# Photon Interactions with External Gravitational Fields: True Cause of Gravitational Lensing.

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**Abstract:**

This study investigates the fundamental equations governing photon behaviour in external gravitational fields due to electromagnetic-gravitational interaction, emphasizing their energy, momentum, and wavelength relationships. Building upon the pioneering contributions of Max Planck and Louis de Broglie, the analysis highlights key equations such as E = hf, ρ = h/λ, and ℓp/tp = c, which elucidate the wave-particle duality and energy conservation principles applicable to photons. The conservation of photon energy in gravitational fields, expressed by Eg = E, underscores the symmetrical nature of photon interactions as they traverse strong gravitational environments.

The observed phenomena of redshift and blueshift are interpreted within this framework, alongside a reinterpretation of gravitational lensing as a consequence of the momentum exchange between photons and the curvature of external gravitational fields. This perspective challenges conventional understandings and suggests that established theories may require refinement. The study advocates for the integration of alternative frameworks, such as quantum gravity and flat spacetime models, to address discrepancies between observed photon behaviour and current gravitational theories. By exploring these interactions, this research aims to enhance our understanding of the fundamental laws governing the universe, contributing to ongoing efforts toward a unified theory that reconciles quantum mechanics and gravity.

**Keywords:** Photon energy, momentum, wavelength, gravitational fields, quantum mechanics, Planck's constant, wave-particle duality, redshift, blueshift, quantum gravity, gravitational lensing, astrophysics, cosmology,

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**Introduction:**

This study investigates the interactions of photons with external gravitational fields, exploring how these electromagnetic-gravitational interactions can be understood through the lens of quantum mechanics and electromagnetic theory. The analysis delves into fundamental relationships between photon energy, momentum, and wavelength, illuminating their implications for astrophysical phenomena, particularly gravitational lensing.

The findings suggest a reinterpretation of gravitational lensing as a result of the momentum exchange between photons and the curvature of external gravitational fields, rather than the traditional view of relativistic curvature in spacetime. This perspective offers new insights into how photons behave in the vicinity of massive celestial bodies, challenging established notions and highlighting the necessity for a comprehensive understanding of these interactions.

By examining the behaviour of photon, representing light, under the influence of gravitational forces, this study contributes to a broader scientific discourse that seeks to reconcile the principles of quantum mechanics with classical concepts of gravity. Through this exploration, we aim to enhance our understanding of the underlying mechanisms that govern the interactions of light and gravity, paving the way for future research in the quest to unify these fundamental aspects of the universe.

The following equations provide a conceptual framework for understanding the interaction of photons with gravitational fields. These equations reflect fundamental relationships between photon energy, momentum, and wavelength, with significant implications for fields such as astrophysics and cosmology. The equations primarily draw upon the pioneering work of Max Planck (1900) and Louis de Broglie (1924), as well as later developments in gravitational physics and quantum field theory.

Key quantities such as photon energy (E), frequency (f), momentum (ρ), and wavelength (λ) are central to these discussions. Additionally, the Planck length (ℓp) and Planck time (tp) play critical roles in connecting quantum mechanics with gravity at the smallest scales, where quantum gravity theories are actively being explored. These equations help describe photon behaviour in the context of external gravitational fields, such as those near massive celestial bodies, and provide insight into the limitations of general relativity in extreme environments.

**Method:**

The investigation of photon interactions with external gravitational fields employed a multi-faceted methodological approach that combined theoretical analysis, mathematical derivations, and conceptual modelling. The key components of the methodology are outlined below:

1. Theoretical Framework

The foundation of the analysis was established by reviewing existing literature on quantum mechanics and gravitational physics. This involved synthesizing fundamental theories and equations related to photon energy, momentum, and gravitational interactions, particularly focusing on the works of Max Planck and Louis de Broglie.

2. Mathematical Derivations

The study included the derivation and application of relevant equations to model the behaviour of photons in external gravitational fields. The following equations were pivotal in the analysis:

- Energy-Frequency Relation: $E = hf$
- Momentum-Wavelength Relation: $\rho = h/\lambda$
- Planck Scale Relation: $\ell p/tp = c$
- Energy Conservation in Gravitational Fields: $Eg = E$

These equations were explored to elucidate the connections between photon energy, frequency, momentum, and wavelength, providing a comprehensive framework for understanding how these quantities interact with gravitational influences.

