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A Unified Perspective Review on Photon Dynamics, the Properties of Superfluid Free Space and Cosmic Phenomena

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Abstract- This perspective review presents a series of profound insights into the understanding of photon dynamics, fundamental constants, the properties of superfluid free space and cosmic phenomena. By integrating mechanical, electromagnetic, and cosmological perspectives, the author re-examines the Hubble constant, introduces dynamic super fluid free space polarization, and explores the Cosmic Microwave Background Radiation alongside fluctuation-dissipation processes. Central to this work is the theory of Elementary Super Photons, underpinned by the concept of superfluid free space as a dynamically polarizable grand medium linking all relatively moving particles and enabling dynamic equilibrium across the universe, which aligns well with March's Principle and non-local hidden variables in quantum mechanics. This ambitious framework unifies the dynamic behaviour of photons, the characteristics of dynamically polarizable superfluid free space, and key observable features of the cosmos. The theoretical advancements presented herein bridge classical mechanics, quantum mechanics and electromagnetism, fostering interdisciplinary exploration and laying the ground work for a deeper understanding of the universe's fundamental nature.

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AUNIFIEDPERSPECTIVEREVIEWONPHOTONDYNAMICSTHEPROPERTIESOFSUPERFLUIDFREESPACEANDCOSMICPHENOMENA

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I. Introduction

For the light, a beam of photons, the widely accepted plane electromagnetic wave functions, derived from Maxwell's equations under the ideal assumption of lossless free space, suggest that the light can propagate indefinitely through the free space without energy dissipation. Hence, the cosmic redshift could only be explained as Space Expansion without any direct evidence, except cosmic redshift itself, the Big Bang cosmology has been developed based on the hypothetical Space Expansion, together with a simplified version of Einstein's General Relativity under several assumptions. In reality, electromagnetic force is a long-range force, there are interactions between propagating electromagnetic waves and dynamic pairs of positive and negative elementary charges distributed in free space. The interactions are extremely weak; hence, they are widely neglected. The neglected tiny part of the energy dissipation of the weak electromagnetic interactions has been derived from Maxwell's equations rigorously, the connection between the Hubble constant and the extremely tiny conductivity of the free space as an integrated dynamic grand medium is elucidated[1]. The Hubble constant is identified as the intrinsic relaxation frequency constant of the integrated dynamic grand medium of free space. Quantitative value for the tiny conductivity of free space as an integrated dynamic grand medium is determined theoretically. Amazingly, it is derived that the total electrical resistance of the whole observable Universe, as a cubic shape confined to the Hubble length, is equivalent to the well-determined impedance of free space. The energy dissipation of a monochromatic electromagnetic wave propagating through the integrated dynamic grand medium of free space per cycle, as derived from Poynting's theorem, is shown to be approximately the product of the Planck constant and the Hubble constant[1]. This result aligns precisely with the energy dissipation of a photon particle propagating through free space with an extremely tiny frictional force per cycle, derived from a lightly damped oscillator model[1,2]. Based on the progresses have been made, this perspective review invites a rethinking of established physical theories by incorporating innovative interpretations of photon dynamics, dynamically polarizable superfluid free space properties and some fundamental constants. Central to this work is the understanding that free space is a dynamically polarisable superfluid grand medium with an intrinsic relaxation frequency, which influences the behaviour of photons across cosmic distances. By integrating concepts such as dynamic superfluid free space polarization, fluctuation-dissipation, and the behaviour of Cosmic Microwave Background Radiation, this perspective review provides a comprehensive approach to re-examining how we view the Universe.

II. Photon Behaviour and the Interpretation of the Planck Constant from a Mechanical Perspective

The exploration begins with reinterpreting the Planck constant through a mechanical framework,

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viewing photons as harmonic oscillators with rotational symmetry[3]. This treatment emphasizes the relationship between a photon's energy equivalent inertial mass, oscillation frequency and spatial displacement, connected through conserved mechanical angular momentum because of rotational symmetry. This interpretation not only provides a deeper understanding of quantum mechanics but extends its relevance to macrocosmic scales, offering a unifying approach that links quantum behaviours with classical physics. This mechanical perspective on photon dynamics enhances our understanding of the wave-particle duality inherent in photons. All photons possess equal mechanical angular momentum because of their rotational symmetry, their propagation and interactions within various media can be explained using the model of the cycloid motion of harmonic oscillators. The cycloid model treats the particle aspect and the wave aspect of photons on an equal footing, the trajectory of particles is approximately determinable and it is possible to be verified experimentally. The implications of these findings resonate across disciplines, reinforcing the Planck constant's role, or more widely the conservation of angular momentum vectors because of rotational symmetries, as a universal connector between energy, frequency and space. The reduced Planck constant is an angular momentum, which is mutually determined by the harmonic oscillator with rotational symmetry and the dynamically polarizable superfluid free space around it, and they interact with each other. The Planck constant is not only important for advancing our understanding on the foundation of modern quantum physics for microcosms, it is also relevant to the current study of cosmology[3-5].

