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Gui Furne Gouveia *

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Velocity as a Geometric Deformation State: Complete Demonstration Within the Spatial Absolute Reference Frame

G. Furne Gouveia

Independent Researcher, France; furnegouveia@gmail.com

Abstract

This article presents a complete mathematical demonstration establishing that velocity corresponds to a geometric deformation state of fundamental wave structures. Within a paradigm where Space itself constitutes the absolute reference frame and matter consists of confined wave excitations, we rigorously derive why relativistic equations emerge naturally as mathematical tools for describing relative velocities, while maintaining the existence of a fundamental reference frame. The proof relies on explicit analysis of moving solutions to the Klein-Gordon and Schrödinger equations.

Keywords: absolute reference frame; spatial medium; geometric deformation; Klein-Gordon equations; Lorentz transformation; absolute velocity; emergent relativity; falsification test

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1. Introduction: Crucial Epistemological Clarification

1.1. The Status of Relativity in Our Paradigm

It is essential to understand that our approach **does not contradict relativistic equations** - it provides a **different physical interpretation**.

> Epistemological Position
>
> **Relativity is mathematically correct but physically incomplete.**
>
> - **Einstein:** "There is no absolute reference frame" (ontological postulate)
> - **Our paradigm:** "There exists an absolute reference frame - Space itself - but we can only measure relative velocities between material objects" (operational description)

1.2. Epistemological Position

Our approach uses relativistic formalism not as a fundamental postulate, but as a mathematical tool to describe geometric deformations.

2. Theoretical Framework

2.1. The Spatial Absolute Reference Frame

We postulate that Space constitutes an absolute reference frame relative to which velocities have real physical significance. This reference frame is not an ad hoc "ether" but Space itself as a physical entity.

2.2. Theoretical Context and Background

This approach fits within the broader framework developed in our previous work where we established that:

- Space constitutes a vibrating physical medium [1]

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- The Michelson-Morley experiment [3] demonstrates not the absence of a medium, but a **precise correlation between transverse and longitudinal deformations** as a function of velocity relative to the medium. The postulate of medium absence thus becomes **superfluous**, and the inverse postulate (medium existence) offers the decisive advantage of resolving paradoxes and mysteries in contemporary physics.
- Particles are quasi-stationary wave structures maintained by the IN/OUT mechanism [2], granting them **intrinsic non-locality** that resolves quantum paradoxes:
  - Violation of Bell's inequalities (which assume locality)
  - EPR correlations without causality violation
  - Results of Alain Aspect's experiments

2.3. Klein-Gordon Equation in the Spatial Reference Frame

Consider a complex scalar field $\psi(\mathbf{r},t)$ satisfying the free Klein-Gordon equation in the spatial reference frame:

$$\left(\Box + \mu^2\right)\psi = 0, \quad \Box = \partial_t^2 - c^2\nabla^2, \quad \mu^2 = \frac{m^2c^2}{\hbar^2} \tag{1}$$

2.4. Rest Solution in the Spatial Reference Frame

A stationary spherical solution at rest relative to the spatial reference frame writes:

$$\psi_0(\mathbf{r},t) = A(r)e^{-i\omega_0 t}, \quad \omega_0 = \frac{mc^2}{\hbar} \tag{2}$$

3. Main Demonstration: The Moving Solution

3.1. Motion Description Relative to the Spatial Reference Frame

For constant velocity v along the z-axis **relative to the spatial reference frame**, we use Lorentz coordinates as a mathematical tool:

$$\begin{aligned} t' &= \gamma\left(t - \frac{vz}{c^2}\right) \\ z' &= \gamma(z - vt) \\ r' &= \sqrt{r_\perp^2 + z'^2} \end{aligned}$$

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

3.2. Ansatz of the Moving ("Boosted") Solution

The solution moving at velocity v relative to the spatial reference frame - which we call "boosted solution" to designate the application of a Lorentz transformation as a mathematical tool - writes:

$$\psi_v(\mathbf{r},t) = A\left(r_\perp, \gamma(z - vt)\right)\exp(ikz - i\omega t) \tag{3}$$

with parameters:

$$\omega = \gamma\omega_0 = \gamma\frac{mc^2}{\hbar}, \quad k = \gamma\frac{\omega_0 v}{c^2} = \gamma\frac{mv}{\hbar} \tag{4}$$

