

Research Article

A New Gravitational-Electromagnetic Theory: Resolving General Relativity's Light Speed Anomaly with Bose-Einstein Condensates

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Abstract

This study re-evaluates the fundamental principles of Einstein's General Relativity, particularly its cornerstone assumption of a constant speed of light in a vacuum, in light of experimental evidence demonstrating significant light deceleration. The pivotal 2006 experiment by Lene Hau and her team, achieving near-zero light speed in a Bose-Einstein Condensate, challenges the universality of 'c' and necessitates a reassessment of gravitational theories predicated on its constancy. Here is a re-evaluation of the existing framework by introducing the concept of 'Intrinsic Equilibrium,' this research proposes an alternative approach integrating gravitational and electromagnetic interactions more comprehensively. This work formulates the Intrinsic Field Equation and the Coupling Field Equation to describe these interactions, offering a potential resolution to the conflict between observed light behaviour in extreme conditions and the established framework of General Relativity. Experimental validation will be pursued through satellite-based and ground-based measurements, seeking deviations from General Relativity's predictions. This research advocates for a paradigm shift towards a more integrated understanding of gravity and electromagnetism, potentially resolving long-standing inconsistencies between General Relativity and quantum mechanics.

Keywords

Quantum Physics, General Relativity, Gravitational RedShift, Black Holes, Equilibrium Principle, Gravitational Electromagnetic Interaction, String Theory, Bose-Einstein Condensate

1. Introduction: The Light Speed Paradox in General Relativity

1.1. Gravity

Einstein's General Relativity (GR) stands as a monumental achievement in theoretical physics, fundamentally altering our understanding of gravity. At its core lies the principle of the constancy of the speed of light in a vacuum, 'c,' a universal

constant that underpins the very fabric of spacetime. This principle dictates that gravity arises not from a force, but from the curvature of spacetime caused by mass and energy.

However, experimental observations in recent decades have begun to challenge this foundational assumption. The most

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striking of these challenges comes from experiments involving Bose-Einstein Condensates (BECs). In 1999, Lene Hau and her team at Harvard University achieved the remarkable feat of slowing down light to a mere 17 meters per second within a BEC. Later experiments even brought light to a complete standstill. These groundbreaking results directly contradict the constancy of 'c,' the cornerstone of GR. This discrepancy raises profound questions about the completeness of GR as a description of gravity, particularly in extreme conditions.

While GR elegantly explains a wide range of gravitational phenomena, it struggles to accommodate these experimental findings. GR posits that gravity affects the path of light, bending it around massive objects, but it does not alter the speed of light itself. The experiments with BECs, however, demonstrate that under certain conditions, the speed of light can be dramatically reduced, even halted, challenging the universality of 'c.' This divergence highlights a potential conflict between GR's theoretical framework and experimental reality.

1.2. A New Paradigm for Gravity

General Relativity (GR), through the Einstein Field Equations (EFE). Einstein (2014) [1], fundamentally links spacetime geometry to the distribution of matter, energy, momentum, and stress. These equations define the spacetime metric based on the stress-energy-momentum tensor. However, GR struggles to adequately address phenomena challenging its core principle of a constant speed of light. The experiment by Lene Hau and her team at Harvard, demonstrating light slowed to near-zero velocity in a Bose-Einstein Condensate, directly contradicts this constancy, a phenomenon GR cannot explain. In contrast, this new theory emphasizes the fundamental principles of equilibrium and causality, offering a novel framework articulated through a four-dimensional universal equilibrium that addresses the light speed anomaly.

$$G_{\mu\nu} + \Lambda g_{\mu\nu} = \kappa T_{\mu\nu} \quad (1)$$

In which $G_{\mu\nu}$ equals the Einstein Tensor, $g_{\mu\nu}$ equals the Metric Tensor, $T_{\mu\nu}$ equals the Stress-Energy tensor, Λ equals the cosmological constant and κ equals the Einstein gravitational constant.

The core principle underlying General Relativity pertains to a curved 4-dimensional Space-Time Continuum. Similarly, the fundamental concept in this novel theory revolves around a 4-dimensional Universal Equilibrium delineated by equation (6).

