *photons* (not co-photons, in order to respect the generalized Compton scattering Luís Dias Ferreira [4]). It is a *positive field*: these photons carry positive energy and a momentum with the same direction of its propagation; in electrostatic interactions, then, this momentum is (partially) transferred to another charged particle. If this particle is another electron, a *pro-reactive* one, it will react backing off from the source; if it is a *co-electron*, which is an electrostatic *anti-reactive* particle [for it, the induced momentum and the correspondent velocity have opposite senses], it will react approaching the electron[1]. If it is a *proton*, somehow its 'element of charge' makes it to be also an anti-reactive particle: it will approach the electron.

[1] One may prove [4] that the effect of a photon upon a co-electron makes this one to move in the semi-space behind the incident photon; the same is true for the effect of a co-photon upon an electron. In both cases, the energy of the incident photon or co-photon increases (in modulus), counterbalancing the energy (with opposite sign) of the particle set in motion.

On the other hand, a proton produces a *negative field*, an attractive one, via the emission of mediator *co-photons*. These co-photons carry negative energy and a momentum with opposite direction to its propagation, this is, in the direction of the proton itself; eventually, this momentum is (partially) transferred to another charged particle. An electron behaves reacting positively to the momentum received, approaching the proton; another proton, however, reacts negatively driving away from it. We see then that, in relation to electrostatic fields, protons are *negative* and *anti-reactive* particles: they create attractive fields and react negatively to another electrostatic field[2].

An important lesson, here, is that one needs to distinguish *interactive processes* from *observable effects*. This is valid for all kinds of fields; and here lies a fundamental problem with Coulomb's and Newton's laws, but also with General Relativity, which describe observable effects.

Before we focus on gravity, let us look at the interference of time reversal in field interactions. It is essential to note here that the Compton scattering is – as many other physical interactions – time-reversible.

Of course, like a proton, a co-electron produces a negative electrostatic field, an attractive one; but this must be done via the *reception* of mediator co-photons. As a matter of fact, due to the inversion of time in PtR transformations, the creation of a field by an electron in a pseudotachyonic frame appears reverted in time in 'our' frame of coordinates, the correspondent co-electron *absorbing* pairs of mediators of its own fields (this is the physical meaning of a negative frequency $\nu = E/h$ in the field generation).

Speaking in general, we will accept that a particle [with positive energy, this is, aligned with time] creates a certain field via the emission of mediator particles (or co-particles) ϵ, which eventually interact with other particles or co-particles by means of momentum transference. A symmetry reasoning leads to the strange conclusion that, inversely, a homologous co-particle [with negative energy, this is, anti-aligned with time] creates a correspondent 'co-field' by the reception of mediator co-particles $\hat{\epsilon}$. This is coherent with the distinctive mark of *time reversal* concerning co-matter; in fact, in its proper frame S^*, the co-particle must appear as a particle (with positive energy), emitting mediators ϵ. The apparently absurd conclusion arises then in this statement:

If a particle's field is characterized by the emission of (positive or negative) mediator particles ϵ, the correspondent field created by an homologous co-particle is characterized by the reception of mediators $\hat{\epsilon}$, co-homologous of ϵ.

Quite surprisingly, the effect of the field remains unchanged!

Take a pair electron/co-electron, $\mathbf{e}_1$ and $\hat{\mathbf{e}}_2$, both immobile at first, in a pseudotachyonic frame S^*. By 'absorbing' negative energy from the mediator photons emitted by the electron, the co-electron, an anti-reactive particle to electrostatic fields, approaches the source of the field, increasing its velocity from moment $t*_0 = 0$ to $t* = \Delta t*$. One must keep in mind that this is a statistical behaviour and that Compton scattering implies just the deviation of the incident photon, never its disappearance. In a bradyonic frame S, the co-electron becomes an electron and vice-versa. Consider then a sequence of mediator photons emitted in S^* by $\mathbf{e}_1$, reaching the target $\hat{\mathbf{e}}_2$ and being scattered by it, making $\hat{\mathbf{e}}_2$ to move in the direction of the source. What happens in the bradyonic frame? We 'see' an electron $\mathbf{e}_2$ moving away from a co-electron $\hat{\mathbf{e}}_1$, from $t = -\Delta t*$ to $t_0 = 0$, but reducing velocity as it is hit by a sequence of scattered co-photons, until it stops. This is exactly the observable effect of an attractive field, but has an extraordinary meaning: in a way, the co-electron $\hat{e}_1$ acts upon e_2 in this one's past!

Once again, it is the sign of energy establishing past and future. Consequently, we'll qualify material fields as centrifugal ones (mediators emitted by the source); and co-material fields as centripetal ones (homologous mediators absorbed by the source).

This is fantastic! As we saw before, two opposite time-flows coexist in the Universe. We now conclude that this amazing structure attains a higher degree of complexity and subtlety: *interactions between matter and co-matter implicate a complex net of interactions connecting the two temporal directions!* More, if interactions involving particles and co-particles are an essential requisite to the mechanics of force fields, then this *intertemporal net* is acting all the time in the Universe. I think this is the only way of resolving the problem and it results in this fundamental conclusion, almost self-evident: the existence of a particle and its interactions with other particles do not depend on frames of coordinates and temporal directions; in this sense, they are 'absolutes'. What is dependent, and therefore 'relative' is the *evaluation* of these existence and interactions. But this is, in fact, Einstein's strong equivalence principle!...

Now, I sustain the reasonable hypothesis that gravitational interactions must also be ruled by the Compton scattering, generalized to co-particles. Why? Firstly because there is nothing about the nature of the interacting particles in the mathematics concerning this scattering, except that one of them has a null mass (and we know this must be the case of the theoretical gravitons); and secondly because, in a gravitational interaction, mediator particles cannot simply disappear, transferring all their energy and momentum to the target particle. Consider, for instance, the gravitational interaction produced by a proton on another proton. According to these ideas, **gravitons are co-particles** since their momentum must be opposite to their velocity; that's why the resulting field of a material particle is attractive. But then, may the graviton transfer all of its *negative energy* to the target proton? The answer is clearly *no*. If this was the case, in its proper frame, the target proton would gradually lose mass, even under its own proper mass, until its annihilation – and this has no sense! Now, as one knows, it is a mathematical consequence from Compton's equation that the incoming photon never disappears; that is, the transference of energy and momentum is always partial. The action of gravitons upon matter or co-matter should work alike. As mentioned before, one may mathematically prove that the graviton should then transfer positive energy to the proton,

[2] It seems that Benjamin Franklin made a mistake when he attributed the signs for electricity; he should have adopted the inverse convention.

increasing, in modulus, its own negative energy. The immediate consequence is that *matter strengthens external gravitational attractive fields by its interactions with it* – and this complicates the problem a lot (as it does, concerning electrostatic fields).

How is the gravitational field generated? As I see it, the heart of the process lies in De Broglie's "clockwork" mechanism, the "internal periodic phenomenon" [7] with an *inner frequency* $\nu_0 = E_0/h$, where E_0 is the (positive or negative) rest energy of the source-particle. According to PtR hypothesis, gravitons have all the same energy and are emitted by a source-particle in pairs and symmetrically (in order to keep a null total linear impulse); the number n of gravitons emitted in a time laps t by a particle, in its proper frame, is then given by

$$n = 2\nu_0\ t = 2\frac{m_0 c^2}{h}\ t,$$

where m_0 is the rest mass of the particle (a positive n is for emission, a negative to absorption, by co-particles). It results that, for a distance $r >\ > dr$ from the source, the *mediators' density* in the spherical sector between radius r and $r + dr$ is

$$\frac{d|n|}{dV} = \frac{|m_0|c}{2\pi h r^2}. \qquad (14)$$

3. Gravity Issues

Gravity issues deserve a large paper on its own. Here I present merely some notes on the subject, mainly regarding some conflicts apparently opposing PtR to Newton or Einstein theories; and some clues to harmonize them, to solve those conflicts. They lead however to the drastic conclusion referred in the Introduction.