III. Mixed Two-Fluid Photons and the Superfluidity of Free Space

The innovative concept of mixed two-fluid photons posits that some photons can behave like a coherence quantum liquid under specific conditions[6]. Drawing inspiration from Bose-Einstein condensation in superfluid helium, it is suggested that a subset of photons at certain wavelengths and densities can enter a state of minimal interaction and collective behaviour, akin to superfluidity, which forms the so-called superfluid free space. Superfluid free space as a medium contributes to photon behaviour through its polarizable, dynamic nature.

The theory of mixed two-fluid photons is supported by observations of deep absorption profiles in radio background spectra and the behaviour of the cosmic microwave background radiation. These findings indicate that photons do not travel unimpeded but interact weakly with dynamically polarizable superfluid free space they traverse. Free space as a dynamically polarizable superfluid medium that resemble quantum coherence seen in superfluid systems, is a perfect black body radiator under perturbations.

IV. Revisiting the Fine-Structure Constant: Implications for Dynamically Polarizable Superfluid Free Space and Photon Behaviour

The fine-structure constant (α), a dimensionless value integral to electromagnetism, gains new significance under the dynamic elementary dipole model. In this model, twin particles with opposite elementary charges in stable orbital motions form a structure integral to electromagnetic and mechanical interactions[7]. Photons with internal structures composed of twin particles with opposite elementary charges, create dynamic elementary dipoles with their energy equivalent inertial mass-centre propagating at light speed. This model not only provides a foundation for deriving the fine structure constant α but also integrates it with the broader properties of the dynamically polarizable superfluid free space.

This model links the fine structure constant α to the dynamic polarization of superfluid free space and the electromagnetic interactions that occur between particles and their fields. This connection reinforces the concept that superfluid free space's dynamic polarizability is essential to the behaviour of photons and their interactions. By viewing photons as entities embedded in a dynamic polarizable superfluid medium that inherently interacts with them, this model offers an explanation for the wave-particle duality that extends beyond the standard quantum model. A step further, dynamically polarizable free space filled with superfluid state of fermion-antifermion fields would be able to provide the vehicles for strong, electromagnetic, weak, and gravitational interactions, thus form a foundation for a unified field theory[8].

V. Dynamic Superfluid Free Space Polarization, Its Role in Photon Interaction and Beyond

One of the most compelling contributions is the detailed examination of superfluid free space as a dynamically polarizable medium filled with dynamic elementary dipoles[1-3,6-10]. This concept challenges the classical view of free space as an inert vacuum and proposes that dynamic superfluid free space inherently possesses electric, magnetic and mechanical polarizability. The notion of dynamic superfluid free space polarization aligns with quantum field theory, where vacuum fluctuations and transient particle appearances are accepted phenomena. The perspective on superfluid free space as a dynamically polarizable medium explains how photons can interact with their surroundings over astronomical scales. The dynamic polarization of superfluid free space results in subtle but meaningful interactions with photons, influencing their energy dissipation and behaviour. This insight is crucial for understanding how light travels through the universe and how it might be impacted by the fluctuating properties of dynamically polarizable superfluid free space itself.

The concept of dynamic superfluid free space polarization can be extended beyond photon interactions to include gravitational effects. The weak but persistent electromagnetic properties of dynamically polarizable superfluid free space suggest that photons, as they propagate, experience slight shifts in energy and momentum due to interactions with this dynamically polarized superfluid medium. This interaction may also influence gravitational redshift and the bending of light near massive celestial bodies. By incorporating dynamic polarization into gravitational models, the behaviours of light in the presence of massive objects shall be able to be explained simply. This could lead to refinements in our understanding of light-matter interactions and the gravitational lensing effects observed in astrophysical studies.