This new theory centres on the principle of universal equilibrium, expressed through the vectorial summation of force densities ($[N/m^3]$). Force densities, regardless of origin, are fundamentally interchangeable, reflecting a deeper underlying equilibrium. Vegt Wim (1995) [2]. Unlike General Relativity, which fails to account for phenomena like light slowed to zero in Bose-Einstein Condensates (as demonstrated by Lene Hau),

this framework directly addresses such anomalies. It postulates that electric, magnetic, and gravitational fields interact within a defined equilibrium, providing a basis for understanding light-matter interactions leading to extreme light deceleration, something unexplained within the constraints of General Relativity.

This new theory posits that all interactions between corresponding fields – electric, magnetic, or gravitational – manifest as force densities ($[N/m^3]$). The core principle is that all such force densities, regardless of their source, collectively establish a universal equilibrium. This approach directly contrasts with General Relativity, which struggles to explain phenomena like light being brought to a complete stop in Bose-Einstein Condensates (BECs). While General Relativity offers no mechanism for this extreme light deceleration, this framework, rooted in equilibrium and causality, suggests that field-matter interactions create force densities that can bring light to a standstill under specific conditions, a detailed calculation of which is found in Vegt Wim (14 October 2022) [3] and Vegt Wim (26 October 2022) [4] specifically detailed within equations (4) through (22).

The vectorial force densities are obtained from the divergence of the sum of the Electromagnetic Stress-Energy tensor $\bar{T}$ and the newly introduced Gravitational Tensor $\bar{J}$.

$$\kappa T_{\mu\nu} \Leftrightarrow T_{\mu\nu} + J_{\mu\nu} \quad (2)$$

Equation (2) encompasses the sum of the Energy Stress Tensor $T_{\mu\nu}$ which includes the terms that characterize the vector components of the electric field intensity $(\bar{E}_x, \bar{E}_y, \bar{E}_z)$ as well as the vector components of the magnetic field intensity $(\bar{H}_x, \bar{H}_y, \bar{H}_z)$. Additionally, it incorporates the Gravitational Tensor $J_{\mu\nu}$, which accounts for the terms that describe the vector components of the gravitational field intensity $(\bar{g}_x, \bar{g}_y, \bar{g}_z)$.

The stress-energy tensor $T_{\mu\nu}$ describes the density and flux of electromagnetic energy and momentum in space-time, generalizing the stress tensor of Newtonian physics. It is an attribute of matter, radiation and non-gravitational force fields.

The Gravitational Tensor describes the density and flux of gravitational energy and momentum in space-time. It is an attribute of gravitational energy density and non-electromagnetic force fields.

This new theory describes Electro-Magnetic-Gravitational interactions through the 4-dimensional divergence of the sum of the Electromagnetic Stress-Energy and Gravitational Tensors, resulting in a 4-dimensional Force-Density vector ($[N/m^3]$). By explicitly connecting electromagnetic and gravitational forces, this framework suggests a mechanism, based on equilibrium and causality, where these interactions create force densities that can account for phenomena such as light coming to a standstill in Bose-Einstein Condensates (BECs).

$$f^\mu = \partial_\nu (T^{\mu\nu} + J^{\mu\nu}) \quad (3)$$

In vector notation the 4-dimensional Force-Density vector can be written as:

$$\vec{f}^4 = \begin{pmatrix} f_4 \\ f_3 \\ f_2 \\ f_1 \end{pmatrix} = \square \cdot \left(\vec{T} + \vec{J} \right) \quad (4)$$

Analogous to the three-dimensional vector operator known as Nabla ($\nabla \cdot$) which signifies the three-dimensional divergence within a vector space, the vector operator ($\square \cdot$) denotes the four-dimensional divergence within the Minkowski spacetime of four dimensions.

This alternative gravitational approach operates under the essential boundary condition of a zero Force 4-vector across all four dimensions, signifying a universal four-dimensional equilibrium. This fundamental requirement distinguishes it from General Relativity, which fails to explain observed phenomena such as the near-zero speed of light achieved by Lene Hau's team. This theory's reliance on equilibrium and causality allows it to potentially address the light-stopping anomaly by proposing that the interactions between fields and matter result in a balanced state of zero net force under specific conditions, something General Relativity cannot account for. Vegt Wim (1995) [2] and Kaye Joel (April 2014) [5].