3.1. On Newton's Theory

Even if the field mechanics proposed by PtR seem to directly fit in Newton's law for gravity, they don't really do (as they don't exactly fit in Coulomb's law). They roughly fit in Gauss's correspondent law, $\Phi_g = \oint \mathbf{g} \cdot d\mathbf{S} = -4\pi G M$; as a matter of fact, the field vector $\mathbf{g}$, which represents the acceleration induced in a target particle, is expected to be statistically proportional to the *mediators' density* at a distance r from the source, that is, according to (14), directly proportional to $M = \Sigma m_i$ and inversely proportional to r^2 [however, based on Compton scattering, one may only obtain mean values for scattering angle and linear impulse, i.e. for gravitational force, and the solution to the problem probably becomes more complicated than this]. Note that the relevant distance r is not the distance from the source mass M to a target mass M' at the moment a graviton is emitted by M but the distance traveled by this graviton when it reaches M'.

By the way, there is the argument that Newton's law implies immediacy:

"Newton's theory of gravitation requires that the gravitational force be transmitted instantaneously. Given the classical assumptions of the nature of space and time before the development of General Relativity, a significant propagation delay in gravity leads to unstable planetary and stellar orbits." Wikipedia [8]

I do not really understand this statement. I would understand a "delay in the propagation of gravity" if there were a small number of gravitons in action and, therefore, a large space and a long time between successive waves of them. But these mediator particles are in an absolute huge number for a mass like the Sun's. Their influence is, so, practically continuous: there are gravitons spread all around, all the time. Of course, gravitons emitted more or less at the same time by the Sun reach Pluto long after those striking the Earth or Saturn; but others have already got there long, long before. In other words, there is a 'contemporary effect' on the influence of gravitons in the field of the Sun (and planets), as with the light emitted by the star. This does not necessarily imply nonlocality. Anyway, if Newton's law would really imply immediacy, and there is none, how does it work so well?

It appears to me that, following Newton himself, the main reason for an inherent immediacy in the gravitational interaction is his third law: " When one body exerts a force on a second body, the second body simultaneously exerts a force equal in magnitude and opposite in direction on the first body." So, coherently, the opposite forces should be simultaneous, hence immediate at every moment. However, the formulation of the same problem by Gauss eliminates this requirement. As a matter of fact, Gauss's general concept of flux is close to PtR's ideas, with the $\pm$ signs corresponding to the *centrifugal* or the *centripetal* behaviour of *something* that mediates the field. This is a gigantic step, from a conceptual point of view, distinguishing the interactive processes that are taking place from their observable effects (as mentioned before). Furthermore, if one puts aside an infinite velocity for the flowing *something*, it sustains implicitly that the interaction is not immediate. Nevertheless, it does not change the simple equation of Newton's law for gravity.

Suppose then that this law is *universally* valid. It says that the gravitational interaction between two bodies is expressed by a central attractive force given by

$$F = -G\frac{m_1\, m_2}{r^2}. \qquad \text{(A)}$$

One should remark that this statement is indeed enunciated as a 'law': it is not deduced from previous results or other postulated laws and there is no fundament to it except the fact that it seems to be intuitive and strongly coherent with several observations (justifying, for instance, Kepler's laws). But the immediate problem with this approach – and therefore, with Einstein's approach – is that it has been established upon experiments and thoughts regarding *matter*, that is to say, *positive mass and energy*.

It is easy to conclude that, if both bodies are made of *co-matter*, the mathematical result of equation (A) is also a mutual attractive force. Should then the two bodies approach each other? The answer is no, because, as we saw before, co-matter is *anti-reactive* to gravity fields; and this means that, submitted to a mutual attractive force, the two co-bodies would move apart from each other. This does not seem 'natural', because one should expect, given the symmetry of the premises for the actual and the classical problem, that these co-bodies would instead approach each other. Another argument is this: in the case of an *observable repulsive effect* on both co-material bodies, this should drastically affect their relative trajectories (as happens in the trajectories followed by two electrons on mutual electric fields). But, then, in a pseudotachyonic frame – that is, basically reversing time – one should find two material bodies submitted to supposedly repulsive forces because, neither in Newton's Physics nor Relativity, reversing time changes trajectories. This is obviously contradictory. So, the observable effect of gravity concerning two co-material bodies *must* be attractive.

On the other hand, suppose that we apply Newton's law to the interaction of a body $\mathbf{M}$ and a co-body $\widehat{\mathbf{M}}$. The mathematical result of (A) is a repulsive force; but then:

• $\mathbf{M}$ would drive away from $\widehat{\mathbf{M}}$;

• $\widehat{\mathbf{M}}$, reacting negatively, would approach $\mathbf{M}$;

and so, the bizarre result would be something like 'a cat chasing a mouse'! This is, of course, unacceptable.

The error comes from assuming that both particles create the same kind of field, this being implicit in the equation (A) itself. As we saw in the precedent pages, there is a consistent alternative:

1. A particle creates an attractive gravity field; a co-particle creates a repulsive one;
2. A particle reacts positively to a gravity field; a co-particle reacts negatively to it.

From these assertions one may conclude for the following generic observable effects concerning gravitational interaction:

1. Two particles attract each other;
2. Two co-particles also attract each other;
3. A particle and a co-particle repel each other.

We know, of course, that Newton's law strongly corresponds to reality, in case of weak gravitational fields. So – and mainly because in its general concepts, several results or mathematical foundations, Newton's Physics do not loose validity in dealing with negative time, masses or energies – it is worthy to reformulate the gravitational law (A) by distinguishing the gravitational fields due to each one of the particles in presence, which are not necessarily opposite. In these terms, the force (simply conceived as an induced $d\mathbf{p}/dt$) of $\mathbf{M}_1$ field upon $\mathbf{M}_2$ is given by

$$\mathbf{F}_{2,1} = -G\frac{m_1|m_2|}{r^2}\,\mathbf{r}_{2,1}\,, \tag{15}$$

$\mathbf{r}_{2,1}$ being the unit vector in the radial direction $\mathbf{M}_1 \to \mathbf{M}_2$; symmetrically,

$$\mathbf{F}_{1,2} = -G\frac{m_2|m_1|}{r^2}\,\mathbf{r}_{1,2}. \tag{16}$$

The point here is that the *sign* of the variation of the linear impulse induced by a gravitational field (for instance, $\mathbf{p}_{2,1}$) does not depend on the nature of a target particle submitted to it (i.e. m_2) but uniquely on the nature of the source particle (m_1) and therefore that

$$\frac{d\mathbf{v}_{2,1}}{dt} = \frac{1}{m_2}\frac{d\mathbf{p}_{2,1}}{dt} = \frac{|m_2|}{m_2}\mathring{\mathbf{g}}_{2,1}$$

where $\mathring{\mathbf{g}}$ is a **modular acceleration**, defined by

$$\mathring{\mathbf{g}} = \frac{\mathbf{F}}{|m|},\quad \text{that is,}\quad \mathring{\mathbf{g}} = \frac{m}{|m|}\mathbf{g}\quad \text{or}\quad \begin{cases}\mathring{\mathbf{g}} = \mathbf{g} & \text{if } m > 0\,;\\ \mathring{\mathbf{g}} = -\mathbf{g} & \text{if } m < 0\,.\end{cases} \tag{17}$$

We'll write, then:

$$\mathring{\mathbf{g}}_{2,1} = \frac{\mathbf{F}_{2,1}}{|m_2|} = -G\frac{m_1}{r^2}\,\mathbf{r}_{2,1}, \tag{18}$$

and this corresponds to the classical *gravitational field* produced by a mass m_1 at a distance r. It results *attractive* for $m_1 > 0$ and *repulsive* for $m_1 < 0$. But we must not forget that, applying it to a co-particle target, yields

$$\mathbf{g} = -\mathring{\mathbf{g}} \quad \text{and} \quad \mathbf{v} = -\mathring{\mathbf{g}}\,t,$$

this meaning that the co-particle tends to drive away from the source particle or to approach it depending on if $m_1 > 0$ or $m_1 < 0$ respectively. According to this, one may rewrite Gauss's law for gravity as

$$\Phi_g = \oint \mathring{\mathbf{g}} \cdot d\mathbf{S} = -4\pi GM, \tag{19}$$

either taking $\mathbf{M}_1$ or $\mathbf{M}_2$ as the source of the field. From here, one can easily derive the equations (15) and (16), keeping in mind the definition of modular acceleration. Besides, the decisive breakthrough is that the flux of the gravitational field can be positive or negative (just like in the case of electricity). Remark that the concept of *centrifugal* and *centripetal force lines* in any Gauss's flux is quite coherent with the vector direction of the linear impulse carried by mediators: this is, with the concept of positive or negative fields.