VI. Cosmic Microwave Background Radiation as Evidence of Polarizable Superfluid Free Space Dynamics

The cosmic microwave background radiation is not the relic radiation of the Big Bang, but the evidence of an ongoing interaction between relatively moving particles and the dynamically polarizable nature of superfluid free space[1,2,6-10]. The cosmic microwave background radiation is tied to the behaviour of relatively moving particles in dynamically polarizable superfluid free space characterized by extremely weak conductivity and polarization. The energy distribution and temperature of the cosmic microwave background radiation can be explained by considering the fluctuation-dissipation theorem, which describes how systems in dynamic thermal equilibrium respond to external perturbations. This approach implies that the cosmic microwave background radiation is part of a continuous interaction where relatively moving particles dissipate or absorb energy as they propagate through the dynamically polarized superfluid free space. The classical concept of a perfect blackbody is extended to include dynamically polarized superfluid free space itself. While traditional blackbody models apply to idealized material bodies, the superfluidity in dynamically polarisable free space introduces the possibility that the universe as a whole, under specific conditions, functions as an ideal blackbody. This redefinition implies that dynamically polarizable superfluid free space can absorb and re-emit radiation seamlessly, achieving a dynamic state where energy is conserved and uniformly redistributed over a cosmic scale, which supports the blackbody spectrum that characterizes the cosmic microwave background radiation.

The consistent temperature of the cosmic microwave background radiation, at around 2.7 K, fits within the predictions about the behaviour of relatively moving particles interacting with a weakly polarized dynamic superfluid free space. This uniformity, coupled with the fluctuation-dissipation process, suggests that the cosmic microwave background radiation is part of an ongoing dynamic equilibrium maintained by the integrated grand superfluid free space's properties. This perspective offers new avenues for interpreting the cosmic microwave background radiation's minute fluctuations, potentially explaining anomalies observed in its power spectrum[11] through the lens of dynamic superfluid free space polarization and energy dissipation react to external perturbations.

VII. The Fluctuation-Dissipation and its Impact on Photon Propagation, The Interplay between Cosmic Microwave Background Radiation and Fluctuation-Dissipation

The fluctuation-dissipation theorem is a cornerstone in understanding how systems in dynamic equilibrium react to external forces[12-13]. This concept is applied to the behaviour of photons in dynamically polarizable superfluid free space, proposing that the energy dissipation experienced by photons is part of a natural interactive fluctuation-dissipation process[1,2,6-10]. This framework challenges the notion that free space is frictionless, suggesting instead that it acts as an extremely low-loss viscous superfluid medium where energy dissipation, although minimal, is measurable over a cosmic distance.

The lightly damped oscillator model supports this idea, demonstrating how the weak friction of dynamically polarizable superfluid free space contributes to photon energy loss. This energy dissipation aligns with the Hubble constant reinterpreted as a measure of dynamically polarizable superfluid free space's intrinsic relaxation frequency. By associating the energy dissipated per cycle of a photon with approximately the product of the Planck constant and the Hubble constant, a bridge between the fluctuation-dissipation process and observable cosmic phenomena is built up. It is suggested that the cosmic microwave background radiation is an ongoing signature of fluctuation-dissipation interactions in dynamically polarizable superfluid free space as a grand medium. It is proposed that as photons traverse the dynamically polarized and weakly conductive superfluid medium of free space, their energy is subtly dissipated, contributing to the uniform temperature and spectrum observed in

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the cosmic microwave background radiation. This view integrates the cosmic microwave background radiation into a broader framework where dynamically polarizable superfluid free space as a grand medium itself participates actively in maintaining dynamic thermal equilibrium through weak photon interactions.

The fluctuation-dissipation theorem helps explain why the cosmic microwave background radiation exhibits such a consistent temperature across vast regions of the sky. This uniformity results from the energy exchange between relatively moving particles and the dynamically polarizable medium of superfluid free space as a grand medium, which acts as a thermal reservoir. The dynamic polarization-induced fluctuation enables superfluid free space to respond to energy inputs, maintaining a dynamic equilibrium that aligns with the observed cosmic microwave background radiation characteristics. The fluctuation-dissipation process allows the superfluid nature of free space to maintain a uniform temperature profile across cosmic scales, underpinning the stable blackbody spectrum of the cosmic microwave background radiation.

VIII. Rethinking the Hubble Constant: Mechanical and Electromagnetic Perspectives

Rather than traditionally associated with the rate of cosmic expansion, the Hubble constant represents deeper, mechanical and electromagnetic aspects of dynamically polarizable superfluid free space. Dynamically polarizable superfluid free space's minimal but non-zero conductivity and non-zero frictional force result in energy dissipation that can be quantified [1,2,6-10]. Three different methods have been developed, which can derive that the energy dissipation of a photon propagating through free space per cycle is approximately the product of the Planck constant and the Hubble constant. This interpretation aligns with a broader understanding of superfluid free space as an integrated dynamic grand medium, characterized by polarization and electromagnetic interactions.

