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Time is a Derived Practical Construct - Distance and Velocity are Fundamental

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Abstract

Distance and time are regarded as fundamental properties of reality, with velocity defined as their ratio. In this paper, we propose a conceptual reassessment, suggesting that distance and velocity are fundamental quantities, whereas time should be understood as a derived, practical construct. This reinterpretation provides a foundation for a revised understanding of the structure and formulation of physical laws.

Key Words: Time; Distance; Light velocity; General relativity; Special relativity

1 Introduction

1.1 Formal

We do not truly know what time is; we only observe motion (Aristotle).

We can construct devices called clocks, whose moving hands (or analogous mechanisms) represent what we call the "passage of time. “The time of an event is defined by the position of the clock's hands at the moment and location of the event.

The hands of the clock must move in a regular, circular motion, ensuring that each cycle is identical. In cases where the motion is not circular but still rhythmic, the physical conditions must be maintained so that each motion mirrors the previous one. Thus, we speak of the clock’s rhythm, or the frequency of its cycles, where each complete cycle defines a unit of time. In reality, we do not measure time; all we do is compare the internal motions of clocks.

1.2 Less Formal

While traveling through the Israeli Desert (Negev), I once encountered a barefoot Bedouin and asked for directions to the nearest spring. His response was, “No problem - it will take you ten cigarettes.” What he meant was that the duration required to reach the spring could be measured by the time it takes to smoke ten cigarettes in sequence - a practical, action-based unit of duration.

Years later, I met him again, still barefoot, and inquired about an uncharted ancient site. This time he pointed to his polished Rolex and said, “You’ll arrive when the short hand points upward and the long hand to the right.” Again, the reference was to an observable physical configuration, not an abstract temporal measure.

1.3 Formal Again

In physics, we adopt a comparable approach: the separation between two events in General Relativity is defined both spatially and temporally, with the latter expressed as the distance light travels between them. This defines time not as an independent entity, but as a relation derived from the behavior of physical systems.

In all these instances, what we refer to as “time” is, in fact, a comparison between observable actions or changes. Yet despite this operational definition, no convincing or universally accepted physical process has been proposed that allows us to eliminate the notion of time as a fundamental attribute of physical reality.

In this paper, we propose, based on our theoretical framework and recent publications, that three-dimensional space be modeled as an elastic, deformable lattice composed of discrete, countable cells. The internal deformations of this spatial lattice can be rigorously analyzed using our Deformed Spaces Geometry. Furthermore, electromagnetic wave – or photons can be reinterpreted as space waves with an invariant velocity for all the local observers. This formulation allows for the demotion of time from a fundamental physical quantity to a derived, operational parameter.

2. Space

2.1 Space as a Lattice

By attributing a cellular structure to space we can explain its expansion, its elasticity and can introduce a cut-off in the wavelength of the vacuum state spectrum of vibrations. Without this limitation on the wavelength, infinite energy densities arise. The need for a cut-off is addressed by Sakharov [1], Misner et al [2], and by Zeldovich [3]. The Bekenstein Bound sets a limit to the information available about the other side of the horizon of a black hole [4]. Smolin [5] argues that:

> *There is no way to reconcile this with the view that space is continuous for that implies that each finite volume can contain an infinite amount of information*

Riemann, quoted by Chandrasekhar in Nature [6], was of the opinion that space is a lattice. Relevant review introductions appear in papers [7] [8] and [9].

2.2 The Linear Dimension of a Space Cell

Let L_{cell} be the linear dimension of a unit cell of space. If we consider L_{cell} as **Planck's length**, then:

$$L_{cell} = L_{planck} = \left(\frac{\hbar G}{c^3}\right)^{\frac{1}{2}} \sim 1.6 \cdot 10^{-33}\text{cm}$$

The cut-off wavelength is: $\lambda_{cut\text{-}off} = 2L$, and the cut-off wavenumber is: $k_{cut-off} = \dfrac{1}{\lambda_{cut-off}}$

t'Hooft [10] explains the meaning of L_{planck}. The GeometroDynamic Model (GDM) [10], our Theory of Everything (TOE), however, **does not** use the value of $\lambda_{cut\text{-}off}$, L_{planck} or L_{cell} in any calculation. In Section 8 of this paper, we present a derivation and calculation of L_{cell} that yields the result $L_{cell} \sim 10^{-22}$cm.