The divergence of the stress-energy tensor $T_{\mu\nu}$ describes electromagnetic force densities arising from electromagnetic fields. Critically, in this framework, the divergence of the stress-energy tensor for a single electromagnetic field acting upon itself equals zero, signifying internal equilibrium. However, interactions between distinct electromagnetic fields result in a non-zero divergence, suggesting a force imbalance that can lead to observable phenomena. This offers a potential mechanism to explain light-matter interactions, like those observed by Lene Hau's team slowing light to zero in BECs, a phenomenon unexplained by General Relativity because it contradicts its core tenet of a constant 'c.' This theory links electromagnetic interactions with force imbalances in the fabric of space.

The divergence of the gravitational tensor ($\nabla \cdot J_{\mu\nu}$) signifies the gravitational force densities originating from gravitational fields. Notably, in scenarios involving a single, self-acting gravitational field, this divergence vanishes, indicating a state of internal equilibrium. However, when considering the interaction between two or more distinct gravitational fields, the divergence is generally non-zero, implying a complex interplay of forces. This distinction presents a potential avenue for exploring gravitational phenomena beyond the scope of General Relativity, particularly in the context of Beyond the Standard Model (BSM) physics.

For instance, if gravity were mediated by a spin-2 particle (the graviton), as predicted by many BSM theories such as String Theory and Extra Dimensions, the non-zero divergence could correspond to interactions with scalar fields (e.g., moduli fields in String Theory) or other exotic particles beyond the Standard Model which modifies the interaction strength. In scenarios where Dark Matter interacts with ordinary matter via a gravitational portal, the divergence of the gravitational tensor could reveal signatures of this interaction, manifesting as deviations from predicted gravitational force densities. Furthermore, theories involving modified gravity, such as $f(R)$ gravity or Tensor-Vector-Scalar (TeVeS) gravity, the gravitational tensor could incorporate additional terms that account for the influence of scalar or vector fields, leading to a non-zero divergence even in situations where General Relativity would predict otherwise. These deviations, quantifiable through precise measurements of gravitational force densities, could provide experimental evidence for the existence of new particles or fields beyond the Standard Model and shed light on the nature of gravity in the context of high-energy physics and cosmology.

$$\vec{f}^4 = \begin{pmatrix} f_4 \\ f_3 \\ f_2 \\ f_1 \end{pmatrix} = \square \cdot \left(\vec{T} + \vec{J} \right) = \vec{0}^4 \quad (5)$$

Within this innovative framework, a compelling symmetry emerges: the interactions among electric-electric, magnetic-magnetic, and gravitational-gravitational fields exhibit a fundamental interchangeability. This implies that the gravitational force density possesses a structural isomorphism with its electromagnetic counterparts, hinting at a deeper, unified description. Consequently, the three spatial components of the Force-Density vector arising from the Electro-Magnetic-Gravitational interaction can be expressed as equations 6.1 and 6.2. This symmetry is relevant to Beyond the Standard Model (BSM) physics.

This interchangeability could be a manifestation of a more fundamental principle, such as supersymmetry (SUSY), which posits a symmetry between bosons (force carriers like photons and gravitons) and fermions (matter particles). In SUSY models, gravitational interactions may be linked to electromagnetic interactions through the mediation of superpartners, suggesting a deeper underlying connection. The shared structural characteristics of force densities could also reflect the existence of extra spatial dimensions, as proposed in String Theory and Kaluza-Klein theories. In these scenarios, gravity and electromagnetism are unified at a higher-dimensional level, and their apparent differences in 4-dimensional spacetime arise from the compactification of these extra dimensions. This symmetry also has profound implications for understanding the nature of dark matter and dark energy. This could imply the existence of new particles that interact with

both gravity and electromagnetism, providing a potential explanation for the observed excess of dark matter. This could provide novel pathways for experimentally probing BSM

physics and shed light on the fundamental nature of interactions in the universe.