The differential form of Gauss's law for gravity becomes

$$\nabla \cdot \mathring{\mathbf{g}} = -4\pi G\rho \tag{20}$$

and this leads to a reformulated Poisson equation for gravity:

$$\nabla^2 \phi\!\!\!/ = 4\pi G\rho, \tag{21}$$

where $\mathring{\mathbf{g}} = -\nabla\phi\!\!\!/$, which makes the potential $\phi\!\!\!/$ to change sign for particle or co-particle sources (as it happens with density ρ).

Most of Newton's mechanics apply to co-matter without changing equations. But some – mainly those depending on the concept of force – need to be re-written. We'll keep as valid Newton's three fundamental laws; and also the principles of conservation of energy, momentum and angular momentum (which validity exceeds this classical frame and is, in fact, a direct consequence of the time-reversal implicit in pseudotachyonic transformations).

It is convenient now to review some other relevant concepts and examine their extension to co-matter. Begining with the *mechanical work*, for a force $\mathbf{F}$ acting upon a particle, it is the dot product

$$W = \int_A^B \mathbf{F} \cdot d\mathbf{r} = \int_A^B \mathbf{F}_T \; ds,$$

where $\mathbf{F}_T = \mathbf{F}\cos\theta$ is the component of $\mathbf{F}$ tangential to the trajectory of the particle. For an homologous co-particle the resulting $d\hat{\mathbf{r}}$ is opposite, so

$$d\hat{\mathbf{r}} = -d\mathbf{r} \quad \Rightarrow \quad \widehat{W} = -W \quad \text{and} \quad d\hat{s} = -ds.$$

As one knows, we may write the mechanical work equation as follows

$$W = \int_A^B m\frac{dv}{dt} ds = \int_A^B mv \; dv = \frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2 = E_{k,B} - E_{k,A}.$$

So, we see that *kinetic energy* concept, $E_k = \frac{1}{2}mv^2$, must remain valid for co-particles; but it is easy to conclude that, for a pair of homologous $\mathbf{P}$ and $\widehat{\mathbf{P}}$ with the same velocity, $\hat{E}_k = -E_k$, and therefore that $\widehat{W} = -W$. This is coherent with the relativistic equation (6).

In a system influenced by conservative forces, the *potential energy* is still given by $E_{p,A} - E_{p,B} = W$; but this means that $\mathbf{F} \cdot d\mathbf{r} = -dE_p$ and so, since $\widehat{W} = -W$, that $\hat{E}_p = -E_p$. We may write, then,

$$\mathbf{F} = \mp\nabla E_p \,, \quad (22)$$

according to what we are dealing respectively with a (positive) particle or a co-particle. In these terms, the potential energy of a particle $\mathbf{P_2}$ in the gravitational field of another particle, $\mathbf{P_1}$, is given by

$$E_{p\;2,1} = \pm G m_1 |m_2| \int_r^\infty \frac{dr}{r^2} = \mp G\frac{m_1|m_2|}{r}.$$

But this, in fact, means that

$$E_{p\;2,1} = E_{p\;1,2} = -G\frac{m_1 m_2}{r} \qquad (23)$$

and we may say that this is the *potential energy of the system of the two particles*, whether they are made of matter or co-matter. This is very satisfying because it results:

$$\begin{cases} E_p < 0 \quad \text{for attractive } \mathit{observable} \text{ interactions:} & \begin{cases} M_1 \text{ with } M_2 \\ \widehat{M}_1 \text{ with } \widehat{M}_2 \end{cases} \\ E_p > 0 \quad \text{for repulsive } \mathit{observable} \text{ interactions:} & \begin{cases} M_1 \text{ with } \widehat{M}_2 \\ \widehat{M}_1 \text{ with } M_2. \end{cases} \end{cases}$$

3.2. On Einstein's theory

The assumption of PtR hypothesis on gravity seems to severely contradict GR theory. Indeed, it does. In GR, there is no force of gravity, just *distortion*: matter distorts space (and time); and other masses (or even massless particles) react to this curvature independently from their masses. With such a point of view, positive or negative masses should respond to a gravitational field exactly in the same way. But they do not, according to PtR and to Newton's modified theory, as we saw in the previous subsection; and this hypothesis seems to be quite reasonable.

Besides, it seems that a real **mass** is required to create a gravitational field (any kind of field, in fact), i.e., mass is needed for a particle to emit mediators of any kind, and this seems to be a good reason for mass to exist (a massless particle, like a photon, 'pure energy' then, would not be not able to do it). This also contradicts the usual assumption in GR, based on the so-called *equivalence mass-energy*, which claims that mass and energy are different manifestations of the same thing or two different ways of describing one physical quantity. Therefore, any kind of energy or related quantities, as momentum, pressure and tension, serve as sources of gravity, and this is expressed in GR by the energy-momentum tensor. But the formula $E = mc^2$ simply establishes a proportion, a correspondence, between mass and energy, as Newton's law $F = am$ does concerning force and acceleration; does this mean that force and acceleration are two manifestations of the same thing?

We must search for an explanation for these contradictions. To do so, we need to carefully reexamine what happens with **light**, beginning with the so-called **inertial frames of coordinates**. In fact, we must understand that in the lucid background of GR there is the following question: how do frames of coordinates react to gravitational fields, this is, to accelerations? Now, since – according to Einstein's principle of equivalence – all frames are equivalent and, so, any frame is viable to evaluate others, what characterizes an inertial frame physically? What makes it *special*? One should answer: *it is not an accelerated frame*. But, if S is supposed to be inertial and S' is an accelerated frame relatively to it, then – if one conceives acceleration independently from mass, i.e. the sole definition $a = dp/dt$ –, it results that S also appears as an accelerated frame relatively to S', in a symmetrical way. So, what's the real difference between them? The answer is: the behaviour of light [and this is not new, of course].

We'll assume that (in the absence of interactions) *in any inertial frame light propagates in a straight line*. Otherwise, there should be a reason for that, to justify a particular curve; that reason does not seem to exist. This statement implicates the Minkowski's pseudo-Euclidean geometry as the fundamental structure of spacetime [this assumption is made within a conception of reality based in the idea of continuity; there are symptoms – as the existence of a constant frontier speed c – that the fundamental structure is discontinuous. I briefly discuss this issue in Appendix B].

Take a ray emitted in the origin O of an inertial frame S in the sense of the yy axis. Let S' be another inertial frame moving along the xx axis with positive velocity v. According to the relativistic transformations, the vector $\mathbf{c}$ appears in S' with components

$$\begin{cases} c'_x = -v4pt \\ c'_y = c\sqrt{1-\beta^2}, \end{cases} \quad \text{which means that} \quad \begin{cases} \sin\varphi' = \frac{c'_y}{c} = \sqrt{1-\beta^2}; \quad \text{and} \\ \cos\varphi' = \frac{c'_x}{c} = -\beta, \end{cases} \tag{24}$$

φ' being the angle of displacement of the ray with the xx axis in S'. This vector is independent from time. So, in S', the ray also moves in a straight line but with an inclination, to the back, of $\varphi' = \arccos(-\beta)$. It is easy to see that:

$$\lim_{v\to c} \varphi' = 180°. \tag{24.a}$$

In the limit, if we admit a timeless 'proper frame' for a photon, all the Universe appears to reduce to a single line.