3. Conceptual Modelling

A conceptual model was developed to visualize the interaction of photons with external gravitational fields. This model illustrated key phenomena such as redshift and blueshift, highlighting the symmetrical gain and loss of energy as photons traverse different gravitational environments. The model depicted the photon's trajectory around a strong gravitational body, emphasizing how momentum and energy exchange occur, particularly focusing on the reinterpretation of gravitational lensing as a result of momentum exchange with the curvature of external gravitational fields.

4. Comparative Analysis

To assess the implications of the findings, the study engaged in a comparative analysis of the presented equations against conventional interpretations of gravitational interactions. This involved identifying discrepancies in photon behaviour as they approach and recede from gravitational wells, as well as examining the broader implications of these discrepancies in relation to alternative theories, including quantum gravity and flat spacetime models.

5. Interpretation and Discussion

The results derived from the mathematical analysis and conceptual modelling were interpreted within the context of current scientific understanding. This involved discussing the significance of the observed phenomena, evaluating the limitations of conventional gravitational theories, and considering the potential for alternative theoretical frameworks to provide a more comprehensive explanation of photon interactions in external gravitational fields.

6. Conclusion Synthesis

The method culminated in synthesizing the findings into a coherent narrative that articulated the implications of the study for future research in astrophysics and cosmology. The conclusions drawn emphasized the need for ongoing exploration of photon behaviour in extreme gravitational environments, thereby contributing to the pursuit of a unified understanding of quantum mechanics and gravity.

By integrating theoretical insights, mathematical rigor, and conceptual clarity, this methodology effectively illuminated the complex interactions between photons and gravitational fields, paving the way for future investigations in this intriguing area of research.

**Mathematical Presentation:**

**Equations and Their Applicability:**

Planck's Energy-Frequency Relation:

$$E=hf$$

This equation, introduced by Max Planck in 1900, expresses the direct proportionality between the energy (E) of a photon and its frequency (f), with h representing Planck’s constant. This relation is foundational to quantum mechanics and is critical for understanding energy exchange in electromagnetic radiation.

Applicability: This equation applies to all forms of light and electromagnetic radiation, making it crucial for studying photon energy in various contexts, including blackbody radiation, spectroscopy, and cosmological observations.

2. Photon Momentum-Wavelength Relation:

$$\rho = h/\lambda$$

The equation $\rho = h/\lambda$ represents the momentum-wavelength relationship for photons, describing the momentum ($\rho$) of a photon in terms of its wavelength ($\lambda$). This relationship is derived from Louis de Broglie’s hypothesis, extending quantum mechanics to all particles and demonstrating that both matter and light exhibit wave-like properties.

Applicability: This relation is vital in quantum mechanics and relativistic physics, particularly for understanding how light interacts with particles and gravitational fields, as well as how its wavelength changes in processes such as red shifting and blue shifting.

Significance: This equation is significant for understanding the dual nature of light and other particles, enabling calculations related to photon behaviour in various contexts, including quantum optics and interactions with gravitational influences.

3. Planck Scale Relation:

$$\ell p/tp = c$$

This equation relates Planck length ($\ell p$) and Planck time ($tp$) to the speed of light (c), encapsulating the shortest measurable scales in the universe where quantum gravitational effects become significant.

Applicability: This equation is important in quantum gravity theories, which aim to unify quantum mechanics and gravitational concepts. It serves as a bridge to understanding how spacetime behaves at very small scales, such as near singularities or during the universe's earliest moments.

4. Energy Conservation in Gravitational Fields:

$$Eg = E$$

This equation represents the conservation of photon energy (Eg) as it interacts with an external gravitational field, stating that the inherent energy of the photon remains unchanged despite external gravitational influences. This principle is critical for understanding phenomena such as redshift and blueshift while maintaining energy symmetry in photon interactions.

Applicability: This equation is useful in astrophysics, particularly in studying light's behaviour in strong gravitational fields, such as near black holes or during cosmological expansion. It challenges conventional interpretations of gravitational interactions, suggesting a reinterpretation of gravitational lensing in terms of momentum exchange with the curvature of external gravitational fields.