In the GDM the elasticity of space means a flexible L_{cell}.

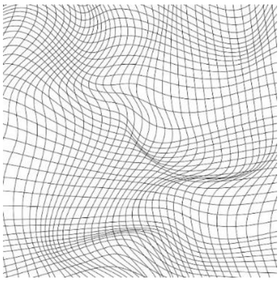


Fig. (1) Artist concept of a 3D deformed space-.

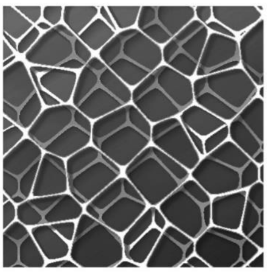


Fig. (2)Artist concept of the cells

2.3 Space Density

Space density ρ is defined as the number of space cells per unit volume. Space density in a zone of space without deformations (far away from masses and charges) is denoted ρ_0. Accurate definitions of these terms appear in our Geometry of Deformed Spaces, Sub-section 2.6.

Let dn be the number of space cells in a given volume dV. Since dn = ρ_0dV and also dn = ρdV' we get:

$$dV = \frac{dn}{\rho_0} \qquad dV' = \frac{dn}{\rho} \qquad \text{Hence:} \quad \frac{dV' - dV}{dV} = \frac{\rho_0 - \rho}{\rho}$$

In Appendix A of [11] we prove that the relative volumetric change equals the divergence of the Elastic Displacement Vector **u**:

$$\nabla \cdot \mathbf{u} = \frac{dV' - dV}{dV} \qquad \text{Thus:} \quad \nabla \cdot \mathbf{u} = \frac{\rho_0 - \rho}{\rho}$$

This proof is a corner stone in the GDM electromagnetism.

It is based on the **strain tensor** u_{ik} , which is defined as:

$$u_{ik} = \frac{1}{2}\left(\frac{\partial u_i}{\partial x_k} + \frac{\partial u_k}{\partial x_i} + \frac{\partial u_l \partial u_l}{\partial x_i \partial x_k}\right)$$

2.4 The Small Deformation Strain Tensor as a Fundamental Metric Tensor

The authors of [12] conclude:

"……. **the small deformation strain tensor could be used as a fundamental metric tensor, instead of the usual fundamental metric tensor.**"

Note, however, that space deformation is **a local feature of curvature**, whereas a manifold curvature can also be a global feature of curvature (like that of a closed spherical surface).

2.6 The Geometry of Deformed Lattices - Definitions and Axioms [13]

In this section we present only the definitions and axioms of our geometry.

This geometry is compatible with **differential geometry** and applies its concept of curvature in a novel way.

2.6.1 Definitions

Space Density ρ **at a point within a singular space cell** is the inverse of

the volume of this particular cell, $[\rho] = L^{-3}$.

Space Density ρ at a point on the boundary between cells is the inverse of the average volume of the cells that share this boundary, $[\rho] = L^{-3}$.

For physicists who consider the linear dimension of a space cell to be the **Planck Length** $\mathbf{1.6 \cdot 10^{-33}}$ cm, **Space Density,** is approximately the **number of space cells per unit volume**.

Line Density ι **at a point within a singular regular space cell** is the inverse of

the linear dimension of this particular cell, $[\iota] = L^{-1}$.

Line Density ι **at a point on the boundary between cells** is the inverse of the average linear dimensions of the cells that share this boundary, $[\iota] = L^{-1}$.

The Space density and **Line Density of an un-deformed (uniform) space** are denoted ρ_0 and ι_0 respectively. Note that, $\iota^3 \sim \rho$.

In a uniform space, all of its elementary cells are of the same size, and Euclidean geometry is valid. Note that in our figures, we represent a space cell (of unknown geometry and structure) by a circle in 2D and a sphere in 3D.