4. Explicit Verification

4.1. Derivative Calculations

Let $\zeta = \gamma(z - vt)$. Calculate carefully:

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Time derivative:

$$\begin{aligned}\partial_t \psi_v &= \partial_t \left[A(\zeta) e^{ikz - i\omega t} \right] \\ &= (\partial_\zeta A)(-v\gamma) e^{ikz - i\omega t} - i\omega A e^{ikz - i\omega t} \\ &= (\partial_\zeta A)(-v\gamma) e^{ikz - i\omega t} - i\omega \psi_v\end{aligned}$$

Spatial derivative along z:

$$\begin{aligned}\partial_z \psi_v &= \partial_z \left[A(\zeta) e^{ikz - i\omega t} \right] \\ &= (\partial_\zeta A)\gamma e^{ikz - i\omega t} + ikA e^{ikz - i\omega t} \\ &= (\partial_\zeta A)\gamma e^{ikz - i\omega t} + ik\psi_v\end{aligned}$$

4.2. Second Derivatives

Second time derivative:

$$\begin{aligned}\partial_t^2 \psi_v &= \partial_t \left[(\partial_\zeta A)(-v\gamma) e^{ikz - i\omega t} - i\omega \psi_v \right] \\ &= (\partial_\zeta^2 A)(v^2\gamma^2) e^{ikz - i\omega t} + (\partial_\zeta A)(2i\omega v\gamma) e^{ikz - i\omega t} - \omega^2 \psi_v\end{aligned}$$

Second spatial derivative along z:

$$\begin{aligned}\partial_z^2 \psi_v &= \partial_z \left[(\partial_\zeta A)\gamma e^{ikz - i\omega t} + ik\psi_v \right] \\ &= (\partial_\zeta^2 A)\gamma^2 e^{ikz - i\omega t} + (\partial_\zeta A)(-2ik\gamma) e^{ikz - i\omega t} - k^2 \psi_v\end{aligned}$$

Transverse Laplacian:

$$\nabla_\perp^2 \psi_v = (\nabla_\perp^2 A) e^{ikz - i\omega t}$$

4.3. Application of the d'Alembert Operator

Now compute $\Box \psi_v = \partial_t^2 \psi_v - c^2 \nabla^2 \psi_v$:

$$\begin{aligned}\Box \psi_v = e^{ikz - i\omega t} &\left[\gamma^2 (v^2 - c^2) \partial_\zeta^2 A - c^2 \nabla_\perp^2 A \right] \\ &+ \psi_v \left[-\omega^2 + c^2 k^2 \right] \\ &+ e^{ikz - i\omega t} \left[2i\gamma(v\omega + c^2 k) \partial_\zeta A \right]\end{aligned}$$

4.4. Crucial Simplifications

Let us carefully analyze the phase-dependent terms. The expression containing $\partial_\zeta A$ is:

$$\text{Phase terms} = 2i\gamma(v\omega - c^2 k) \partial_\zeta A e^{ikz - i\omega t}$$

Substituting the parameters from equation (4):

$$\begin{aligned}v\omega - c^2 k &= v(\gamma\omega_0) - c^2 \left(\gamma \frac{\omega_0 v}{c^2} \right) \\ &= \gamma v \omega_0 - \gamma v \omega_0 = 0\end{aligned}$$

Thus, the phase-dependent terms vanish exactly, confirming the internal consistency of our ansatz. For the $\partial_\zeta^2 A$ term:

$$\gamma^2 (v^2 - c^2) = \gamma^2 v^2 - \gamma^2 c^2 = \frac{v^2}{1 - v^2/c^2} - \frac{c^2}{1 - v^2/c^2} = -c^2$$

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Therefore:

$$\Box\psi_v = e^{ikz-i\omega t}\left[-c^2\partial_\zeta^2 A - c^2\nabla_\perp^2 A\right] + \psi_v\left[-\omega^2 + c^2k^2\right]$$