Note that *the angular deviation of light does not imply any deformation of space*, in particular with respect to orthogonality. The yy axis, orthogonal in S maintains its orthogonality, as it moves, in S'. Simply, the beam of light emitted in the sense of the yy axis in S is left behind in S' as it rises.

The important thing now is to analyze what happens if we deal with accelerated frames. The dependence of the angular deviation on the velocity v of the frame S' makes it obvious that, if this one is accelerated, the angular deviation is no longer constant *in it*, i.e. the beam of light follows a curved trajectory [of course, the vector **c**, as given by (22), is tangent to the trajectory at every moment]. The nub of the matter is that, as said before, mathematically the frame S will also appear in S' as an accelerated one. So, from this abstract point of view, they are alike, and one should be allowed to conceive a beam of light propagating in a straight line in S'... which would appear curbed in the supposed inertial S ! This has no sense, of course, because the movement of light itself has a physical existence which cannot depend on the frame of coordinates that evaluates it. Particularly, in inertial frames and in the absence of interactions, it may not follow either curbed either straight lines, depending on arbitrary considerations.

The resolution of the contradiction lies on *"mass"*. Physically, there is a crucial difference in the nature of the above frame's acceleration: the acceleration on S' is *real*, whilst the acceleration on S is not, it is a *virtual* one. We can only resolve this issue by associating any aspect of matter to the origin of both systems. In fact, following Newton's principle, for something to be actually accelerated – not an abstraction – in the context, there needs to be a **force**... and a **mass** on which the force acts. So, physically there needs to be a massive particle (or co-particle) in the origin of any **real frame** of reference. Besides, as noted before, the sign of the energy/mass of the particle establishes **past** and **future** in its frame of reference. Therefore:

• If no *real* force is present, the frame is an inertial one; and, in it, light moves in straight lines.

• If a real force acts on the frame's origin, the frame is accelerated and, in it, light moves in curbed lines.

All this reasoning means that there isn't any deformation of spacetime associated with accelerated frames; spacetime appears to be flat, with a pseudo-Euclidean structure. The same must happen regarding gravity, despite Einstein's analogy. Let's see why.

Consider, for instance, a particle of rest mass m_0 submitted in S to a constant force **F** in the sense of the xx axis. From

$$F = \frac{dp}{dt} = \frac{d}{dt}\left(\frac{m_0 v}{\sqrt{1-v^2/c^2}}\right),$$

integrating this expression, making F constant (and also $v = 0$ for $t = 0$), it comes

$$Ft = \frac{m_0 v}{\sqrt{1-v^2/c^2}}, \tag{25}$$

which, resolved in relation to the velocity v, gives

$$\beta = \frac{kt}{\sqrt{1+k^2t^2}}, \quad \text{putting} \quad k = \frac{F}{m_0 c} = \frac{a_0}{c}. \tag{26}$$

Remark that $a_0 = F/m_0$ may be seen (improperly) as a *constant acceleration* on the particle [It is not *really* a constant acceleration because it relates to the inertial mass m_0, not to the growing mass m with velocity v; the real acceleration progressively diminishes] and that we obtain for the instantaneous Lorentz factor:

$$\gamma = \frac{1}{\sqrt{1-\beta^2}} = \sqrt{1+k^2t^2}. \tag{27}$$

One can easily see that these equations also apply in the case of *co-particles*; but then, the mass m_0 is negative and the co-particle accelerates in the opposite sense [for $F > 0$, the constant k is positive to particles ($m_0 > 0$) and negative to co-particles ($m_0 < 0$)]. This makes all the difference in the response to gravity forces.

Now, let S' be an accelerated frame, with the particle of rest mass m_0 mentioned above in its origin; I demonstrate in Appendix A that, if a photon moves in the inertial frame S in the direction of the yy axis (from its origin), then its movement in S' obeys to the following equation:

$$x' = -\frac{c}{2k}\ln\left[1+\tan^2\left(\frac{k}{c}\ y'\right)\right] \tag{28}$$

and the tangent vector **c** has components

$$\begin{cases} c'_x = \frac{dx'}{dt'} = -v \\ c'_y = \frac{dy'}{dt'} = \frac{c}{\sqrt{1+k^2t^2}}. \end{cases} \tag{29}$$

The inverse of the slope of the tangent to the trajectory at any point is given by

$$\cot\varphi' = \frac{c'_x}{c'_y} = -\frac{v}{c}\sqrt{1+k^2t^2} = -\frac{\beta}{\sqrt{1-\beta^2}},$$

just as in (24).

All this leads directly to the conclusion that, if identical proper frames of a particle and of an homologous co-particle are submitted to the same force **F**, they react (accelerate) in exactly opposite ways; and so, every trajectory in S (non-parallel to the xx axis), such as a light ray, deflects to opposite sides in those frames; this is symmetrically in the case of orthogonal trajectories to the movement of the frames. Therefore, if we push Einstein's analogy *gravity* $\equiv$ *accelerated frames* to the end, we discover that: 1) a pair of homologous material and co-material bodies should react inversely to a gravity field [and this perfectly agrees with the previous statements]; and 2) the effect of gravity on their frames of coordinates would be inverse, the 'distortion of spacetime' included [Remember that time appears reversed in the correspondent proper frames, so it appears symmetrically distorted].

On the other hand, gravity fields created by homologous material and co-material bodies are inverse because the same happens with their generating force. But then again, the effect on the frames of coordinates of other bodies depends on these ones' material or co-material nature.

By the way, the so-called "Uniform Relativistic Acceleration" problem (or better saying, "Relativistic Motion Under Constant Force" problem) has been studied by several authors, including Einstein himself. It leads to hyperbolic paths in a Minkowski diagram and to the so-called Rindler coordinates [9], [10]. GR generalizes this problem and is a work of genius. But Einstein restricted himself to positive masses and energies, the only ones he was aware of. This is the major problem!

Remark that Einstein's principle concerning the equality of *inertial* and *gravitational mass* is fully justified by PtR field theory basis, mainly the equation (14), where m_0 is an inertial mass. On the other hand, the gravitational response of a target-particle to the linear impulse imparted by the field mediators consists on a classical acceleration process, i.e. concerning inertial mass [or, better saying, an inertial mass multiplied by a *gravitational charge factor* $\phi_g = 1$, which makes the mass to be sensible to the field]. If inertial and gravitational masses are indeed the same, and the intensity of the gravitational field is, in fact, an ordinary acceleration, it is not surprising that

$$a \cdot m_i = g \cdot m_g.$$

Secondly, for the same reasons, the equivalence principle stands, as stated by Einstein Wikipedia [11]:

We [...] assume the complete physical equivalence of a gravitational field and a corresponding acceleration of the reference system.

The problem comes from pushing this too far, disregarding the possibility of negative energies.

That is, being on the surface of the Earth is equivalent to being inside a spaceship (far from any sources of gravity) that is being accelerated by its engines. The direction or vector of acceleration equivalence on the surface of the earth is "up" or directly opposite the center of the planet while the vector of acceleration in a spaceship is directly opposite from the mass ejected by its thrusters. From this principle, Einstein deduced that free-fall is inertial motion. Objects in free-fall do not experience being accelerated downward (e.g. toward the earth or other massive body) but rather weightlessness and no acceleration. In an inertial frame of reference bodies (and photons, or light) obey Newton's first law, moving at constant velocity in straight lines. Analogously, in a curved spacetime the world line of an inertial particle or pulse of light is as straight as possible (in space and time)[11].

I think Einstein was wrong here. In fact, objects in "free fall" are indeed submitted to acceleration, due to the interactions with gravity mediators. They do not 'feel' it because there are no barriers, all around is falling at the same growing speed. But *co-objects* in the same spaceship would react in an opposite way, in a "free-ascent" movement! This last simple conclusion invalidates the analogy with inertial motion. So, *free-fall is not inertial motion*. And, if I am right, we see that this error conduced Einstein to the misleading conception of curved spacetime.