2.6.2 The Axioms

1. **Space is a Lattice -** its structure is cellular
2. **Space is elastic** – its cells sizes can change
3. **Space is without boundaries** – infinite
4. **The linear dimension of a space cell serves as the intrinsic yardstick unit of length**

3. Distance and Yardstick

3.1 Distance and Yardstick in an Un-Deformed (Euclidean) Space no Presence of Mass and Charge

In Barak's Deformed Space Geometry [13], the space lattice consists of discrete, deformable cells. Thus, no measurable length can be smaller than the linear size of a cell at a given location. Therefore, a yardstick dr is constrained by the minimum local spatial scale and cannot be reduced arbitrarily. A **standard unit of length** can be defined as n contiguous space cells aligned in a straight row, where n is the same for all observers and is chosen arbitrarily. In a deformed space the **distance** between the two points is the minimal number of space cells in a series on a trajectory between the points. This trajectory is considered the **geodesic** trajectory in a deformed space.

3.2 Distance and Yardstick in a Deformed Space with the Presence of Mass and Charge

3.2.1 Deformed Spaces versus Bent Manifolds

We relate to space not as a passive static arena for fields and particles but as an active elastic entity, which is the, one and only, entity that exists. Physicists have different, sometimes conflicting, ideas about the physical meaning of the mathematical objects of their models. The mathematical objects of General Relativity, as an example, are n-dimensional manifolds in hyper-spaces with more dimensions than n. These are not necessarily the physical objects that General Relativity accounts for, and n-dimensional manifolds can be equivalent to n-dimensional elastic spaces. Rindler [14] uses this equivalence to visualize bent manifolds, whereas Steane [15] considers this equivalence to be a real option for a presentation of reality. Callahan [16], being very clear about this equivalence, declares: "…**in physics we associate curvature with stretching rather than bending**". After all, in General Relativity gravitational waves are space waves and the attribution of elasticity to a 3D space is thus a must. The deformation of space is the change in size, of its cells. The terms positive deformation and negative deformation, around a point in space, are used to indicate that space cells grow or shrink, respectively, from this point outwards. Positive deformation is equivalent to positive curving and negative deformation to negative curving [13] [17].

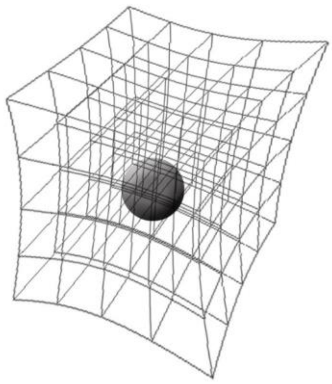


Fig. (3) The True Deformation of Space by a Mass

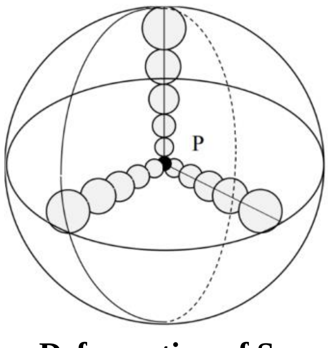


Fig. (4) The True Deformation of Space by a Mass at Point P

And Not

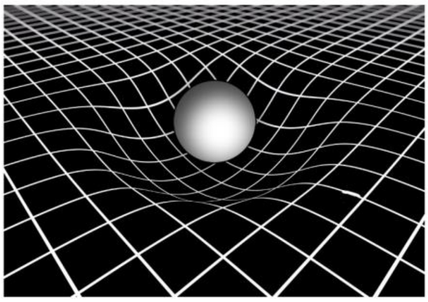


Fig. (5) The Curving of Space by a Stellar Mass

3.2.2 Spatial Distance and Yardstick

The term **Spatial distance** appears here for future application in Section 6 about **the Event Arena** that is suggested as a replacement of the term **Spacetime**.

In Barak's Deformed Space Geometry, the space lattice [13] consists of discrete, deformable cells. Thus, no measurable length can be smaller than the linear size of a cell at a given location. Therefore, a yardstick dr is constrained by the minimum local spatial scale and cannot be reduced arbitrarily. A **standard unit of length** can be defined as n contiguous space cells aligned in a straight row, where n is the same for all observers and is chosen arbitrarily. In a deformed space the **spatial distance** between the two points is the minimal number of space cells in a series on a trajectory between the points. This trajectory is considered the geodesic trajectory in a deformed space.

Let space cells A and B be marked where the distance between them is m cells. This **spatial distance** δ between A and B**,** by definition, is **invariant** under any deformation of space.

It is clear that $\delta^2 = dx^2+dy^2+dz^2$, but the Cartesian coordinate system is not relevant here.

