

THE PROPERTIES OF LIGHT***Lie Chun Pong**Received 15th December 2025; Accepted 19th January 2026; Published online 27th February 2026

Abstract

Over a century ago, Einstein [1] postulated that the speed-of-light in a vacuum, denoted as c , is invariant and serves as a fundamental constant in the framework of special relativity. According to established physical laws, no known entity or information surpasses this universal speed limit. This research paper aims to investigate, from a novel theoretical perspective, whether the constancy of the speed of light holds universally or if variations exist among different photons, potentially implying photon mass or novel quantum effects. We will examine contemporary discussions surrounding Lorentz invariance violation, potential dispersion relations in quantum gravity, and the implications of deformed special relativity on photon propagation speeds. This research paper hopes to explore from a completely new perspective whether the speed of light is constant or whether different photons have different speeds.

Keywords: Speed of light, Invariant speed c , Photons, Tachyons, Slow photons, Background noise, Fast light, Light interference, Gravitational lensing, Spacetime curvature.

INTRODUCTION

Physicists have hypothesized the existence of faster-than-light particles known as tachyons, which would possess imaginary mass and violate causality principles. In contrast, particles with subluminal velocities, those traveling slower than the speed of light, are referred to as slow-moving particles or massive particles. The concept of tachyons arises from certain extensions of special relativity and quantum field theory, although their existence remains unconfirmed. These particles would exhibit superluminal motion, leading to intriguing implications for causality and the structure of spacetime.

In contrast, a "slow particle" refer to a substantial quantum of energy input to reach velocities approaching the speed of light, often requiring relativistic kinetic energy levels that increase dramatically as velocity nears this universal constant. Conversely, a "tachyon" a hypothetical superluminal particle would require an equally significant expenditure of energy to decelerate from superluminal velocities down to relativistic speeds close to light speed, owing to its intrinsic properties predicted by certain theoretical frameworks in quantum field theory and advanced astrophysics.

This research paper introduces and postulate an innovative conceptual framework: particulate entities can be classified into three distinct categories based on the different prospective of spacetime and especially the measurement event. Their propagation velocities relative to the universal constant denoting the speed-of-light in a vacuum (c) can be different in different spacetime curvature and environmental circumstance.

The first category comprises hypothetical faster-than-light particles termed 'sutra-fast-wave-Photon,' characterized by superluminal velocities exceeding c . The second category includes standard quanta known as 'wave-photons,' which propagate precisely at the invariant speed c , mediating electromagnetic interactions. The third category pertains to 'slow-wave-photons,' referring to hypothetical particles or inhibition traveling at subluminal velocities less than c . This tripartite classification aims to deepen the understanding of

particle kinematics within relativistic and quantum field theoretical frameworks, potentially informing models in astrophysical phenomena where extreme velocities and particle interactions are prevalent.

Fundamentally, the hypothesis proposed in this research paper indicates that photons exhibiting relativistic velocities, whether approaching the speed of light or significantly slower, share certain conceptual similarities with hypothetical faster-than-light particles such as tachyons. Nonetheless, these photon populations also possess distinctive characteristics rooted in their respective kinematic and quantum properties, which warrant further investigation within the frameworks of advanced physics and astrophysics.

DISCUSSION

This research paper posits that the fundamental interpretation of "tachyons" differs somewhat from traditional conceptions. While the invariant speed of light in vacuum, denoted as c , remains a fundamental constant, the notion here suggests that entities exceeding this speed could be realized through mechanisms that accelerate particles beyond c , thus effectively transforming a photon into a superluminal particle. This concept diverges from the conventional, intrinsic definition of tachyons within string theory and relativistic field theory, where such particles are hypothesized to always travel faster than light without emission or absorption of energy.

Furthermore, the generally accepted view in quantum electrodynamics and photonics is that photons is always remain the constant c , our research paper, posit that, photon may interact with curvature or wavelengths, often termed as slow or fast photons, do not possess different intrinsic velocities; rather, their apparent velocity changes due to interactions with spacetime curvature properties, such as curvature layers index variations, and are better understood as different states of photon propagation within dispersive curvature. These phenomena may emergent, not ontological, attributes of the photon itself.

The invariant light speed c remains unchanged in a vacuum, but we proposed that, under specific conditions, such as nonlinear optical effects or quantum field interactions, photons can exhibit effective group velocities exceeding c (superluminal propagation) or appearing slowed. The evolution of photon states under these conditions suggests that the notion of a photon being inherently fast or slow is an emergent property dependent on the quantum and optical environment. Moreover, the apparent velocity of such superluminal or slowed photons can be frame-dependent, meaning that experimental observation, may have change the variation of the speed of light.