This is what I call 'Einstein's mistake'. It condemns GR as an "unified description of gravity *as a geometric property of space and time, or spacetime*" [11]. Despite this, the theory keeps its validity as a formidable conceptual and mathematical tool, because the equivalence principles still hold, provided one renounces thinking on the distortion of spacetime produced by gravity as something real, objective. *Distortion is a **non-objective** feature, an appearance, resulting from measurements made in frames submitted to gravitational forces.* It depends on whether we are dealing with matter, co-matter or both.

4. The Stars in the Sky: A Simultaneous Vision of Past and Future

If the double time flow is a reality, it conduces to an astonishing hypothesis: as well as stars are sending us light form the past, stars made of co-matter or antimatter send us light from the future. As a result, cosmic images of past and future superpose in our view of the sky.

Now, as stated in Luís Dias Ferreira [4] and reviewed in Luís Dias Ferreira [2], PtR theory naturally assumes the universal validity of the quantum equations $E = h\nu = \hbar\omega$ and $\mathbf{p} = \hbar\,\mathbf{k}$, thus deriving from the table (3) the transformation of the phase 4-vector

$$(i\omega/c,\ k_x, k_y, k_z,):$$

$$\begin{cases} \omega^* = \frac{k_x c - \omega\beta}{\alpha} \\ k_x^* = \frac{k_x\beta - \omega/c}{\alpha} \\ k_y^* = k_y \\ k_z^* = k_z. \end{cases} \quad \text{and} \quad \begin{cases} \omega = \frac{k_x^* c - \omega^*\beta}{\alpha} \\ k_x = \frac{k_x^*\beta - \omega^*/c}{\alpha} \\ k_y = k_y^* \\ k_z = k_z^*. \end{cases} \qquad (30)$$

This makes positive frequencies to correspond to negative ones and vice-versa, describing a *co-photon* as a particular case of co-particle, with negative energy and moving with co-velocity $\hat{c} = c$, in modulus.

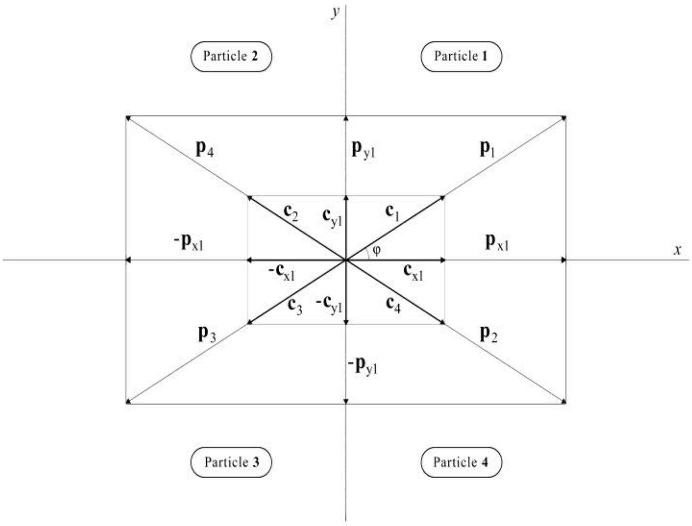
Regarding the longitudinal and the transversal *pseudotachyonic Doppler effects* on the radiation (photons) of frequency ν emitted by a tachyonic source moving with velocity v, we obtain

$$\nu = -\nu^* \sqrt{\frac{c \mp \hat{v}}{c \pm \hat{v}}}\ ; \quad \text{and} \quad \nu = -\nu^* \sqrt{1 - (\hat{v}/c)^2}, \tag{31}$$

"using the upper signs if the source is moving away from the observer, with a detection velocity $\hat{v} = c^2/v$; the lower ones if the source is coming closer. Both the results are symmetrical to those obtained for the bradyonic Doppler effect. They both mean that the photon is detected as a co-photon, with negative energy."

So, 'co-stars' send us co-photons from the future. Besides, reflection leads one to believe that the 'colour' of a radiation with frequency ν remains the same for the symmetric frequency $-\nu$; hence, if the light of a co-star in the future suffers a redshift, then the Universe is still expanding at that time. This seems to be the case, since all spectres present measurable redshifts, which are used to calculate the distance of their source. Therefore, some of these co-stars (or anti-stars) must be the most distant massive objects we perceive.

Figure-1. The simultaneous creation of the four aspects of a matrix-photon



One must be aware that in the primordial 'radiation era' of the Universe, the ultra-energetic radiation should exist in any of its four aspects. In fact, suppose that, in the singularity that marks the beginning of the Universe (usually known as the 'Big Bang') a photon of energy E is created. Because of the equivalence of all frames of coordinates, this implicates the simultaneous creation of the four aspects of a matrix-photon, as, for instance, represented in the figure-1:

1) a **photon** γ with energy E_1, moving with an angle $\varphi_1 = \varphi$ with the xx axis:

velocity components $\begin{cases} \mathbf{c}_{x1} = \mathbf{c}\cos\varphi \\ \mathbf{c}_{y1} = \mathbf{c}\sin\varphi \end{cases}$ and $\begin{cases} \mathbf{p}_{x1} = \mathbf{p}\cos\varphi \\ \mathbf{p}_{y1} = \mathbf{p}\sin\varphi \end{cases}$

2) a **co-photon** γ^* with energy $E_2 = -E_1$, angle $\varphi_2 = 180° - \varphi$:

velocity components $\begin{cases} \mathbf{c}_{x2} = -\mathbf{c}_{x1} \\ \mathbf{c}_{y2} = \mathbf{c}_{y1} \end{cases}$ and $\begin{cases} \mathbf{p}_{x2} = \mathbf{p}_{x1} \\ \mathbf{p}_{y2} = -\mathbf{p}_{y1} \end{cases}$

3) a **prime-antiphoton** $\overline{\gamma}$ with energy $E_3 = -E_1$, angle $\varphi_3 = 180° + \varphi$:

velocity components $\begin{cases} \mathbf{c}_{x3} = -\mathbf{c}_{x1} \\ \mathbf{c}_{y3} = -\mathbf{c}_{y1} \end{cases}$ and $\begin{cases} \mathbf{p}_{x3} = -\mathbf{p}_{x1} \\ \mathbf{p}_{y3} = -\mathbf{p}_{y1} \end{cases}$

4) a **co-prime-antiphoton** $\overline{\gamma}^*$ with energy $E_4 = -E_2 = E_1$, angle $\varphi_4 = -\varphi$:

velocity components $\begin{cases} \mathbf{c}_{x4} = \mathbf{c}_{x1} \\ \mathbf{c}_{y4} = -\mathbf{c}_{y1} \end{cases}$ and $\begin{cases} \mathbf{p}_{x4} = \mathbf{p}_{x3} = -\mathbf{p}_{x1} \\ \mathbf{p}_{y4} = -\mathbf{p}_{y3} = \mathbf{p}_{y1} \end{cases}$

The result of this process is a null total energy and a null total impulse (particles **1** and **3** cancel each other and so do **2** and **4**):

$$E_t = E_1 + E_2 + E_3 + E_4 = 0 \quad \text{and} \quad \mathbf{p}_t = \mathbf{p}_1 + \mathbf{p}_2 + \mathbf{p}_3 + \mathbf{p}_4 = \mathbf{0}.$$

Focusing on co-radiation, I showed in [4] that a colliding pair of homologous particle/co-particle give rise to a pair photon/co-photon. The inverse process is an immediate consequence of PtR time reversion. The creation of pairs electron/co-electron should then appear in the transition of the 'radiation era' to the following stage, with a dramatic consequence: the emergency of mass and the creation of force fields. Due to the huge energies of both members of each pair creation, their velocities avoided their mutual Coulomb attraction to bring them back and so to annihilate each other. Then, in the 'atomic era', the gravitational attraction of elementary particles of the same kind (aspect) that did not annihilate with their co-particles (or antiparticles) may have lead to 'clusters' of neutral atoms (and molecules later), whilst the repulsive gravity with co-particles leaded to their increasing separation. It is reasonable, therefore, to admit the existence in the Universe of separated 'reigns' dominated by each aspect of matter, antigravity being a fundamental agent in the expansion of this Universe.