5. Space waves – Gravitational (Gravitons) and Electromagnetic (Photons)

5.1 Arguments for the Space Density Dependence of Light Velocity in a Deformed 3D Space Lattice

Gravitational waves are fundamentally waves of space itself, propagating at the same speed as electromagnetic waves—that is, the speed of light. According to Quantum Field Theory (QFT), all 17 known fields are embedded within space and conform to its topology. It is therefore reasonable to consider light as a space wave as well. This view is supported by our models of the photon and graviton, which conceptualize these particles as manifestations of space vibrations. When ensembles of such particles are in phase, they exhibit quasi-classical wave behavior. In our theory, space is treated as a physical entity possessing a cellular internal structure characterized by local properties such as density and degree of deformation. Furthermore, classical electromagnetism relates the speed of light to the permittivity ε and permeability μ of space via the well-known relation:

$$c(r) = (\varepsilon\varepsilon_0 \cdot \mu\mu_0)^{-1/2}$$

Here, ε and μ are the relative values associated with matter, while ε_0 and μ_0 pertain to the vacuum properties of space. Since ε and μ depend on matter density, we posit that ε_0 and μ_0 are, analogously, functions of the local space density $\rho(r)$ [13]. This assumption aligns with our foundational view that matter is not foreign to space but is instead a localized configuration of the vibrating space itself - space is the only substance that exists. In our paper titled "Electric Charge and Its Field as Deformed Space" [18] we define electric charge density in terms of space density. Remarkably, this definition alone - without relying on phenomenological evidence - leads directly to the theory of Electrostatics. Moreover, when combined with the Lorentz Transformation, Electrostatics, without any phenomenology, yields the complete Maxwell Electromagnetic Theory, as we have demonstrated. From this, we infer that the true (local) speed of light is inversely proportional to the local space density:

$c(r) \propto 1/\rho(r)$

In the following section, we present the well-known expression for **coordinate light velocity** in the presence of gravitation, which corresponds to space contraction (See Appendix A):

$$c(r) = (1-2Gm/rc^2)\cdot c$$

Our interpretation of this equation - and the derivation provided in Section 7 proving the invariance of light velocity for all local observers - leads to the logical conclusion that this expression describes a physically real variation of light speed due to space deformation. This conclusion stands in contrast to the conventional interpretation, which attributes the variation to time dilation of observers' clocks. A detailed discussion of this discrepancy lies beyond the scope of this paper.

4.1 Light velocity

We propose that the speed of light is influenced by the density of space, analogous to its dependence on the density of the medium through which it propagates; denser regions of space correspond to a reduced light speed. In previous work [19], we demonstrated that gravitation can be interpreted as a contraction of space, leading to increased spatial density near massive bodies and, consequently, a slower propagation of light. This insight prompted us to investigate the validity of our hypothesis and to affirm that the constancy of light speed for all local observers remains intact. This constancy arises because the measuring instruments of local observers, such as yardsticks, also undergo contraction in regions of higher spatial density [18]. Our investigation is grounded in General Relativity (GR), wherein we replace the traditional Riemannian geometry with the novel framework of Deformed Spaces Geometry [13]. This approach preserves the equations and solutions of GR, along with the concept of curvature, while offering a more tangible and intuitive understanding of gravitational phenomena. It addresses longstanding issues and predicts new phenomena, some of which have been observed in recent experiments conducted at the Hebrew University of Jerusalem (HUJI) [20].

Equation $c(r) = (1-2Gm / rc^2)\, c = ac$ of coordinate light velocity [Section 5.1] suggests that, within the conventional interpretation of GR, space can be attributed a virtual index of refraction:

$n(r) = c/c(r) = 1/(1-2Gm / rc^2) = 1/a$

Gravitational phenomenon are **traditionally** explained by spacetime curvature and the resulted time dilation. This refractive index with our geometry offers an intuitive mechanism for understanding. By attributing variations in light speed and measuring standards to changes in space density, we provide alternative explanations for several key gravitational effects:

- **Gravitational Lensing**: Interpreted as the refraction of light in regions with a gradient in space density, leading to the bending of light trajectory near massive objects.
- **Shapiro Delay**: Explained by the increased travel time of light signals traversing areas of higher space density, resulting in observable time delays.
- **Gravitational Redshift**: Reconsidered as a frequency shift arising from the energy exchange of photons moving through varying space densities.
- **Casimir Effect Variations**: Predicted changes in the speed of light between closely spaced plates due to vacuum energy density levels affecting space density (assuming nonlinearity of the elasticity of space). In this case a local observer can observe directly the change in light velocity.