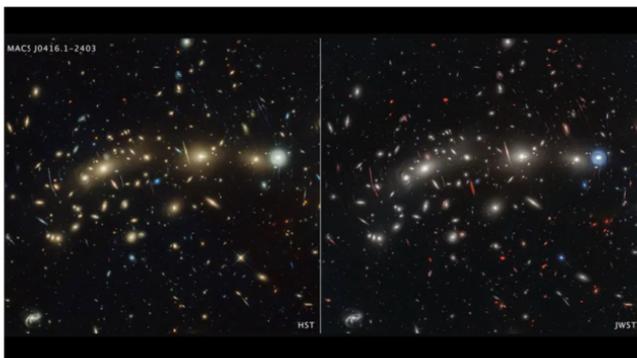
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James Webb: Inside NASA's gold-mirrored space telescope | CNN

Figure 1: Jame Webb Telescope

This may imply that light behaves as a highly sensitive substance. For example, when using highly sensitive interferometric techniques, a photon traveling faster than c might appear to be slower behind and faster in front under different observational conditions due to relativistic and quantum effects (Figures 1 & 2) [2].



This side-by-side comparison of galaxy cluster MACS0416 as seen by the Hubble Space Telescope in optical light (left) and the James Webb Space Telescope in infrared light (right) reveals different details. (NASA, ESA, CSA, STScI)

Figure 2. Galaxy cluster MACS0416 from James Webb

Or it may happen when the instrument is always being correct, in any situation, but the light may be traveling faster than the speed of (c), so that the image, such as (Figure 2), can provide a clearer image than the conventional one.

Practical Applications:

James Webb Space Telescope captures new detailed snapshot of iconic 'Pillars of Creation'

By Jackie Wattles, CNN
Thursday, October 20, 2022



The Pillars of Creation is a vista of three looming towers made of interstellar dust and gas that's speckled with newly formed stars.

Figure 3. Comparison the Pillars of Creation

In practical astrophysical observations (Figure 3), scientists frequently encounter interference from background radiation and various noise sources, which hinder the acquisition of clear cosmic signals. I postulate that this background noise arises from three distinct classes of hypothetical light particles, each propagating at different velocities.

The first category consists of 'sub-relativistic luminous particles,' which travel at speeds less than that of photons. Due to their slower velocity, these particles generate a localized region of intensified electromagnetic emission, akin to a 'bright light front,' leading to a convolution of the observed image and resulting in optical blurring. The second category involves 'superluminal light particles,' hypothetical entities exceeding the speed of photons. Their superluminal propagation could cause anomalous scattering effects, producing pseudo-shadowing phenomena and reducing the clarity of observed astrophysical objects under intense background illumination (Figure 3 & 4).



Figure 4. The Pillars of Creation from ESA

The interplay between these 'sub-relativistic' and 'superluminal' particles effectively limits the resolution & fidelity of the cosmic images accessible to our instruments. Consequently, in the efforts to suppress noise and background interference, the astrophysical community often neglects the fundamental implications of 'light' and its velocity spectra in the context of observational cosmology. Therefore, this research paper seeks to address a gap in the current scientific discourse by elucidating the underlying mechanisms of observed phenomena. We aims to employ physical and astrophysical

phenomenon to substantiate the theoretical existence of distinct photon subpopulations and supra-fast-wave-photon characterized by their velocities, specifically the hypothesized "fast photons" and "slow photons." (Figure 4).

As previously discussed (Figure 3 & 4), phenomena such as surrounding noise and background illumination are commonly encountered during astrophotography and the analysis of cosmic images. In this context, we postulate that the background noise is hypothesized to consist of "fast photon" and "slow photon." Fast photons, which propagate at superluminal speeds or exhibit phase velocities exceeding the speed of light, whereas the background noise, often attributed to scattered or secondary particles, can be characterized as "slow particles" or slower-moving light components. We suggested that, by systematically comparing the intensity and propagation characteristics of strong and weak light signals, such as high-contrast versus low-contrast features in astrophysical observations, it is possible to infer and quantitatively measure the true propagation velocities of these different light components. This approach could potentially shed light on the fundamental properties of photon-like excitations and their interactions with the interstellar medium, advancing our understanding of relativistic effects, quantum field interactions, and the nature of background radiation in the universe (Figure 5).



Figure 5. Universe from James Webb Telescope

If the hypotheses presented in this research paper are accurate, the propagation velocity of what can be termed "fast photons" appears to be contingent upon the cosmological expansion rate dictated by the metric expansion of spacetime. Conversely, 'slow photons' exhibit an apparent deceleration phenomenon when observed under certain relativistic conditions, suggesting an external influence reminiscent of a pulling force, possibly indicative of gravitational potential gradients or exotic cosmological effects. Therefore, we suggested by employing comparative shadow analysis, specifically, transmission measurements, it may be possible to empirically determine the intrinsic velocities of purported "fast photons" and "slow photons." Additionally, the velocity of "slow photons" can be inferred more precisely through quantitative assessments of their emitted electromagnetic spectral intensity, thereby enabling an accurate determination of their true propagation speed. This approach leverages principles of photonic momentum transfer and radiative transfer physics within the