This appears to be a quite relevant hypothesis in cosmology. But is it possible to test it? I think so, concerning co-radiation. Even if we cannot distinguish radiation from co-radiation in terms of wavelength, it is (at least theoretically) possible to do it by means of Compton scattering because the effect is opposite for photons and co-photons colliding with an electron: the first ones push the electrons forward, the seconds backward [4].

5. Conclusion

The theory of Pseudotachyonic Relativity, an extension of Special Relativity to the "faster than light", brought the consistent and fruitful hypothesis of negative energies and opposite time-flows in the Universe. It clarified the existence of homologous particles/co-particles (latter extended to antiparticles) as manifestations – 'aspects' – of a single 'archeparticle'. PtR proposed the foundations for a field theory based on positive/negative energies; and, also, on the concepts of positive, negative, pro-reactive or anti-reactive behaviour of particles and co-particles.

These foundations collide with either Newton's or Einstein's theories on gravity. It is not difficult to harmonize the first one with PtR. But, in what comes to General Relativity, the conclusion arises that Einstein made a mistake when he denied the existence of the force of gravity, taking the effect as the cause. He made a mistake when he concluded that gravity is a geometric property of spacetime, responsible for its distortion, the final cause for bodies to behave like they do. This would make all bodies, even those with negative mass, to behave in a similar way; which, according to PtR, must be false. The thesis is defended here that the force is real, the distortion is just appearance.

Besides, as well as 'ordinary' stars send us light form the past, stars made of co-matter or antimatter should send us light from the future.

Appendix A: Relativistic Motion Under Constant Force

As we saw in subsection 3.2, a particle with rest mass m_0 submitted in an inertial frame S to a constant force $\mathbf{F}$ in the sense of the xx axis (making $v_0 = 0$ at $t_0 = 0$), acquires a velocity v at time t given by

$$\beta = \frac{kt}{\sqrt{1+k^2t^2}} \quad \text{making} \quad k = \frac{F}{m_0 c}\ ; \tag{32}$$

$a = F/m_0$ may be understood as the *initial acceleration*, which will decrease (in modulus) with the increasing speed; the constant k represents a *frequency*. The instantaneous Lorentz factor γ at time t is:

$$\gamma = \frac{1}{\sqrt{1-\beta^2}} = \sqrt{1+k^2t^2}. \tag{33}$$

These equations apply as well to particles ($m_0 > 0$) as to co-particles ($m_0 < 0$).

We may combine both equations (32) and (33) to obtain

$$v = at\sqrt{1-\beta^2},$$

where at is the Galilean result of the acceleration; $\sqrt{1-\beta^2}$ is a relativistic 'correcting term', which makes the velocity increment dv to progressively slow down. Of course,

$$\lim_{t\to\infty} \beta = \pm 1,$$

depending on what the mass m_0 is positive or negative.

We are now interested in the Lorentz transformations for a frame S' accelerated in these circumstances. Firstly, concerning time:

$$dt' = \frac{dt}{\sqrt{1+k^2t^2}} \tag{34}$$

and therefore

$$t' = \int_0^t \frac{dt}{\sqrt{1+k^2t^2}}$$

We know that

$$\int \frac{dt}{\sqrt{t^2 \pm u^2}} = \ln\left|t + \sqrt{t^2 \pm u^2}\right| + C,$$

so, making $u = \frac{1}{k}$, for $k \neq 0$ [remark that $\lim_{c\to\infty} k = 0$ and also that this limit represents the Newtonian situation], we get

$$\int \frac{dt}{\sqrt{1+k^2t^2}} = \frac{1}{|k|}\ln\left|t + \frac{1}{|k|}\sqrt{1+k^2t^2}\right| + C.$$

or, finally,

$$\begin{aligned} t' = {} & \frac{1}{|k|}\left[\ln\left|t + \frac{1}{|k|}\sqrt{1+k^2t^2}\right|\right]_0^t = \\ & \frac{1}{|k|}\left[\ln\left|t + \frac{1}{|k|}\sqrt{1+k^2t^2}\right| - \ln\left|\frac{1}{|k|}\right|\right] = \\ & \frac{1}{|k|}\ln\left|\frac{t + \frac{1}{|k|}\sqrt{1+k^2t^2}}{\frac{1}{|k|}}\right|, \end{aligned}$$

that is,

$$t' = \frac{1}{|k|}\ln\left||k|t + \sqrt{1+k^2t^2}\right|. \tag{35}$$

Concerning now the transformation of $x = 0$:

$$\frac{dx'}{dt'} = -v = -c\frac{kt}{\sqrt{1+k^2t^2}}$$

and so, according to (34),

$$x' = -c\int_0^{t'} \frac{kt}{\sqrt{1+k^2t^2}}\ dt' = -c\int_0^{t} \frac{kt}{1+k^2t^2}\ dt.$$

Once again, the integral may be resolved by substitution; making

$$u = kt \quad dt = \frac{du}{k};$$

then

$$\int \frac{u}{1+u^2}\ du = \frac{1}{2}\ln(1+u^2) + C.$$

Therefore:

$$x' = -\frac{c}{2k}\ln(1+k^2t^2). \tag{36}$$

Remark that we obtain for the first two derivatives of the function $w = \ln(1+k^2t^2)$:

$$w^{(1)} = \frac{2kt}{1+k^2t^2} \qquad \Rightarrow \quad w^{(1)}(0) = 0$$

$$w^{(2)} = 2k^2\frac{1+3k^2t^2}{(1+k^2t^2)^2} \quad \Rightarrow \quad w^{(2)}(0) = 2k^2.$$

So, the MacLaurin series expansion for x' gives (remembering that $a = kc$):

$$\begin{aligned} x' \quad &= f(t) = f(0) - \frac{c}{2k}\left[\frac{t}{1}w^{(1)}(0) + \frac{t^2}{2!}w^{(2)}(0) + \ldots\right] \\ &= 0 - 0 - \frac{1}{2}\ at^2 - \ldots \end{aligned}$$

One may recognize in the first non-null term the Galilean expression for uniform accelerated movement with departure from rest at the origin O: $x'_G = -\frac{1}{2}\ at^2$. As usual, for small values of a and t, there's hardly any difference between relativistic and classical results. But, for instance, making $a = 100000 m/s^2$ (a huge acceleration), one gets

$$For \quad t = 1000 \ s \ : \quad \beta \approx 31.6\% \quad \frac{x'_R}{x'_G} \approx 94.82\%$$

$$For \quad t = 50000 \ s \ : \quad \beta \approx 99.8\% \quad \frac{x'_R}{x'_G} \approx 2.03\%$$

$$For \quad t = 90000 \ s \ : \quad \beta \approx 99.9\% \quad \frac{x'_R}{x'_G} \approx 0.76\%.$$

The (increasing) large discrepancy between x'_R and x'_G results from the proportional increase of speed in the Galiliean transformation: only $\beta_G \approx 33.3\%$ for $t = 1000\ s$; but $\beta_G \approx 1666.7\%$ for $t = 50000\ s$ and $\beta_G \approx 3000.0\%$ for $t = 90000\ s$.

