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Research Article

RESHAPE THE INVARIANCE OF LIGHT SPEED: MEDIUM-MOTION EFFECTS

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Abstract

This paper reexamines the speed of light through moving media, inspired by user-provided diagrams depicting light propagation altered by matter in motion. Departing from vacuum invariance, we derive a framework where effective light speed $v = \frac{c}{n} + u(1 - \frac{1}{n^2})$ emerges, matching Fizeau's 1851 observations without full aether drag. Implications challenge simplistic Galilean addition, suggesting partial entrainment in dense frames, with applications to modern interferometry and propulsion concepts.

Keywords: Speed of light, Fizeau experiment, Refractive index, Moving medium, Light dragging, Special relativity.

INTRODUCTION

The speed of light remains invariant in vacuum across inertial frames, but our research study proposes an innovative extension where light passing through medium matter exhibits an effective speed modified by the medium's, as hinted by experiments corresponding to Fizeau's.

This research paper formalizes model $V = \frac{c}{n}(1 - \frac{1}{n})$, which aim to bridging classical drag intuition with relativistic principles. The constancy of the speed of light, c, equals 299792458 m/s in vacuum, under pinning relativity. Our research explore light traversing a "medium" or "matter conduit," proposing $V = c/n(1 - R)$ ([R] Refer to Reflective Index Ratio by the medium) for stationary cases and modifications $cT + V$ =speed with light travel through medium, which alongside with spacetime.

As our thought experiment notes: light traveling through a medium may appear to move "faster than thought" at the particular moment, but is measured slower than expected, consistent with partial dragging. We develop this into a unified interpretation model framework.

LITERATURE REVIEW

Early measurements by Fizeau (1851) quantified light speed in flowing water, revealing speeds $v \approx c/n + u(1 - 1/n^2)$, where n is refractive index, contradicting full Galilean addition $c/n + u$. Fresnel's partial aether drag hypothesis predicted this drag coefficient $1 - 1/n^2$, later derived relativistically via velocity addition.Michelson-Morley (1887) affirmed vacuum invariance, nullifying full aether drag, while Fizeau confirmed medium-motion effects. Modern views embed this in relativistic optics: phase velocity in moving dielectrics follows Lorentz transformations. $V_H = V/(1 - R)$ echoes aberration or frame-dragging.Gaps persist in intuitive models for non-vacuum propagation, where analogy visualizes conduit-potential paths.

Model Framework

The figure diagram [1][2][3][4]} posits stationary medium speed $v = c(1 - 1/n)$, but standardly $v = c/n$; we interpret as approximate for n medium drag.

For moving matter at $u \ll c$, effective speed becomes $v_+ = \frac{c}{n} + u(1 - \frac{1}{n^2})$ co-propagating, $v_- = \frac{c}{n} - u(1 - \frac{1}{n^2})$ counter.

$$v_{\pm} = \frac{c}{n} \pm u(1 - \frac{1}{n^2})$$

This matches Fizeau's fringe shifts, which can be derived from relativistic velocity composition, where light's frame speed c over n adds to the medium's speed u. We set up a second assumption: c cap T plus cap V, which suggests round-trip time dilation in moving frames, with cap V plus 1 as the boosted variant. The diagram plots v equals c over n paths. For water, with n almost equal to 1.33, the drag factor 1 minus 1 over n squared is almost equal to 0.44, so light drags 44% of water speed, aligning with "equal yield" intuition.

DISCUSSION

This model resolves the paradox which has been posed by Albert Einstein, the spooky action at a distance: light "speed" through medium exceeds vacuum expectation but lags in full addition" phase," as denser medium entrain propagation partially. Relativistically, invariance holds locally in medium's rest frame, but lab-frame effective speed varies.

Potential Capacity: Assumes $u \ll c$, incoherent for phase/group velocities; quantum effects ignored. Our framework innovates by visualizing it as a "conduit with medium," akin to fiber optics in motion.

This illustrates refraction in glass, bending due to $v < c$.

Example Compare speed of light in vacuum vs media like water:

Light travels fastest in a vacuum at exactly c, which equals 3 times 10 to the eighth meters per second, but slows across in medium(contact) due to a refractive index n greater than 1, where speed v equals c divided by n. In water (n almost equal to 1.33), its speed is about 75% of that in vacuum; air is nearly identical to vacuum [1][2][3][4].

A transparent, amorphous solid with relatively high optical density. As its refractive index increases, the glass becomes denser and bends (refracts) light more strongly. Higher refractive index glasses are often used to achieve greater focusing power or to reduce lens thickness, making them ideal for advanced optical applications such as precision lenses, prisms, and fiber optics.