framework of relativistic electromagnetism and quantum electrodynamics. It is not difficult to conceptualize, within the framework of our hypothetical conceptual experiment, that the velocity of light may vary across different cosmological or physical regimes. We uphold the principle that a photon beam maintains a constant flux, yet we remain open to the possibility that individual photons could experience variations in their propagation velocities under specific conditions. While photons conventionally are considered to be massless particles and do not contribute directly to gravitational fields in the classical sense, but we believed their energy-momentum tensor can influence spacetime curvature. This interaction can, in principle, lead to local modifications in the metric tensor, resulting in effective variations in photon propagation speeds. Such phenomena could occur in highly anisotropic or dynamically evolving spacetime geometries, where gravitational lensing, frame-dragging effects, or quantum field effects in curved spacetime might induce acceleration or deceleration of photon trajectories, thereby affecting their effective group velocity. In light of this, the present article offers detailed hypotheses concerning the aforementioned points, incorporating advanced terminology from physics and astrophysics as previously elaborated.

In summary, there are eight possibilities:

1. Light interference phenomena, which may have constructive interference of the light wave effect or destructive interference (negative light wave effect). This effect may occur when the cosmos image is distracting, creating background noise in the photo-image.
2. Constructive interference, the light may not travel fast enough, so that the front of the light has made with a cone shape that is conformal to the later light, which travels behind the front light. So, it will produce a stronger light effect and cast a shadow when we capture the image in front of the screen. As a result, the background of the light wave is greater than the now-stationary of the image, creating a shadow image (backlight) because the background stage light is greater than the now stage.
3. Destructive interference may happen when it has a negative conformal wave shape that is destructive to the resilience (negative interference) of the light, so both light waves hit together at their sharp points, creating a negative interference (dark image) that may darken the stationary image.
4. The various phenomena affecting the propagation of light beams resulting from the dynamic expansion of spacetime in the universe. In the broader context of cosmology and general relativity, the invariant nature of the speed of light in a vacuum asserts its constancy; however, we believed under certain general relativistic conditions and cosmological models, the effective or observed speed of light may appear non-constant due to effects such as gravitational lensing, spacetime curvature, and the expansion of the metric. Furthermore, the local measurement of the speed of light is intrinsically influenced by the curvature of spacetime, as described by the Einstein field equations, which govern the gravitational dynamics and geometric structure of the universe.
5. It may be developed, by the measurement event, which the state of condition (Phase) may be vary as the different of the measurement. So, the speed of light condition, may be faster, slower or normal depend on the measurement stage (Phase) moment.

6. The measured state may evolve as a consequence of the measurement event itself, such that the physical condition under observation exhibits variation depending on the measurement framework. Accordingly, the apparent speed of light could manifest as higher, lower, or invariant relative to the standard value c , contingent upon the specific spacetime context, measurement apparatus, or phase of observational interaction.
7. Or the measurement event, may induce the light to become different "act," which is faster than light, normal, or slower than light of behaviors. Which we have category comprises hypothetical faster-than-light particles termed 'sutra-fast-wave-Photon,' characterized by superluminal velocities exceeding c . The second category includes standard quanta known as 'wave-photons,' which propagate precisely at the invariant speed c , mediating electromagnetic interactions. The third category pertains to 'slow-wave-photons,' referring to hypothetical wave-like-particles or inhibition traveling at subluminal velocities less than c when measuring happen.
8. The properties of the photon itself may possess consciousness, so when being measured, it could exhibit different characteristics, such as wave-like or particle-like behaviors. That means the properties of a photon may be influenced by a form of consciousness, implying that when it is measured, light may display different behaviors or characteristics, such as wave-like or particle-like properties, depending on how it is observed.

Conclusion

We propose that there are six possible interpretations (IV) (V) (VI) (VII) (VIII) offers the most innovative plausible explanation. In the (IV) interpretation, the speed of light may be influenced by the curvature of the universe, as a result of curvature-induced distortions in spacetime layers that create gravitational lensing effects, distorting the speed of photon.

The (V) (VI) (VII) (VIII), suggesting that during the measurement event, a form of "fast light" could have created, light traveling faster than the current constant speed c . Such phenomena might have originated at the moment of capturing event & emerged (sutra-fast-wave-Photon). These measurement effects could allow certain light waves to propagate at effective speeds exceeding the constant c . Furthermore, interaction with black holes might transform these light forms, as their passage through regions of extreme spacetime twisting could alter their velocity characteristics. This potential transformation aligns conceptually with the Relativities & Random Walk Hypothesis within the Efficient Cosmos framework (Random is not a random phenomenon) proposed by Lie, C.P (2025) [3]. It is anticipated that this research paper will assist the industry in rapidly developing a more comprehensive and precise cosmological model, facilitating advancements in astrophysics and theoretical physics, thereby benefiting both the scientific community and humanity at large.

REFERENCES

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