Consider now **the movement of a photon in the direction of the yy axis of the inertial frame S**; this gives, for the components of the vector **c**, $c_y = c$ and $c_x = 0$. Let's search for the correspondent movement in S'. Since

$$c'^2_x + c'^2_y = c^2, \quad \text{that is,} \quad \left(\frac{dx'}{dt'}\right)^2 + \left(\frac{dy'}{dt'}\right)^2 = c^2$$

and $\frac{dx\prime}{dt\prime} = \beta c$, it must be

$$c'_y = \frac{dy\prime}{dt\prime} = c\sqrt{1-\beta^2} = \frac{c}{\sqrt{1+k^2t^2}}. \tag{37}$$

Therefore, applying (34), one gets

$$\frac{dy'}{dt} = \frac{dy'}{dt'}\frac{dt'}{dt} = c(1-\beta^2) = \frac{c}{1+k^2t^2},$$

that is,

$$y' = c\int_0^t \frac{dt}{1+k^2t^2},$$

which solution is

$$y' = \frac{c}{k}\arctan(kt). \tag{38}$$

Inversely, $kt = \tan(y'k/c)$ and this, applied in (36) puts x' as a function of y':

$$x' = -\frac{c}{2k}\ln\left[1 + \tan^2\left(\frac{k}{c}\ y'\right)\right]. \tag{39}$$

In a Galilean transformation, as it is well known, we obtain $x' = -\frac{a}{2c^2}y'^2$, which is the equation of a parabola. Finally, as well as we did for x, we may compare the results for y, concerning relativistic and Galilean transformations:

$$For\quad t = 1000\ s:\quad \beta \approx 31.6\%\quad \frac{y'_R}{y'_G} \approx 96.53\%10pt$$

$$For\quad t = 50000\ s:\quad \beta \approx 99.8\%\quad \frac{y'_R}{y'_G} \approx 9.07\%10pt$$

$$For\quad t = 90000\ s:\quad \beta \approx 99.9\%\quad \frac{y'_R}{y'_G} \approx 5.12\%.$$

Appendix B: The Constant Velocity c and Spacetime Structure

As much Newton's as Einstein's theories operate on the conceptual frame of continuous space and time. A theory of gravity based on mediator particles puts the problem in discontinuous terms.

The controversy on the subject *Continuous versus Discontinuous* is an old one, dating back at least to the Presocratic philosophers, and this regarding not only matter but also the structure of space and time. The Greek philosopher Zeno of Elea invented several paradoxes – four have survived – condemning both conceptions [12]. His *"arguments against motion"* puzzled and challenged thinkers for over two millennia [13], until those concerning continuity ("Achilles and the tortoise" and "The dichotomy") were resolved with the development of the theory of limits; but this in the field of Mathematics, solely, not really in Physics. From those concerning discontinuity, "The arrow" is hard to deal with and "The moving rows" is not algebraically resolvable (yet, in a continuous theory) but with Special Relativity.

Newton's Physics raised over his predecessors based on Galileo's revolutionary principle of relativity. Special Relativity took a step forward, adding to this principle a second one, which however establishes an absolute: *the constancy of the speed of light*.

The immediate question is: why this absolute, if almost everything else is relative? More, why is the speed of light constant in inertial frames? On the other hand, the existence of c as a speed limit – or as a frontier if we accept PtR – is a symptom that the fundamental structure of spacetime must be discreet. If this wasn't so, if space and time were fundamentally continuous, why should there be a speed limit? And why c and not any other one?

If we admit the existence of a **lenght-quantum** $\kappa_\bullet$ and a **time-quantum** $\tau_\bullet$, then c is a speed-frontier because it corresponds to a unit of length per unit of time:

$$c = \frac{\kappa_\bullet}{\tau_\bullet}. \qquad (40)$$

This is quite understandable and replaces the postulate of the constancy of the speed of light by the existence of such minimal length and time in the geometry of the Universe.

One must notice that **these proposed units $\kappa_\bullet$ and $\tau_\bullet$ are obviously the same in any frame of coordinates**, due to the principle of equivalence; and this means that they are not subject to Lorentz length contraction and time dilation. These Lorentz's phenomena relate to the *number* of $\kappa_\bullet$ and $\tau_\bullet$ in measurements made in different frames of coordinates, as the idealized experiment of a ray reflected in a mirror – in the sense either of the $x'x'$ axis or the $y'y'$ axis – may easily show. This means that not even relativistic phenomena or measurements concerning inertial frames (including energy, linear impulse, etc.) correspond to objective distortions of spacetime.

Consider for now just positive integer numbers n and m. Bradyonic Relativity reasonably sustain that ordinary movements cannot take place unless

$$v = \frac{n\kappa_\bullet}{m\tau_\bullet}\quad implicates\quad n < m\,; \qquad (41)$$

this is why c appears as a speed limit $(n = m)$. Pseudotachyonic Relativity adds the possibility of $n > m$; but, if so, the detection-velocity is

$$\hat{v} = \frac{c^2}{v} = \frac{\kappa_\bullet^2}{\tau_\bullet^2}\cdot\frac{m\tau_\bullet}{n\kappa_\bullet} = \frac{m\kappa_\bullet}{n\tau_\bullet}, \qquad (42)$$

which turns out to be subluminal. This is a very satisfactory result, consequence of the interchange of spacetime axis presupposed in pseudotachyonic transformations, which allows us to understand what the physical meaning is of

$$\hat{v} = c^2/v.$$

In this conception, from a simplistic point of view, a photon is supposed to be a linear particle, with no volume (no mass) but with length $\kappa_\bullet$ (or, better saying, a kind of vector pointing in the sense of its unstoppable motion). This is because nothing should exist between two contiguous lenght-quanta; and, also, all 'perception' of space in a frame S', when $v \to c$, tends to the xx axis [see equation (24.a)]; in the limit, a 'photonic frame' reduces to the the line of its movement. An electron, a prior elementary particle, should appear as a sphere with diameter $\kappa_\bullet$, corresponding to a space-quantum we'll symbolize by $\boldsymbol{\kappa}_\bullet^{s3}$, which is a 'point', and also as an indivisible electric charge. This meets the concept of the electron defended by Max Abraham (1875-1922), a tempting though discredited idea, except that the charge is not "divided evenly around its surface" [14], the charge **is** the elementary whole.

It follows that the electron should then keep its spherical form and size in any frame of coordinates; its charge should also be invariant, which is effectively true. These hypotheses eliminate Max Born's pertinent objection to the 'corpuscular' nature of the particle proposed by the resilient Abraham [15]:

"The calculations of the electromagnetic mass of the electron rested on the assumption that the electron is rigid, retaining its form throughout the motion; which implies the assumption of infinitely great internal forces of non-electromagnetic origin. If the assumption is dropped, we obtain not only other numerical factors, but also other functions of the velocity. Besides, the assumption of absolute rigidity is quite incompatible with the theory of relativity (on account of the Lorentz contraction; ...); if instead of this we postulate invariability of form in the reference system in which the electron is instantaneously at rest, we obtain a formula which agrees, to a numerical

factor, with that stated on p. 27 (Lorentz's electron, 1909). The numerical factor, however, must to a large extent remain arbitrary, since it depends on the distribution of the charge, as to which we know nothing. Worse still, even in this relativistic form very great internal forces of cohesion must be assumed, to keep the parts of the electron together, these having charges of the same sign and therefore repelling each other; and this leads to a contradiction of a fundamental theorem of the mechanics of radiating systems, of which we have now to speak."

Born alludes to Einstein's theorem $E = mc^2$. He himself, however, speaks in the following pages of an embarrassing problem:

"As the quantum theory developed, physicists became sceptical about definite models of the elementary particles. They preferred therefore to think of the electron, in regard to all external actions, as a charged point mass, without troubling further about its internal structure. The awkward fact remains, however, that the electron's proper energy, which is proportional to e^2/a, becomes infinite when a is put equal to 0. One way of overcoming this difficulty consists in eliminating the infinite terms from the laws of electrodynamics without changing these otherwise. This has been done by Paul [16], by modifying the expression for the force on a point charge and by Pryce (1938) by changing the definitions of electromagnetic energy and momentum. But this seems to be evading, not solving, a real problem.

For the radius a of the electron has an actual physical significance; by a we understand that length which satisfies Einstein's relation $\alpha \cdot e^2/a = mc^2$, where α is a numerical factor of the order of magnitude 1."