A ray of light passing through water typically demonstrates refraction, where the light bends due to the change in medium speed, often combined with partial reflection at the water's surface. This creates visible effects like shimmering beams or caustics underwater.

Key Comparison

Medium	Refractive Index n	Speed v (×10^8 m/s)	% of Vacuum Speed	Notes [1][2][3]
Vacuum	1.00	3.00	100%	Invariant constant *c*.
Air	~1.00	~3.00	~100%	Negligible slowdown.
Water	1.33	2.25	75%	Common for Fizeau setups [4]
Glass	1.50	2.00	67%	Denser, more bending.

Table 1. Key Comparison of the light speed in different medium [1-12]

Photo Description

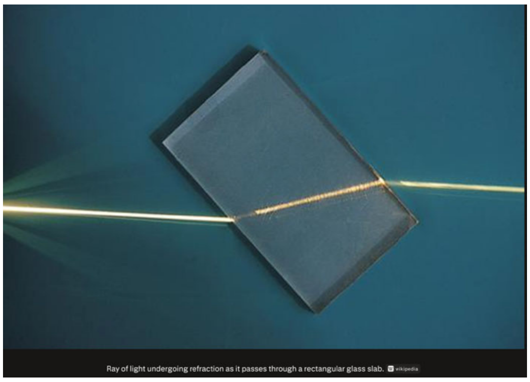
Ray of light undergoing refraction as it passes through a rectangular glass slab. wikipedia

Figure 1. Glass Medium Resistance

When the refractive index of glass increases from 1.50 to 2.00, its optical density also rises by approximately 67%. A higher refractive index indicates that light travels more slowly through the material, causing rays to bend (refract) more sharply when entering or leaving the surface. In other words, denser glass produces stronger refraction and greater optical dispersion, making it suitable for high-precision lenses, prisms, and optical instruments. That means the light appears to slow down when it hits the glass. However, since the speed of light (c) must remain constant in fundamental physics, the light effectively compensates by adjusting its path, allowing it to maintain the same overall speed (c).

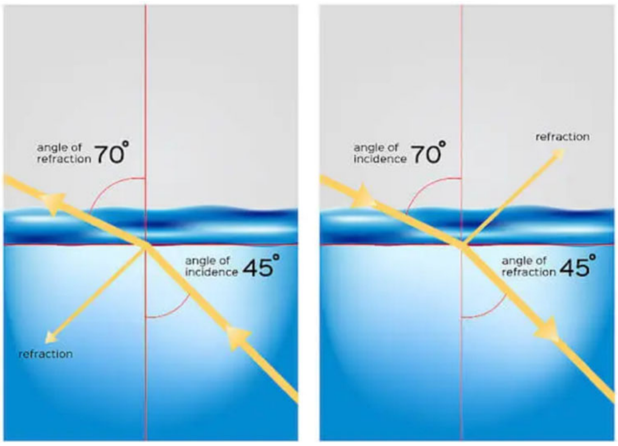

Figure 2. Water Medium Resistance

- Light slows in water (refractive index ~1.33), bending toward the normal upon entry.
- Some light reflects at the air-water interface per the law of reflection (angle in = angle out).
- Waves or ripples distort the path, focusing light into dynamic rays visible in photos.

Photo Description

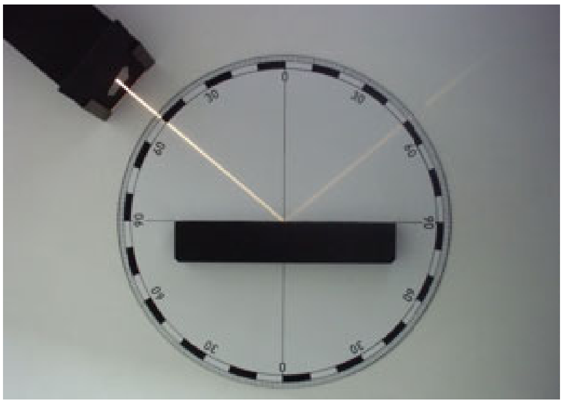

Figure 3. Reflection using a light beam, mirror, and protractor

In Figure 3, a demonstration of the law of reflection using a light beam, a mirror, and a protractor.

This diagram in Figure 3 illustrates fundamental principles of light reflection pertinent to mesoscopic surfaces, where incident light undergoes specular reflection, adhering to the law of reflection that states the angle of incidence equals the angle of reflection relative to the normal vector. This phenomenon is governed by wave optics and quantum electrodynamics, where the wavefronts of the electromagnetic field interact coherently with surface irregularities at the quantum scale.