4.5. Mass Term

Compute $-\omega^2 + c^2k^2$:

$$\begin{aligned}
-\omega^2 + c^2k^2 &= -\gamma^2\omega_0^2 + c^2\left(\gamma^2\frac{\omega_0^2 v^2}{c^4}\right) \\
&= -\gamma^2\omega_0^2 + \gamma^2\omega_0^2\frac{v^2}{c^2} \\
&= -\gamma^2\omega_0^2\left(1 - \frac{v^2}{c^2}\right) \\
&= -\omega_0^2 = -\mu^2c^2
\end{aligned}$$

4.6. Final Verification

We therefore have:

$$\begin{aligned}
(\Box + \mu^2)\psi_v &= e^{ikz-i\omega t}\left[-c^2\partial_\zeta^2 A - c^2\nabla_\perp^2 A\right] + \psi_v(-\mu^2c^2) + \mu^2\psi_v \\
&= -c^2e^{ikz-i\omega t}\left[\partial_\zeta^2 A + \nabla_\perp^2 A\right]
\end{aligned}$$

Now, $\partial_\zeta^2 A + \nabla_\perp^2 A = \nabla'^2 A$, and since A satisfies the stationary rest equation in coordinates $(r_\perp, \zeta)$, we have $\nabla'^2 A = -\mu^2 A$. Thus:

$$(\Box + \mu^2)\psi_v = -c^2e^{ikz-i\omega t}(-\mu^2 A) = \mu^2c^2\psi_v - \mu^2\psi_v = 0$$

The moving solution therefore indeed satisfies the Klein-Gordon equation.

4.7. Demonstration Conclusion

The demonstration rigorously establishes that the ansatz (3) with parameters (4) constitutes an exact solution of the Klein-Gordon equation. This result shows that:

$$\psi_v(\mathbf{r}, t) = \psi_0(\mathbf{r}', t') \tag{1}$$

where ψ_0 is the rest solution and $(\mathbf{r}', t')$ are the Lorentz coordinates. Velocity v thus appears as a **deformation parameter** of the stationary solution, rather than as an independent dynamic variable.

5. Physical Interpretation within the Absolutist Framework

5.1. Geometric Deformation as Physical Reality

Solution (3) reveals that motion relative to the spatial reference frame manifests as a **real geometric deformation**:

- **Velocity-dependent spatial deformation:** The $\gamma(z - vt)$ dependence shows that the solution's geometry is determined by velocity relative to the spatial medium
- **Phase modification:** $e^{ikz-i\omega t}$ reflects dynamic adaptation of the wave structure
- **Temporal reorganization:** $\omega = \gamma\omega_0$ shows real slowing of internal processes

Geometric depth: Contrary to the standard interpretation that postulates $\Delta_\perp = 0$, our Michelson-Morley analysis [3] reveals only the constraint $\frac{L_0+\Delta_\parallel}{L_0+\Delta_\perp} = \sqrt{1 - v^2/c^2}$. The exact deformation remains to be determined experimentally.

5.2. Status of Special Relativity

Special Relativity emerges as an **effective description** because:

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1. All our measuring instruments consist of matter that deforms identically
2. We can only measure relative velocities between material objects
3. The speed of light appears constant in all material reference frames

5.3. Position Relative to Established Frameworks

Our approach fundamentally differs from:

- Einsteinian Relativity [5] which postulates no privileged reference frame
- Lorentz's ether [6] which assumes an added material medium
- de Broglie-Bohm pilot wave theory [7,8]
- Transactional interpretation [9]

We affirm that Space itself is the fundamental reference frame, without requiring additional ether.

5.4. Major Epistemological Consequence

Epistemological Conclusion

Relativistic equations are **mathematically correct** and **operationally indispensable**, but they describe how objects **appear** relative to each other, not how they are **absolutely** relative to Space.
Our paradigm provides the **physical substrate** that explains **why** relativistic laws work so well.