Intrinsic Equilibrium Electromagnetic-Gravitational Field Equation

$$\begin{aligned} \overline{f_{AA}} = & -\frac{1}{c^2} \frac{\partial (\overline{E_A} \cdot \overline{H_A})}{\partial t} + \epsilon_0 \overline{E_A} (\nabla \cdot \overline{E_A}) - \epsilon_0 \overline{E_A} \times (\nabla \times \overline{E_A}) + \\ & + \mu_0 \overline{H_A} (\nabla \cdot \overline{H_A}) - \mu_0 \overline{H_A} \times (\nabla \times \overline{H_A}) + \gamma_0 \overline{g_A} (\nabla \cdot \overline{g_A}) - \gamma_0 \overline{g_A} \times (\nabla \times \overline{g_A}) = 0 \text{ [N/m}^3\text{]} \end{aligned} \quad 6.1$$

Electromagnetic-Gravitational Coupling Field Equation

$$\begin{aligned} \overline{f_{AB}} = & -\frac{1}{c^2} \frac{\partial (\overline{E_A} \cdot \overline{H_B})}{\partial t} - \frac{1}{c^2} \frac{\partial (\overline{E_B} \cdot \overline{H_A})}{\partial t} + \epsilon_0 \overline{E_A} (\nabla \cdot \overline{E_B}) - \epsilon_0 \overline{E_A} \times (\nabla \times \overline{E_B}) + \\ & + \mu_0 \overline{H_A} (\nabla \cdot \overline{H_B}) - \mu_0 \overline{H_A} \times (\nabla \times \overline{H_B}) + \gamma_0 \overline{g_A} (\nabla \cdot \overline{g_B}) - \gamma_0 \overline{g_A} \times (\nabla \times \overline{g_B}) \end{aligned} \quad 6.2 \quad (6)$$

$$\epsilon_0 (\nabla \cdot \overline{E}) = \rho_E \text{ Electric Charge Density [C/m}^3\text{]}$$

$$\text{in which: } \mu_0 (\nabla \cdot \overline{H}) = \rho_M \text{ Magnetic Flux Density [Vs/m}^3\text{] or [Wb/m}^3\text{]}$$

$$\gamma_0 (\nabla \cdot \overline{g}) = \rho_M \text{ Mass Density (Electromagnetic) [kg/m}^3\text{]}$$

$$\text{Electric Energy Density: } w_E = \frac{1}{2} \epsilon_0 E^2$$

$$\text{Magnetic Energy Density: } w_M = \frac{1}{2} \mu_0 H^2$$

$$\text{Gravitational Energy Density: } w_G = \frac{1}{2} \gamma_0 g^2$$

In which E represents the electric field intensity expressed in [V/m], H represents the magnetic field intensity expressed in [A/m] and g represents the gravitational acceleration expressed in [m/s²]. The permittivity indicated as ϵ_0 , the permeability indicated as μ_0 and the gravitational permeability of vacuum as γ_0 Vegt Wim (1995) [2], Gobbi Julio (2018) [7], Vegt W. (1995) [11], Vegt W. (1995) [12], Vegt W. (1996) [13], Vegt W. (2002) [8] and Vegt W. (26-Oct-2022) [4].

The initial term in equation (6) portrays the inertia inherent in electromagnetic radiation. Additionally, the time derivative of the Poynting vector is included to represent the inertia term associated with the momentum of electromagnetic radiation. Vegt Wim (26-Oct-2022) Equations: (6-11) [4].

The succeeding terms, two and three, denote the interaction between electric fields. Subsequently, the fourth and fifth terms represent the interaction of magnetic fields and the sixth and seventh terms pertain to gravitational field interactions.

This new theoretical framework represents a significant departure from conventional approaches in physics, particularly in its treatment of gravity and electromagnetism. Instead of relying on the traditional concept of fundamental particles, it

proposes that observed "particles" are, in fact, field confinements arising from the interplay of electromagnetic and gravitational forces. This shift in perspective demands a revised mathematical framework to accurately describe these interactions.