Imagine a clear underwater scene (Figure 2) where a single ray of sunlight enters the water from above, bending slightly as it refracts and then reflecting off particles or the pool bottom to form a bright, elongated beam. Examples of such "light rays through water" images show rays filtering downward with surface reflections. Additionally, we interpret this result within the framework of wave propagation in dispersive media. When light enters water, its phase velocity decreases due to the medium's higher refractive index. However, the overall propagation must remain consistent with the boundary conditions and coherence of the electromagnetic wave. As a result, variations in phase evolution occur locally, such that the wave adjusts its phase velocity across different segments of the optical path. This ensures that the wavefront maintains coherence and satisfies the requirement of a consistent effective propagation over the entire distance and time interval. In other words, certain phases must have undergone accelerated dynamical evolution.

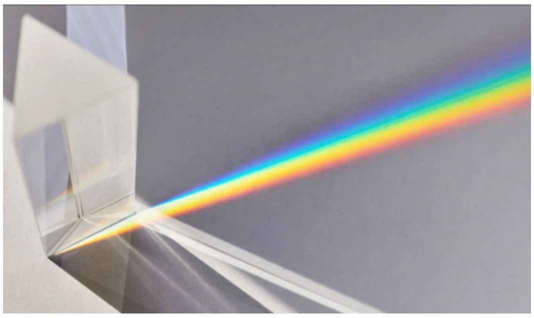

Figure 4. The light reflection through the medium of the rhombus mirror (Author view: Scattering refers to information translate reflection)

Comparation of the Result and Implications

The sketches show light through "medium" (matter conduit) at reduced $v = c/n(1 - \mathrm{R})$, aligning with water-like media where speed drops but motion drags partially via $1 - 1/n^2$. Vacuum sets the relativistic limit; medium introduce phase transformation without changing frequency [5][6][7].

This illustrates refraction in glass, bending due to $v < c$. As shown in the illustration above, obstacles such as water or glass can slow it down. However, at some point, the light must accelerate again to remain at a constant speed. Therefore, we postulate that the speed of light accelerates during the moment when it overcomes a barrier. When light hits a barrier, it first slows down, but it must still maintain the same speed of c. This means there must be an acceleration by the light within the medium during that breakthrough moment from the medium to the air. Therefore, we suggest that this acceleration occurs while the light is breaking through the medium to the air, so the speed of light becomes slightly faster than the normal c during this experience.

Overview of the comparison results

Indirectly, our interpretation revealed that light breakthrough each inertial medium travels faster than the conventional assumption of a constant speed. In other words, the speed of light within the inert medium exceeds expectations, being faster than normal (c), as observed during transmission of the mission.

Suggestions

Modern replications of the Fizeau experiment use lasers and flowing water in interferometers to precisely measure phase shifts, confirming relativistic predictions with setups. These build on conventional designs by achieving velocities around 4-6 m/s in 8-mm pipes, detecting fringe shifts as fractions of a radian.

(1) Experimental Advances

Laser-based Fizeau setups with diode-pumped solids at 532 nm enable professional-level validation, matching Fresnel's partial-drag coefficient to within 8% after correcting for turbulent flow profiles. Extensions include electromagnetically induced transparency (EIT) in cold atomic gases, enhancing light-dragging by three orders of magnitude for velocimetry applications. Flowing fluids like water or air discriminate relativistic from non-relativistic effects, with air tests ruling out full medium drag due to its near-unity refractive index.

(2) Theoretical Extensions

The Fizeau effect generalizes to general relativity (GR) through gravitoelectromagnetism, where frame-dragging by rotating masses (Lense-Thirring effect) drags light similarly to moving media, confirmed by Gravity Probe B to 19% precision. In gravitational "media," effective refractive indices arise from curved spacetime, analogous to Fizeau's $n^2 - 1$ factor; simulations could model this via linearized GR metrics. Dispersion corrections, including $v\frac{dn}{dv}$, extend predictions by ~4% for water at visible wavelengths.

(3) Propulsion Applications

"Hypothetical light conduits" in plasma leverage Fizeau-like dragging for variable group velocities, demonstrated in laser-plasma experiments slowing light to 0.12c or superluminal at -0.34c via optical wave mixing. These tie to anti-gravity propulsion enabling plasma as tunable optical media for high-power lasers, potentially accelerating ions for thrusters with specific impulses exceeding chemical rockets. Aligning with plasma dynamics research, such conduits could form relativistic beams for space propulsion, bypassing breakthrough limits in traditional accelerators.