This fourth predicted phenomenon can be explored locally, where no gravitational gradient is involved. The first three phenomena are interpreted by faraway observers far from the places in which they occur. The Deformed Space Geometry framework not only preserves the mathematical structure of General Relativity but also provides a more tangible interpretation of gravitational interactions. By focusing on the material-like properties of space, this approach offers new insights into the nature of gravity and its effects on light and measurement standards.

Recent experimental observations, such as those conducted at the Hebrew University of Jerusalem, reveal phenomena consistent with the predictions of Deformed Space Geometry.

4.2 The Velocity of Elementary Particles with Inertia (mass)

The Velocity $v < c$ of a Particle with Inertia

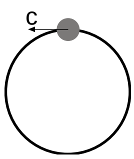
Elementary particles with no inertia move in the empty space at the speed of light, whereas the velocity v of Particles with Inertia is $v < c$.

In the GDM **Rest** is related to the situation in which a wavepacket moves in a closed loop. In this case the geometrical center of the circulating wavepacket is at rest. The particle, which is this wavepacket, can be regarded as staying at "rest". This circular motion, we argue is the spin of the particle.

The resultant motion of an elementary charge, of any elementary particle with inertia that necessarily includes an elementary charge, is always at the wave velocity c. Thus, the circulating elementary charge motion at rest turns into a spiral with a **translatory motion,** at constant velocity, v, See Fig. (6) This motion at v does not involve any exertion of force and necessarily

$v \leq c$. Force is required just to change v, namely to accelerate the charge.

Newton's first law, and the **first postulate of the theory of relativity**, which implies that no particle or signal can move at a speed that exceeds the light/wave velocity c, are thus a natural result. The helical motion, which is an electric current formally in the direction -z, is related to the magnetic field **B** and the vector potential **A**. The Circular Track is stable since the centrifugal force is balanced by an equal but opposite centripetal force. The Lorentz force, created by the magnetic field of the circulating charge acting on itself, is the required centripetal force.

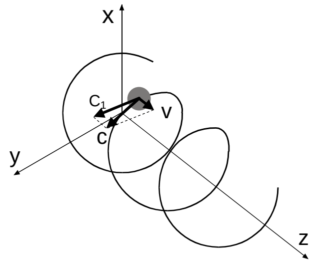


$$c_1^2 = c^2 - v^2 \quad \text{or:}$$

$$c_1 = c\left(1-\beta^2\right)^{\frac{1}{2}} = \frac{1}{\gamma}c$$

$$\text{where:} \quad \beta = \frac{v}{c}$$

$$\text{and:} \ \gamma = \left(1-\beta^2\right)^{-\frac{1}{2}}$$



"Rest" **Motion**

Fig. (6) Rest and Motion

Fig. (6), on the right, describes motion. Motion is the situation in which the circle of revolution of a wavepacket becomes a spiral. The GDM considers the **length of the wavepacket** to be **retained**. From this conjecture alone we derive the results of the Theory of Special Relativity (SR). Since the length of the wavepacket is retained, the spiral radius R is smaller than R_0. This is analogous to a stretched spring. As Fig. (6) shows:

$R = 1/\gamma \ R_0$ **Microscopic Contraction.** The resultant electron motion is always at the wave velocity c. Thus, a translatory motion at constant velocity, v, does not involve any exertion of force and necessarily $v < c$. This understanding led to the derivation and calculation of the masses of the leptons and quarks and their anti-particles (see Appendix B).

4.3 Temporal Distance and the Clock

Temporal Distance τ is defined as the distance (counted space cells) light travels along the spatial trajectory between A' and B', where A' is marked, on the trajectory of light, simultaneously with A and B’ with B. Say τ = m space cells. The measurement accuracy is thus, 1**:** m.

Thus, since the counted space cells along the trajectory between A’ and B’ is the same regardless of space deformations the **Temporal Distance τ** is invariant.