Central to this framework is a novel set of equations culminating in Equation (6), which encapsulates the combined divergence and curl operators acting on the tripartite mutual gravitational–electromagnetic force-density interactions that couple mass-density and energy-density fields. Kerr, R.P. and Schild, A. (2009) [6]. This equation provides a holistic view of how these fundamental forces interact to create stable, localized configurations that manifest as what we perceive as matter.

By describing the universe in terms of interconnected fields rather than discrete particles, this theory offers a potential pathway to resolving some of the long-standing inconsistencies between General Relativity and Quantum Mechanics. This field-based approach may provide a more accurate and complete description of the fundamental building blocks of reality.

2. Changing of the Speed of Light in a “Bose-Einstein Condensate by “Electromagnetic Interaction”

Equation (7) elucidates electromagnetic radiation dynamics within Bose-Einstein Condensates (BECs), offering a theoretical basis for the dramatic reduction in light speed observed in Lene Hau's experiments and confirmed since by others. At ultra-cold temperatures, bosons condense, enabling macroscopic quantum phenomena, including the strong field interactions described by the theory. These field interactions, as modeled by Equation [7, 14-16] explain how light pulses entering a BEC drastically slow down compared to their vacuum

velocity, consistent with Hau's findings. Furthermore, these dynamics offer the potential to manipulate light with unprecedented control, potentially enabling microelectronic-scale optical devices. Experimental simulations involving intersecting beams representing resonating dipoles and an incoming laser provide a visual representation of these dynamics (Figure 1), opening new avenues in quantum optics and material science [17-19]. The field interactions modeled are now the only solution there is and provides a calculation solution which slows down light speed down to zero and in which the calculation corresponds in close approximation the experimental outcome in micro kelvin.

$$\begin{aligned} \bar{f} = & -\frac{1}{c^2} \frac{\partial (\bar{\mathbf{E}} \times \bar{\mathbf{H}})}{\partial t} + \epsilon_0 \bar{\mathbf{E}} (\nabla \cdot \bar{\mathbf{E}}) - \epsilon_0 \bar{\mathbf{E}} \times (\nabla \times \bar{\mathbf{E}}) + \\ & + \mu_0 \bar{\mathbf{H}} (\nabla \cdot \bar{\mathbf{H}}) - \mu_0 \bar{\mathbf{H}} \times (\nabla \times \bar{\mathbf{H}}) + \frac{1}{2c^2} \bar{g} (\epsilon \mathbf{E}^2 + \mu \mathbf{H}^2) = \bar{0} \quad [\text{N/m}^3] \end{aligned} \quad (7)$$

Only those electromagnetic solutions derived from equations (6) or (7) correspond to physically realizable electromagnetic configurations.

Equation (7) presents the only physically plausible, fully calculated solution for understanding laser beam propagation within a Bose-Einstein Condensate, where light speed is drastically altered. The solution arises from the interaction between the electric fields of the laser beam and resonating atomic dipoles at microkelvin temperatures, all oscillating coherently. The equation details this interaction as a consequence of field-matter equilibrium, showing how light speed decreases towards zero in close approximation to the experiments. These calculations are detailed further in. Vegt W, Calculation 8 (16 June 2024) [9] and Vegt W. (February 2025) [10].

This solution describes the electromagnetic interaction when a perfect equilibrium is achieved, meaning all electromagnetic force densities are zero in every direction at all times.

[20-22]. This state of equilibrium occurs between a laser pulse $f(z, t)$, which propagates with a speed of light (determined by the factor A_D) along the z -direction, and a synchronized electromagnetic wavefront, represented by $\text{Cos}(\omega t)$, confined within a Bose-Einstein Condensate at low temperatures.