6. Formalism Generalization

6.1. Applicability to Other Equations

The presented method naturally extends to other fundamental equations. For the Schrödinger equation:

$$i\hbar\partial_t\psi = -\frac{\hbar^2}{2m}\nabla^2\psi \tag{2}$$

the moving solution writes:

$$\psi_v(\mathbf{r},t) = A(r_\perp, z - vt)\exp\left(i\frac{mv}{\hbar}z\right)\exp\left(-i\frac{mv^2}{2\hbar}t\right) \tag{3}$$

This solution satisfies the Schrödinger equation and shows the same correspondence between velocity and geometric deformation.

6.2. Extension to the Dirac Equation

The formalism generalizes to the Dirac equation describing relativistic fermions:

$$(i\gamma^\mu\partial_\mu - m)\psi = 0 \tag{4}$$

The moving solution is obtained by Lorentz transformation of spinors, leading to the same geometric interpretation. Dirac plane wave solutions:

$$\psi_v(x) = u(p)e^{-ip\cdot x} \tag{5}$$

with $p^\mu = (\gamma m, \gamma m\mathbf{v})$, show that energy and momentum emerge as parameters of the boosted solution, confirming that velocity characterizes a **deformation state** of the fundamental wave structure.

This generalization reinforces the central thesis: inertial motion is a geometric property of wave equation solutions, not the result of external dynamics.

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6.3. Unifying Perspective

This approach reveals a unifying principle: in wave theories, uniform motion corresponds to **coherent deformation** of the rest solution, where velocity plays the role of geometric parameter.

7. Experimental Perspectives

7.1. Crucial Falsification Test: Fundamental Principle

Our paradigm leads to a testable prediction based on a fundamental physical principle:

> Physical Principle of Asymmetry Test
>
> *"If more energy is required to accelerate a helium ion than to accelerate a hydrogen ion to relative velocity v, then this energy differential must manifest through observable effects in collisions."*

7.1.1. Resolved Paradox

Consider the following thought experiment:

- **Configuration A:** Proton A accelerated → Proton B at rest
- **Configuration B:** Proton B accelerated → Proton A at rest

In special relativity, both configurations are identical - kinetic energy is relative and its origin cannot be determined. This indetermination leads to an **attribution paradox**: during annihilation, kinetic energy seems to come alternately from one particle or the other depending on the reference frame.

7.1.2. Our Resolution

In our paradigm:

- Kinetic energy is **really stored** in each particle as geometric deformation
- Each configuration has a **distinct physical reality** in the absolute reference frame
- Relativity emerges as a **computational tool** for deformed material observers, not as a description of underlying reality

7.1.3. Specific Prediction

Our paradigm leads to a testable prediction that fundamentally distinguishes it from Standard Relativity. As detailed in [4], we propose an asymmetry test in H^+/He^+ ion collisions:

- **Configuration 1:** H^+ accelerated → He^+ at rest
- **Configuration 2:** He^+ accelerated → H^+ at rest

We predict a **measurable asymmetry** in:

- Reaction cross-sections
- Collision product spectra
- Branching ratios

This asymmetry would violate Lorentz invariance and reveal the **physical reality** of kinetic energy individually attributed to each particle in the spatial absolute reference frame.

8. Conclusions

This demonstration establishes that:

1. Velocity relative to the spatial absolute reference frame corresponds to a specific state of real geometric deformation
2. Relativistic equations naturally emerge as descriptions of relationships between deformed material objects
3. Kinetic energy represents the real deformation energy of the fundamental structure

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4. Our paradigm reconciles the existence of an absolute reference frame with the operational efficiency of Relativity

Relativity remains the correct mathematical tool for describing observations, but it now finds its justification in more fundamental physics.

Appendix A. Summary of Key Demonstration Steps

This appendix summarizes the logical structure of the main proof:

1. **Ansatz:** $\psi_v(\mathbf{r}, t) = A(\zeta)e^{ikz - i\omega t}$ with $\zeta = \gamma(z - vt)$
2. **Explicit calculation** of first and second derivatives
3. **Consistency confirmation:** Terms in $\partial_\zeta A$ cancel exactly with the physical choice $k = \gamma\frac{\omega_0 v}{c^2}$, validating solution construction
4. **Simplification** of $\gamma^2(v^2/c^2 - 1) = -1$
5. **Final verification** using $\nabla'^2 A = -\mu^2 A$

The complete demonstration is found in Sections 4.1–4.7.

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