If the Temporal Distance τ is significantly greater than the Spatial Distance δ simultaneity between events at B' and B can be practically ensured as follows: when event A occurs, a pulse of light is emitted toward point B. Upon arrival at B, the pulse enters a box where it reflects back and forth between two walls. A counter records the number of round trips the light completes. The total temporal distance τ traveled by the pulse is then calculated as the product of this count and the distance between the walls, plus the initial distance between A and B.

5. Summary of Sections 1, 2, 3, 4

The **current consensus** on space includes the following properties:

Lattice Structure – A structured space – a lattice (cellular structure) - is assumed to ensure a finite energy density.

Elasticity – The size of space cells can vary, though their structure and composition remain unknown and are considered here irrelevant. The bending of light serves as experimental evidence**.**

Vibration – Space exhibits vibrational characteristics, supported by phenomena such as the Casimir effect and gravitational waves.

Fluid-like Behavior – Experimental evidence from frame dragging supports this perspective.

To overcome the limitations of Riemannian geometry, we introduce an alternative, reality-isomorphic geometry in which space is modeled as a lattice - a cellular structure. Within this framework, differential geometry is used to assign curvature to spatial deformations. These deformations reflect variations in the energy of space cells, resembling a mattress made of interconnected springs. As a result, energy and curvature are inherently connected, aligning with Einstein's original intuition.

We define the space density ρ as the number of space cells per cubic centimeter in a deformed three-dimensional region, with ρ_0 representing the density of undeformed, “standard” space.

While the precise structure and composition of space cells remain unknown, this lack of detail does not impede the development of our theoretical model.

6. The Events Arena (~~the events in Spacetime~~)

6.1 The Interval

For the interval we use the following notations: **Spatial distance interval** $d\delta^2$ and **Temporal distance interval** $-d\tau^2$**.** Spatial and temporal distances are required to define the interval between two events (the origin of coordinates is the event zero). **An event E** can be described by a **vector** $\boldsymbol{\delta}$ and the **imaginary number** $i\tau$ where $\boldsymbol{\delta} = \mathbf{i}x + \mathbf{j}y + \mathbf{j}z$ (x, y, z, are the distances on the geodesies from the origin):

$E = (\boldsymbol{\delta}, i\tau)$ and the **Interval between two events** (the conventional meaning) is:

$ds^2 = d\delta^2 - d\tau^2$

$ds^2 < 0$ for events with a **possible** causal connection

$ds^2 > 0$ for events **without** a causal connection

6.2 Light Velocity

Let the event A’ be the emission of a narrow pulse of light from point A towards the point B and the arrival at B as the event B’. This is a velocity measurement of light and in this case

$ds^2 = 0$ and thus $d\delta^2 - d\tau^2 = 0$ or $d\delta = d\tau$.

The velocity of light than becomes $c = d\delta / d\tau = 1$

For other velocity $0 \le v \le c$ we get $0 \le v \le 1$

Note that in our framework velocity is dimensionless – a pure number.

6.3 The Invariant Interval for All Observers at for Any Deformation of Space

In this framework not only, the interval is invariant as in SR and GR but also the spatial distance interval and the temporal distance interval are invariants. Thus, in a sense, we are back to the Newtonian absolutism.

7. A New Interpretation of Planck Constant h

$E = h\upsilon$, $[E] = [h][\upsilon]$, erg = erg sec · 1/sec, but if time is merely a practical term, we can eliminate the time unit in the above equation erg = erg ~~sec~~ · 1/~~sec~~ as if the energy E is divided into n packages of energy h' where $[h'] = 1$ and $[\upsilon'] = 1$.

Note that to differentiate between the standard Planck length unit, h, and our modified unit—which lacks the time component (seconds) - we denote the latter as h′. Similarly, we use ν′ instead of ν for frequency. For instance, when an electron in a hydrogen atom transition from level 2 to level 1, energy is released in a stepwise manner through discrete h' energy quanta. We propose that this quantum of energy corresponds to the maximum energy a single space cell can hold, whether as vibrational energy or through contraction or dilation - analogous to the energy stored in a spring or a string.