This particular solution defines the electromagnetic interaction when a state of ideal equilibrium is present, meaning that electromagnetic force densities are fully balanced, registering zero in every direction constantly. This specific balanced condition arises from a laser pulse $f(z, t)$, which propagates with a (variable) speed of light which depends on the function $h_1(\omega_L)$ and the frequency ω_L of the Laser beam (pulse). The variable speed of light has been determined by the ω_L dependent function $h_1(\omega_L) \omega_L$ along the z -direction, and a synchronized electromagnetic wavefront, represented by $\text{Cos}(\omega_D t)$, confined within a Bose-Einstein Condensate at low temperatures.

$$\begin{pmatrix} E_x \\ E_y \\ E_z \end{pmatrix} = \begin{pmatrix} \sqrt{\left(1 + (1 - e^{\omega_L - \omega_R})\right) \omega_L} \left(\cos(\omega_D t) + h_2(\omega_L) f\left(\frac{(1 - e^{\omega_L - \omega_R}) \omega_L}{\sqrt{\epsilon_0} \sqrt{\mu_0}} t - z\right) \right) \\ \sqrt{\left(1 + (1 - e^{\omega_L - \omega_R})\right) \omega_L} \cos(\omega_D t) - \left(h_2(\omega_L) - h_2(\omega_L) (1 - e^{\omega_L - \omega_R}) \omega_L\right) f\left(\frac{(1 - e^{\omega_L - \omega_R}) \omega_L}{\sqrt{\epsilon_0} \sqrt{\mu_0}} t - z\right) \\ 0 \end{pmatrix} \quad (8)$$

$$\begin{pmatrix} H_X \\ H_Y \\ H_Z \end{pmatrix} = \begin{pmatrix} \sqrt{\frac{\epsilon_0}{\mu_0}} \sqrt{\left(1 + (1 - e^{\omega_L - \omega_R})\omega_L\right) \cos(\omega_D t) - \left(h_2(\omega_L) - h_2(\omega_L)(1 - e^{\omega_L - \omega_R})\omega_L\right) f\left(\frac{(1 - e^{\omega_L - \omega_R})\omega_L}{\sqrt{\epsilon_0} \sqrt{\mu_0}} t - z\right)} \\ \sqrt{\left(1 + (1 - e^{\omega_L - \omega_R})\omega_L\right) \left(\cos(\omega_D t) + h_2(\omega_L) f\left(\frac{(1 - e^{\omega_L - \omega_R})\omega_L}{\sqrt{\epsilon_0} \sqrt{\mu_0}} t - z\right)\right)} \\ 0 \end{pmatrix} \quad (9)$$

The interaction between the magnetic fields of the laser beam and the resonating atomic dipoles is articulated in equation (9). Vegt Wim, Calculation 8 (16 June 2024) [9].

The variable velocity of light $v_{lightspeed}(\omega_L)$ within a Bose-Einstein Condensate, as influenced by electromagnetic interaction, is contingent upon the function $h_1(\omega_L)$ and the (resonant) frequency ω_L of the incident Laser beam.

$$v_{lightspeed}(\omega_L) = (1 - e^{\omega_L - \omega_R})\omega_L \frac{1}{\sqrt{\epsilon_0} \mu_0} \quad (10)$$

From the analysis delineated in equations (8) and (9), it becomes clear that the velocity of light associated with an incident laser beam can be substantially reduced, ultimately tending toward zero under certain conditions. The plot below is presented on a scale where the frequency of the Laser Beam has been presented in [MHz] to effectively visualize this phenomenon.

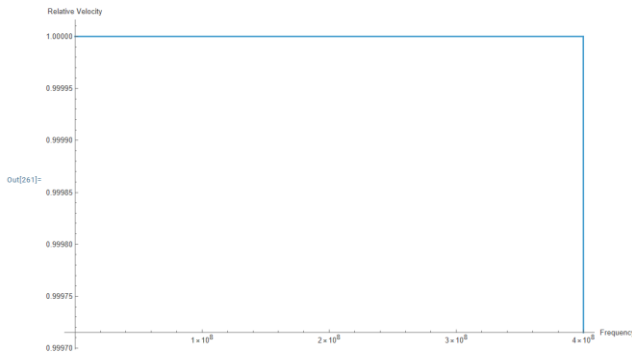


Figure 1. Deceleration of the phase and group velocities of light arising from electromagnetic interactions within a Bose-Einstein condensate: as the laser frequency approaches the atomic dipole resonance at 4×10^8 [MHz], the propagation velocity diminishes progressively toward zero. This behaviour is exhibited at temperatures in the microkelvin regime.