Dynamically polarizable superfluid free space, when viewed as a grand medium, exhibits properties akin to a subtle resistive material with an extremely weak conductivity, which helps in the application of Maxwell's equations in a rigorous way to photons propagating, to derive some novel and interesting results. This framework suggests that the cosmic redshift observed in distant galaxies can be attributed to photon energy loss in a dynamically polarized, weakly interacting superfluid free space as an integrated dynamic grand medium, rather than to an expanding universe. This perspective challenges the Big Bang model's reliance on space expansion as the driver of redshift. This interpretation aligns with the concept of dynamically polarizable superfluid free space as an ideal blackbody, suggesting that the large-scale structure and energy dissipation properties of dynamically polarizable superfluid free space maintain the cosmic microwave background radiation's uniform spectrum.

IX. Mach's Principle, Elementary Super Photon Theory, Universal Coupling and Interconnectedness

Mach's Principle posits that the properties of any local system are influenced by the large-scale distribution of matter and energy across the universe[14-15]. The theory of dynamic free space polarization and superfluidity provides a new interpretation of Mach's Principle, suggesting that dynamically polarizable superfluid free space itself acts as a grand medium linking all matter and energy across cosmic distances. Elementary Super Photon Theory extends Mach's Principle by proposing that photons lose small energy fragments, called Elementary Super Photons, as they traverse free space. These fragments form a universal and coherence quantum liquid "thermal bath" that enables dynamic interaction among all particles. The Universal Gravitational Constant is thus seen as a coupling constant representing each particle's relationship with the cosmic field of Elementary Super Photons as an integrated grand medium[2]. This theory aligns with Mach's Principle, suggesting that local properties of relatively moving particles are influenced by the cosmic energy field, with dynamically polarizable superfluid free space acting as a grand medium for continuous and dynamic energy exchange. In this light, the perplexing nature of non-local hidden variables in quantum mechanics may become clearer as well.

The dynamically polarizable superfluid model of free space implies that the cosmic microwave background radiation is a Machian equilibrium state sustained by the universe's energy distribution. In this view, the cosmic microwave background radiation reflects the fluctuation of cosmic energy field on the influence of relatively moving particles, embodying Mach's Principle in maintaining dynamic equilibrium across cosmic scales. The cosmic microwave background radiation's uniformity reflects a cosmic balance upheld by the dynamically polarizable superfluid properties of free space, which acts as an ideal blackbody in re-emitting absorbed energy.

The Tully-Fisher relation illustrates Mach's Principle in the Elementary Super Photon theory, where a galaxy's rotation and mass are influenced by the cosmic energy field. The dynamically polarizable superfluid nature of free space allows galaxies to interact with the universal coherence quantum liquid photon bath, maintaining dynamic equilibrium with the universe's cosmic energy field. This interpretation realizes Mach's Principle by showing how galactic rotation and structure are dynamically linked to the entire cosmic energy field.

The Elementary Super Photon theory represents a transformative perspective on universal inter connectedness, expanding Mach's Principle by treating dynamically polarizable superfluid free space as a grand medium with ideal blackbody properties. This framework suggests that all matter and energy are linked through a cosmic energy field, enabling dynamic equilibrium across the universe. By interpreting the Hubble Constant, cosmic microwave background radiation, and gravitational effects through dynamically polarizable superfluid free space as a grand medium, the theory provides a cohesive framework that challenges conventional models of cosmic expansion, proposing instead that the properties of dynamically polarizable superfluid free space and relatively moving particles' behaviour, and dynamic energy exchanging between them maintain cosmic balance.

The cosmic microwave background radiation's blackbody spectrum is not a relic from the Big Bang but a steady-state result of dynamically polarizable superfluid free space behaving as an ideal blackbody emitter. This dynamic equilibrium within dynamically polarizable superfluid free space as a grand medium, governed by Mach's Principle, sustains a unified cosmic energy field that influences local and universal phenomena alike.