If this assumption holds true, we may attempt to estimate the size of a space cell (as explored in the following section). This perspective likely reflects **the true nature of energy quantization.**

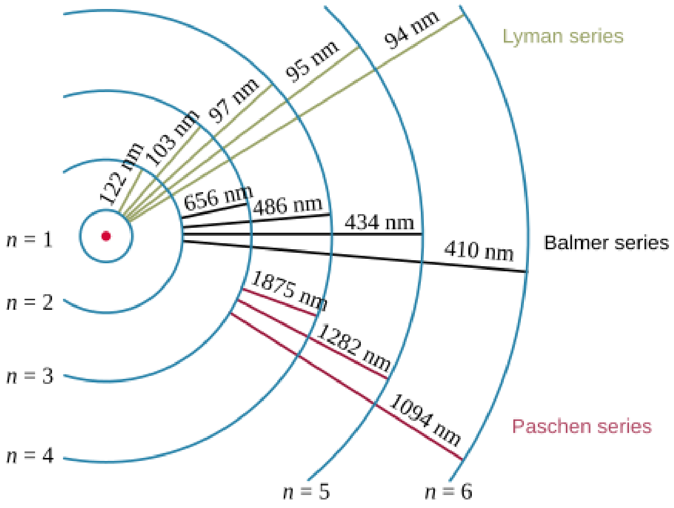


Fig. (7) The Hydrogen Atom Spectrum

Note that h pertains to photons, whereas for ground-state photons - referred to as **photoms** – it is 1/2h. The relevant quantum of energy is thus respectively h′ and 1/2h′. In the GDM, there are two types of photoms: one associated with oscillatory contraction and the other with oscillatory dilation. The combination of these two photoms represents the oscillatory contraction and dilation behavior of a photon [21]. This concept offers a compelling explanation for the nature of the photon and its constituent photoms:

Ephoton = hυ with spin S = 1

Ephotom=1/2hν with spin S = 1/2

Oscillatory contraction and dilation are fundamental vibrational modes of individual space cells. A photon, then, is constructed from the combined oscillations of two different types of photoms, each originating from different cells. Both photoms and photons are collective, in-phase oscillations involving several cells or cell pairs - typically a number ν′.

8. An Estimate of the Linear Dimension of a Space Cell

8.1 Derivation and Calculation Based on the Hydrogen Atom

As one can see Fig. (7), the wavelength of the photon emitted due to the jump from level 2 to level 1 is $\lambda = 122$ nm $= 122 \cdot 10^{-7}$ cm. The frequency is thus: $\upsilon = c/\lambda = 2.5 \cdot 10^{13}$ sec^{-1}

This frequency is **the number** $n = 2.5 \cdot 10^{13}$ **of steps** in which quants of energy were transferred to the space cells. Consequently, **it represents as we assume**, the number of space cells along the trajectory of electron jump between level 2 to level 1. From the Bohr model of the hydrogen atom, we can calculate the distance $r_2 - r_1$ between these levels, where r_n is the radius of the nth orbit. For all one-electron (hydrogen-like) atoms, the radius of an orbit is:

$r_n = n^2/Z\ a_B$ (allowed orbits $n=1,2, 3...$),

Z is the **atomic number** of the element and a_B is the **Bohr radius**, which is:

$a_B = h^2/4\pi^2 m_e k q^2_e = 0.529 \cdot 10^{-8}$ cm. Therefor:

$r_2 - r_1 = 1.5 \cdot 10^{-8}$

and the estimated linear dimension of a space cell is thus:

$r_{cell} = (r_2 - r_1) / n = 1.5 \cdot 10^{-8} / 2.5 \cdot 10^{13} = 6 \cdot 10^{-22}$ cm

$\mathbf{r_{cell} = 6 \cdot 10^{-22}}$ **cm**

8.2 A Check of Our Result, Based on the Mass and Volume of the Electron

The Electron Mass is $m = 0.9 \cdot 10^{-27}$grm and its energy $U = mc^2 = 0.9 \cdot 10^{-6}$erg

The energy of an energized space cell is $1/2h' = 3.1 \cdot 10^{-27}$erg

The number of energized space cell of the electron are:

$n = U/(1/2h') = 0.9 \cdot 10^{-6/}/3.1 \cdot 10^{-27} \sim 3 \cdot 10^{20}$

The radius of the electron elementary charge, **estimated** to be $r \sim 10^{-15}$ cm gives:

$V_{cell} = 4\pi/3\ r^3/n \sim 10^{-65}$

$\mathbf{r_{cell}} = (3/4\pi\ V_{cell})^{1/3} \sim \mathbf{1.3 \cdot 10^{-22} cm}$ Close to our result in sub-section 8.1.