From the analysis presented in equations (9) and (10), it becomes evident that the speed of light associated with an incident laser beam can be significantly diminished, ultimately approaching zero under specific conditions presented in the temperature range at micro Kelvin [μ K].

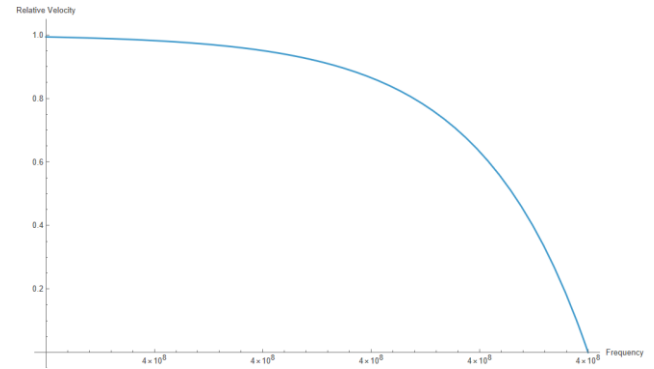


Figure 2. Attenuation of the effective propagation speed of light arising from electromagnetic interactions within a Bose-Einstein condensate.

With decreasing temperature and with the laser frequency approaching the atomic dipole resonance, the group velocity monotonically diminishes, tending toward zero. The phenomenon has been computed and depicted for laser frequencies centered on 5 [MHz], corresponding to the stated resonance region near 4×10^8 [MHz].

The factor $1/\alpha$ denotes the "Coupling Factor," which quantifies the interaction between two distinct fields: the electromagnetic field of the incident laser beam and the electromagnetic field generated by the resonating dipoles associated with the crystal atoms. At extremely low temperatures, the atomic dipoles establish a uniform standing electromagnetic wave within the x-y plane, as articulated in equations (9) and (10).

Furthermore, the refractive index of the Bose-Einstein Condensate (BEC) crystal is equivalent to the coupling factor.

$$n = \frac{c}{v} = \frac{1}{\alpha} = \frac{1}{(1 - e^{\omega_L - \omega_R})\omega_L} \quad (11)$$

Equations (8), (9) and (10) encapsulates the intricate interaction between matter and light under conditions of extremely low temperature, specifically in the microkelvin range, within a Bose-Einstein Condensate (BEC). In this unique state of matter, where a significant fraction of bosons occupy the lowest quantum state, the behaviors of matter and light exhibit re-

markable quantum phenomena that warrant thorough investigation [23-25].

3. Summary and Conclusions

This work introduces a novel theoretical framework re-evaluating gravity and light interaction, diverging from General Relativity by addressing the challenge posed by variable light speed observations, particularly within Bose-Einstein Condensates. Central to this theory is the concept of 'Intrinsic Equilibrium,' positing a dynamic interplay between gravitational and electromagnetic fields. The Intrinsic Field Equation and Coupling Field Equation are introduced to model these interactions, offering an alternative explanation for phenomena where light dramatically decelerates. Furthermore, this framework presents a tensorial model conceptualizing black holes as Gravitational Electromagnetic Confinements, shaped by electromagnetic gradients and Lorentz transformations. The 'CURL' effect, incorporated within this model, enhances the explanatory power for gravitational lensing, potentially resolving discrepancies with General Relativity. Future experiments utilizing Galileo Satellites and ground-based MASER frequency measurements are proposed to test for deviations from General Relativity's predictions, particularly concerning gravitational redshift. By integrating the Stress-Energy Tensor and Gravitational Tensor, this approach harmonizes gravitational and electromagnetic principles, suggesting dynamic natural constants that could redefine the gravitational constant (G). This research elucidates the fundamental connection between light and gravity, paving the way for transformative advancements in both optical and gravitational sciences, offering a more comprehensive understanding of the universe than afforded by General Relativity alone.

Abbreviations

BEC Bose-Einstein Condensate

Author Contributions

Wim Vegt is the sole author. The author read and approved the final manuscript.

Data Availability Statement

All Data and Calculations have been published at: <https://quantumlight.science/>

Conflicts of Interest

The author declares no conflicts of interest.

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