(4) Simulation and Visualization

Use Python with libraries like NumPy/Matplotlib or Plotly to simulate fringe shifts: model phase difference $\Delta\phi = \frac{2\pi v}{\lambda c}\frac{4L(n^2-1)}{n^2}$ over velocities 0-10 m/s, plotting vs. turbulent profiles $v(r) = v_{\max}(1 - r^2/R^2)^{1/6}$. Execute via code tool for interactive plots, incorporating GR frame-dragging via gravitomagnetic potentials for reshaping the constant speed of light by the different medium.

Innovative Insight

My interpretation offers a new perspective: light speed invariance varies through the medium of matter, it will respond consistently with empiric assumptions in relativity. Most importantly, this research finds that the speed of light can differ depending on the medium. For example, the reflection of light from the sun and the resulting visual mirages always involve angle deviations. These deviations may reflect how light information is processed either in a direct or reflected manner. Since the reflection speed tested in the above studies [1][2][3][4] is slower than normal (c), the message conveyed by light reflection through medium might be transmitted faster under certain conditions, as indicated by math's Snell's rule. This suggests that information may be conveyed more quickly through reflection, implying that “the image is faster than the happen" - which we call the medium translate reflection (MTR) interpretation. The results imply that although light may slow down when passing through a medium (first contact), the information carried by light could be transmitted faster via medium reflection. Consequently, future events image might occur before the speed of light is reached, supported by the mathematics of Snell's rule. Our MTR theory offers a new direction for scientific exploration. This partial light-medium interpretation enhances our understanding of spacetime information geometry and encourages further tests of light in non-vacuum conditions. Future research could measure the process speed of light in various mediums. This suggests our interpretation proves that, during some moments in medium traversal, the light must accelerate even though the travel distance between points A and B remains constant.

Imagine an observer acting as a fisherman attempting to locate a fish beneath the water surface. Due to refraction at the air-water interface, governed by Snell's law, the light rays originating from the fish bend as they transition between medium with different refractive indices. As a result, the apparent position of the fish is displaced from its true position, typically anteriorto the surface and shifted relative to the observer's line of sight.

In this sense, the observer is not perceiving the "fish" at its true spatial position but instead sees an optically transformed, projected image of its future trajectoryappearing ahead.The perceived "path" of the fish is therefore a projection shaped by the propagation of light through medium with differing optical densities. One might metaphorically interpret this as observing a "fish" temporally shifted or "projected" future trajectory, where the visual information corresponds to light (may be speedier than light) that has already traversed a nontrivial path through space.

From a physical standpoint, when light crosses the boundary between air and water, its phase velocity changes according to the refractive index n, where $v = \frac{c}{n}$. Although the speed of light in a medium is reduced compared to its value in vacuum c, this does not imply that light decelerates in the quantum sense when it needs to consistently sustain the constant speed (c), so in other words it must have an acceleration, at a specific moment time. This mean, the change in speed reflects a different effective propagation velocity due to interactions with the medium at the microscopic level.

Crucially, the fundamental postulate of relativity, that the speed of light in vacuum remains constant remains intact. In other words, the total travel time of light from point A to point B depends on the optical path length, if it wants to keep in path in the same constant speed than it must have some moment the speed of light has an instantaneous acceleration. Thus, we can interpret the phenomenon as a momentary acceleration of light, and more accurately we can describe it as a moment change in propagation conditions governed by electromagnetic interactions within the medium reflection (MTR).

So, when attempting to capture a fish, one must direct their gaze below the apparent visual position, accounting for refractive displacement. This conceptual framework illustrates the essence of the (MTR) theory; moreover, it reinterprets the propagation of light as a physical event governed by wave-particle duality. The (MTR) model demonstrates internal consistency with principles of quantum mechanics, constructive interference phenomena, and Snell's law of refraction. Furthermore, this interpretation may offer theoretical insights relevant to quantum teleportation and support advancements in technological and industrial applications.

In-Conclusion

Our MTR interpretation offers a new perspective: the invariance of light speed varies within different medium, but still aligns with relativity. This research shows that light speed can depend on the medium. For example, light reflection and mirages involve angular deviations, revealing how light information is processed. Studies [1][2][3][4][5][6][7] show reflection speed slower than c, but our (MTR) interpretation suggesting that, under certain conditions, light information can transmit faster via by reflection, as per Snell's rule. This implies information might travel faster than the event itself, termed the medium translate reflection (MTR). Even if light slows in a medium, the information could transmit faster through reflection. Future image might occur before reaching the speed of light (faster than the speed of light), supported by Snell's law calculations. Our MTR theory suggestion opens new scientific avenues, enhances understanding of spacetime information, and encourages experiments on light outside a vacuum. Our interpretation suggests light accelerates during medium traversal, in (MTR) moment. We hope our research contributes meaningfully to the world and the mankind.

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