7. Summary

This paper examines the role of time in physics, proposing that time is not a fundamental dimension but a derived practical construct. Within this framework, distance and velocity emerge as the truly fundamental physical quantities. This analysis reframes physical laws to exclude time as a primary variable, offering a more coherent formulation aligned with the geometry of deformed 3D space lattices.

In a significant extension, the paper introduces a derivation of the linear dimension of the space lattice by incorporating the Planck constant as a bridge between quantum and geometric descriptions. By analyzing the relationship between quantized energy, spatial deformation, and momentum transfer, the lattice's characteristic length is calculated - linking macroscopic physical behavior to the discrete, structured nature of space itself.

This reconceptualization of time and space challenges prevailing models based on spacetime, offering a novel, experimentally informed approach to understanding physical reality at its most fundamental level.

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Declarations

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Conflict of interest

The author declares no conflicts of interest.

Data available with the paper

The authors declare that the data supporting the findings of this study are available within the paper

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The Essence of the Elementary Charge and the Derivation and Calculation of the Electron Inertial Mass September 2019 Applied Physics Research 11(5):26-26

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Appendix A The GR Schwarzschild Metric

In 1916, Karl Schwarzschild was the first to derive a solution to Einstein's field equations—a general spacetime metric—describing the region outside a spherically symmetric mass m with radius R. For r > R according to Schutz [22], the line element ds^2 is given by:

$$ds^2 = - (1-2Gm / rc^2)\, c^2dt^2 + (1-2Gm / rc^2)^{-1}\, dr^2 + r^2\, d\Omega^2 \qquad \text{(10.36 in [5])} \quad (1)$$

Note that we have included the factor c^2 in equation (3), following classical physics conventions. We define the **gravitational scale factor** a as:

$$a = (1-2Gm / rc^2) \qquad (2)$$

At the surface of the Sun or at the edge of our galaxy, the quantity Gm / rc^2 is approximately 10^{-6}, meaning: $Gm / rc^2 \sim 10^{-6}$ and thus $Gm / rc^2 \ll 1$.

For $Gm / rc^2 << 1$ and as $r \to \infty$ the scale factor tends to: $a \to 1$

Rewriting equation (3) using the scale factor a (4) we obtain:

$$ds^2 = - a\, c^2 dt^2 + a^{-1}\, dr^2 + r^2\, d\Omega^2 \qquad (3)$$

The mass center m is used as the origin of their coordinate systems.

Appendix B The Derived and Calculated Electron/Positron Mass

Our geometry of deformed zones of space (Barak 2019), rather than Riemannian geometry of bent manifolds, enables us to attribute positive curvature to a contracted zone of space, i.e., to a positive charge, and negative curvature to a negative charge. This enables us to apply General Relativity (GR) in our derivations, and show that the positive elementary charge can be considered a kind of **black hole**, whereas the negative elementary charge - a **white hole**.

Based on the above we construct a model of the Electron (and other elementary particles) and derive and calculate its attributes, including inertial mass and spin [23]. Neither the Standard Model nor String Theory has provided such results.

The equations for these masses contain only the constants G, c, $\hbar$ and α (the fine structure constant). Our calculated results comply with CODATA 2014.

Our result for the Inertial Mass of the Electron

$$\mathbf{M_e = \frac{s^2\sqrt{2}}{\pi(\,1+\pi\,\alpha)}\sqrt{G^{-1}\alpha\hbar c^{-3}}} \qquad s = 1,\ [s] = LT^{-1}$$

M_e (calculated) = 0.910,36 10^{-27}g

M_e (measured) = 0.910,938,356(11) 10^{-27}g

A dimensionality check: $[G^{-1}] = ML^{-3}T^2$, $[\alpha] = 1$, $[\hbar] = ML^2T^{-1}$, $[c^{-3}] = L^{-3}T^3$. Thus:

$$M = \left[s^2\sqrt{G^{-1}\alpha\hbar c^{-3}}\ \right] = L^2T^{-2}(ML^{-3}T^2\cdot ML^2T^{-1}\cdot L^{-3}T^3)^{1/2} = L^2T^{-2}(M^2L^{-4}T^4)^{-1/2} = L^2T^{-2}ML^{-2}T^2 = M$$

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