From some considerations, Born deduces that

$$a = \sqrt{\frac{8}{3}} \cdot \frac{e^2}{mc^2}.$$

"This quantity, he argues, *is the "radius" of the electron if α is put equal to $\sqrt{8/3}$."* And he adds: *"The remarkable thing about this method is that it makes no use of any hypothetical extrapolation of electrostatics to the interior of the electron, but works with a point electron."*

If one makes $\kappa_{\bullet} = 2a$, it comes from Born's reasoning that

$$\kappa_{\bullet} \approx 1.02 \times 10^{-24} m \quad \text{and,} \quad \text{therefore,} \quad \tau_{\bullet} = \frac{\kappa_{\bullet}}{c} \approx 3.41 \times 10^{-33} s.$$

Remark that these evaluations are considerably bigger than Planck length and time:

$$l_P = \sqrt{\frac{\hbar G}{c^3}} \approx 1.62 \times 10^{-35} m \quad \text{and} \quad t_P = \frac{l_P}{c} = \sqrt{\frac{\hbar G}{c^5}} \approx 5.39 \times 10^{-44} s.$$

Whatever the value of $\tau_{\bullet}$ is, its concept brings an immediate difficulty: whilst, according to Relativity, energy measure can grow infinitely, the same cannot happen with frequency because the existence of a minimal time $\tau_{\bullet}$ implicates a maximal frequency, $\nu_{\bullet} = 1/\tau_{\bullet}$.

This approach recalls the "Doubly Special Relativity" (DSR) theories, which postulate "a new absolute (...) observer-independent length (momentum) scale, in addition to the familiar observer-independent velocity scale c" [17] and which search for a compatible reformulation of Lorentz transformations. DSR theories consider Planck units as good candidates to the role of fundamental 'bricks' and associate the above-mentioned maximal frequency to Planck unit of energy (1.22Ã—1019 GeV), which is then considered the maximal energy of particles.

There is, however, another *drastic* way to resolve this: by a non-linear modification of Planck's law. For instance (and this is just a guess, just a suggestion):

$$E = \frac{h\nu}{\sqrt{1-(\nu/\nu_{\bullet})^2}} \tag{43}$$

For small frequencies, by comparison with $\nu_{\bullet}$, the result is $E \approx h\nu$. As a matter of fact, if $\tau_{\bullet} = t_P$, this is $\nu_{\bullet} \approx 1.86 \times 10^{43}/s$, this modification of Planck's law has no measurable consequences even at quantum scales, except for very high values of $\beta = v/c$; for instance, for an electron or a muon, the denominator is indistinguishable from 1. But, for high frequencies, energy would grow fast and

$$\lim_{\nu \to \nu_{\bullet}} E = \infty.$$

The inverse transformation would be

$$\nu = \frac{E/h}{\sqrt{1+\left(\frac{E}{h\nu_{\bullet}}\right)^2}}. \tag{44}$$

In these terms, one keeps the 4-momentum quadrivector Lorentz covariant, which is quite reasonable because of its tensorial equivalence with spacetime quadrivector transformation. If, for waves, the equality $\mathbf{k} = \omega\mathbf{p}/E$ still holds, then a simple operation gives

$$\mathbf{k} = \frac{\mathbf{p}}{\hbar}\sqrt{1-(\nu/\nu_{\bullet})^2} \quad or \quad \mathbf{p} = \frac{\hbar\mathbf{k}}{\sqrt{1-(\nu/\nu_{\bullet})^2}}. \tag{45}$$

From another hand, an infinite energy associated to the maximal frequency would implicate that the scale of elementary time $\tau_{\bullet}$ is not attainable by any experimental means; but then neither $\kappa_{\bullet}$ because of the interchangeability of time and space axis presupposed in PtR transformations. This is, 'an elementary frame' would be physically beyond our experience. One should expect this limitation not to appear suddenly, the 'elementary scale' being increasingly unreachable as one approaches it. Is there a progressive restriction to Euclidean geometry down the physical scale? Or a progressive 'dilution' of its operational frame? Or are there several grades on the scale for frequencies? This does not make much sense if the scale is infinite; but, if not, would these 'grades' allow to explain the 'multiplication' of the electron in heavier versions?

The fully comprehension of all this, if possible, would maybe allow us to face many other issues whose resolution is far from simple (and some theories are still dealing with them). For example: 1) the interrupted nature of movement (a sort of instantaneous “hop on hop off” where, as in Zeno’s paradox “The Arrow”, there is nothing between two instants $\tau_{\bullet}$); 2) the chaining of multiple $\kappa_{\bullet}$ in a straight line movement; 3) the possibility of irrational proportions β for $v = \beta \cdot \kappa_{\bullet}/\tau_{\bullet}$; and 4) the structure itself of spacetime.

Anyway, a discrete nature of spacetime is seemingly a requirement for discrete operation of gravitational and electrostatic fields based on mediator particles, as proposed by PtR. Indeed, how can a finite number of mediators (photons, gravitons) work, having no volume/mass, on a spherical surface infinitely divisible?

The onset of an answer to these problems probably lies in a statistical behaviour of nature, starting by the basic units $\kappa_{\bullet}$ and $\tau_{\bullet}$ [and nothing seems to oblige these units to maintain their ratio along the evolution of the Universe, which would produce a varying speed of light, like in the theories of João Magueijo]. And this behaviour, it seems to me, relates to *energy*. Finally, it is important to understand that this hypothesis does not implicate that space is well organized (structured) in ‘atoms’ of $\boldsymbol{\kappa}_{\bullet}^{s3}$; in fact, whatever the distribution or organization of these supposed ‘cells’ would be, it would favour some inertial frames on others, and this is unacceptable. A mysterious virtual organization must be behind the fabric of space, manifesting itself in an Euclidean geometry, because there seems to be even less justification for a distorted structure.

References

[1] Luís Dias Ferreira, 2007. "Tachyons and pseudotachyonic relativity." *Concepts of Physics,* vol. 4, pp. 35-69.

[2] Luís Dias Ferreira, 2016. "The four aspects of matter and radiation." *Physical Sciences International Journal*, vol. 10, pp. 1-32.

[3] Luís Dias Ferreira, 2008. "De Broglie waves and pseudotachyonic relativity." *Concepts of Physics,* vol. 5,

[4] Luís Dias Ferreira, 2007. "Antimatter and Pseudotachyonic Relativity." *Concepts of Physics,* vol. 4,

[5] Hendrik, A., Lorentz, and Albert Einstein e Hermann Minkowski, 1983. *The Principle of Relativity - Portuguese translation*. 3th edition ed. Lisbon: Calouste Gulbenkian Foundation. pp. 55-62.

[6] Alonso & Finn, 1967. *Fundamental University Physics*. Brasilian edition ed.: Addison-Wesley Publishing Company.

[7] Louis de Broglie, 1987. "Interpretation of quantum mechanics by the double solution theory, translation by Maurice Surdin." *Annales de la Fondation Louis de Broglie,* vol. 12,

[8] Wikipedia. "Newton’s law of universal gravitation." Available: https://en.wikipedia.org/wiki/Newton%27s_law_of_universal_gravitation

[9] Benjamin Knorr, 2010. *Uniform relativistic acceleration*. University of Leipzig, Faculty of Physics and Earth Sciences.

[10] Smoot, G. F., 2003. "Physics 139 Relativity." *Relativity Notes,* Available: http://aether.lbl.gov/www/classes/p139/homework/homework.html

[11] Wikipedia. "General relativity." Available: https://en.wikipedia.org/wiki/General_relativity

[12] Kirk, G. S. and Raven, J. E., 1962. *The presocratic philosophers: A critical history with a selection of texts, chapter xi*. Cambridge University Press.

[13] Wikipedia. "Zeno of Elea." Available: https://en.wikipedia.org/wiki/Zeno_of_Elea

[14] Wikipedia. "Max Abraham." Available: https://en.wikipedia.org/wiki/Max_Abraham

[15] Max Born, 1969. *Atomic Physics, Chapter 3, § 1*. 8th Edition ed. Blackie & Son Ltd.

[16] Paul, A. M. D., 1958. *The principles of quantum mechanics*. 4th ed. Oxford University Press.

[17] Giovanni Amelino-Camelia, 2002. *Doubly special relativity, Preprint version of Nature* vol. 418. Dipartamento de Fisica, Università “La Sapienza”, Roma, Italy, pp. 34-35.