Scientific Significance:

These equations form the foundation for analysing photon interactions with gravitational fields, emphasizing the energy and momentum exchanges due to electromagnetic-gravitational coupling. By exploring these interactions, scientists gain deeper insight into phenomena such as gravitational lensing, cosmic redshift, and the potential limitations of existing gravitational theories. The relationships between $E = hf$, $\rho = h/\lambda$, and $\ell p/tp = c$ are particularly critical for future developments in quantum gravity and the quest for a unified theory of the fundamental forces in nature.

The Equations Used in the Study:

1. Photon Energy and Momentum:

$$E = hf \; ; \; \rho = h/\lambda \; ; \; \ell p/tp = c$$

Where E is the photon energy, f is the frequency, ρ is the momentum, λ is the wavelength, and ℓp/tp refers to the ratio of Planck length to Planck time.

2. Photon Energy and Gravitational Influence:

$$Eg = E + \Delta E = E - \Delta E \; ; \; E = Eg$$

This equation reflects the inherent photon energy (E) and its interaction with the gravitational field of its source, resulting in a net energy change (ΔE) but maintaining energy symmetry.

3. Momentum Exchange in Gravitational Interaction:

$$Eg = E + \Delta\rho = E - \Delta\rho = E \; ; \; h/\Delta\lambda = h/-\Delta\lambda$$

This equation describes the momentum exchange (Δρ) as the photon undergoes a shift in wavelength (Δλ) during its trajectory through a strong gravitational field, highlighting the symmetrical nature of the interaction.

4. Symmetry in Energy and Momentum Exchange:

$$Eg = E \; ; \; \Delta\rho = -\Delta\rho \; ; \; \ell p/tp = c$$

This final equation expresses the balanced, symmetrical exchange of momentum and energy in the photon's interaction with the gravitational field, reinforcing the photon's inherent energy conservation despite external influences.

**Conceptual Foundation of the Study:**

A photon, representing light, carries inherent energy denoted as E. As the photon ascends from the gravitational well of its emission source, it loses part of this energy, resulting in a redshift (increase in wavelength, $\Delta\lambda>0$). However, the photon's behaviour changes significantly when it encounters a strong external gravitational field.

As the photon approaches a strong external gravitational body, it undergoes a blueshift (decrease in wavelength, $\Delta\lambda<0$) due to its interaction with the external gravitational field. This shift occurs as a result of electromagnetic-gravitational interaction, causing the photon to follow an arc-shaped trajectory. During this process, the photon's momentum increases, described by the relation $\Delta\rho = h/\Delta\lambda$, where h is Planck's constant. This momentum gain reflects the gravitational influence on the photon's trajectory.

Completing half of the arc path (1/2 arc) around the gravitational body, the blueshift transitions into a redshift ($\Delta\lambda>0$) as the photon begins to lose momentum ($\Delta\rho=h/\Delta\lambda$). This process indicates a symmetrical momentum exchange, where the photon experiences a balanced gain and loss of external energy (Eg), preserving symmetry in its overall energy behaviour.

Importantly, while the photon undergoes these external changes in wavelength, momentum, and energy during its trajectory around the gravitational body, it retains its inherent energy (E). The only exception occurs when the photon loses energy (ΔE) while escaping the gravitational well of its source. Thus, despite these external interactions, the photon's inherent energy remains conserved, except for the loss associated with its initial emission.

After bypassing the gravitational field, the photon resumes its original trajectory, maintaining its inherent energy (E) and continuing unaffected by further gravitational influences.

Conclusion: The observed symmetry, where photons gain energy as they approach an external gravitational well and lose energy as they recede, could provide critical insights into refining our understanding of spacetime and gravity. This phenomenon challenges the predictions of general relativity, suggesting that the theory may be incomplete or require revision. The symmetrical behaviour of photon energy and momentum around strong gravitational fields aligns with alternative models, such as quantum gravity and flat spacetime theories, which might offer a more comprehensive explanation for these interactions.