X. Critiquing Established Cosmological Models, The Elementary Super Photon Theory and Beyond

The new advancements challenge the Big Bang and Expanding Space models by proposing that cosmic redshift can be explained through energy dissipation rather than space expansion[1,2,6-10]. This interpretation finds roots in the Tired Light hypothesis, which posits that photons lose energy as they travel, leading to redshift without invoking cosmic inflation. The lightly damped oscillator model, along with the understanding of dynamic superfluid free space polarization and fluctuation-dissipation, offers a more mechanically and electromagnetically grounded explanation for this phenomenon, resolving the blurred image issue associated with the old Tired Light theory. This model also addresses limitations in traditional explanations for the Tully-Fisher relation and Modified Newtonian Dynamics. By framing gravitational interactions as emergent properties of dynamic photon energy and mass circulation, the forces observed in galaxies are reinterpreted, providing alternative insights into galactic rotation curves and gravitational behaviour.

The comprehensive nature of the theory necessitates further experimental and observational validation. Testing the mixed two-fluid photon hypothesis and the Elementary Super Photon theory could involve high-precision astronomical observations, laboratory experiments that replicate superfluid free space polarization conditions, and the direct and accurate measurement of the near zero conductivity and the extremely low viscous frictional force of dynamically polarizable superfluid free space. Theoretically, it has been demonstrated that a moving particle in vacuum experiences a resistive force akin to friction, and experimental technologies are proposed or in development to measure it through its effects[16-19]. Recently, it is reported that the vacuum friction force has been experimentally verified[20]. Observations made by advanced telescopes, such as the James Webb Space Telescope, may provide empirical support for the predictions regarding mature galaxies at extreme distances, potentially challenging the Big Bang model.

Additionally, the modified uncertainty principle invites new approaches to quantum experiments, promising breakthroughs in fields that require ultra-precise measurements. Actually, there are already a number of reported experimental evidences demonstrating the violation of Heisenberg's Uncertainty Principle[21-23]. Incorporating the concepts of dynamic superfluid free space polarization and fluctuation-dissipation could revolutionize methodologies in quantum physics, particle physics and cosmology.

XI. Theoretical and Practical Challenges

While the theories present a compelling reinterpreting of photon dynamics, the properties of dynamically polarizable superfluid free space, some physical constants and cosmic phenomena, they face challenges that must be addressed through further study and experimentation. The idea of superfluid free space as a polarizable, interactive medium and the energy dissipation implied by the Elementary Super Photon theory require rigorous empirical validation. Additionally, integrating these concepts with the broader framework of General Relativity and the Standard Model poses theoretical challenges that could redefine how these foundational theories interact.

Skeptics may point to the departure from conventional interpretations as a significant hurdle, questioning whether the integration of dynamic superfluid free space polarization and energy dissipation can withstand observational scrutiny. However, these very challenges open doors to interdisciplinary exploration that blends aspects of classical mechanics, quantum mechanics and electromagnetism.

XII. Conclusion: Toward a Unified Model of Photon Dynamics, Dynamically Polarizable Superfluid Free Space and Cosmology

The Elementary Super Photon theory represents an ambitious attempt to weave together the dynamic behaviour of photons, the properties of dynamically polarizable superfluid free space, and the observable features of the cosmos. By positioning dynamic superfluid free space as a polarizable, slightly conductive medium that actively interacts with relatively moving particles, the theory shifts our understanding of light, energy, space and cosmic phenomena. The implications for Cosmic Microwave Background Radiation, cosmic redshift, and the Hubble constant challenge conventional cosmological narratives and suggest new paths for theoretical and observational exploration. The integration of fluctuation-dissipation and dynamic superfluid free space polarization into the broader dialogue of physics encourages future research aimed at refining our grasp of the dynamics of relatively moving particles and dynamically polarizable superfluid free space itself.

By proposing that dynamically polarizable free space as a grand superfluid medium, can behave as an ideal blackbody emitter, this advancement presents a model where the universe's large-scale properties directly influence local behaviour through dynamic equilibrium and energy exchange, which aligns well with March's Principle and also non-local deterministic hidden variables in quantum mechanics. The redefinitions of the Hubble Constant, cosmic microwave background radiation and cosmic redshift, integrate cosmic phenomena into a coherent system, emphasizing dynamically polarizable superfluid free space's essential role in achieving ideal blackbody conditions that sustain observable cosmic harmony.

Whether through the validation of the Elementary Super Photon Theory, exploration of mixed two-fluid photon states, or advanced observations of the universe's deep structures, the theoretic advancements lay the groundwork for a richer, more connected understanding of our universe's fundamental nature.

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Author Declarations

Conflict of Interest

The authors have no conflicts to disclose.

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