This discrepancy between observed photon behaviour and general relativity invites further exploration and refinement of our theoretical frameworks. By engaging with alternative perspectives, we can advance our understanding of the universe's underlying principles, contributing to a more complete and unified description of reality.

**Discussion:**

The study of photon interactions with gravitational fields offers profound opportunities to deepen our understanding of the fundamental principles governing light and gravity. By emphasizing momentum exchange and the curvature of external gravitational fields, this research challenges conventional interpretations rooted in general relativity and proposes an alternative perspective on gravitational lensing.

**Reinterpretation of Gravitational Lensing**

Traditional explanations of gravitational lensing have relied on spacetime curvature as described by general relativity, suggesting that massive objects bend light rays due to the warping of spacetime. Our findings highlight that interactions between photons and gravitational fields can be understood through momentum exchange, offering a nuanced understanding of this phenomenon.

The equations presented reveal that photon interactions with gravitational influences lead to shifts in energy and momentum, rather than being solely consequences of spatial curvature. This reinterpretation emphasizes the symmetrical nature of photon behaviour as they traverse gravitational environments, illustrating that while external forces affect their trajectory, the intrinsic properties of photons remain conserved.

**Energy and Momentum Conservation**

The conservation of energy in gravitational fields, articulated through the equation Eg = E, is central to our analysis. This principle asserts that despite interactions with external gravitational forces, the inherent energy of photons is preserved. Our reinterpretation of redshift and blueshift aligns with this framework, suggesting that observed changes in photon energy result from momentum exchange rather than changes in the intrinsic energy of the photon. This perspective provides a fresh lens for interpreting cosmological observations.

**Implications for Quantum Gravity**

The implications of this study extend to the quest for a unified theory that reconciles quantum mechanics with gravitational physics. By emphasizing momentum exchange in photon interactions, this research contributes to ongoing discussions in quantum gravity and the nature of spacetime at small scales.

Exploring these interactions reveals potential discrepancies between observed photon behaviour and predictions made by traditional gravitational theories. This study advocates integrating quantum gravity models, suggesting that understanding photon behaviour in strong external gravitational fields may require revising established notions about the interplay between light and gravity.

**Future Research Directions**

The findings open new avenues for future research in astrophysics and cosmology. Investigating the implications of photon momentum exchange in various gravitational environments—such as near black holes and during the universe's expansion—could yield valuable insights into the fundamental laws governing our universe. Additionally, experimental validation of the proposed momentum exchange mechanisms through observational data could provide further support for this framework.

Future studies could explore the implications for gravitational wave detection, cosmic inflation theories, and the behaviour of light in extreme astrophysical scenarios. By examining the intersections of quantum mechanics, gravity, and photon behaviour, researchers may uncover a more unified understanding of the forces shaping our universe.

In conclusion, this study challenges conventional interpretations of gravitational lensing by framing it within the context of momentum exchange and curvature in external gravitational fields. By emphasizing the conservation of photon energy and momentum, we provide a new perspective on light's interactions with gravitational influences, enriching the dialogue surrounding quantum mechanics and gravity. The ongoing pursuit of a unified theory remains an essential endeavour for the scientific community.

**Conclusion:**

The study offers a novel approach to understanding the interactions of photons within gravitational environments, diverging from conventional frameworks rooted in general relativity. By emphasizing the principles of momentum exchange and the energy conservation of photons as they traverse external gravitational fields, this research reinterprets phenomena such as redshift, blueshift, and gravitational lensing, shedding new light on their underlying mechanisms.

The findings underscore a crucial symmetry in photon behaviour: as photons approach an external gravitational well, they gain energy, while they lose energy as they recede. This behaviour invites a reconsideration of established theories, suggesting that general relativity may not fully account for the complexities involved in photon interactions with gravity. The preservation of a photon's inherent energy despite external influences challenges traditional interpretations, advocating for a deeper exploration of alternative models such as quantum gravity and flat spacetime theories.

Moreover, the implications of this study extend to the broader scientific discourse on the unification of quantum mechanics and gravitational physics. By integrating concepts of momentum exchange into our understanding of light's behaviour, we may unlock new insights into fundamental astrophysical phenomena and the nature of spacetime itself.

This research encourages future investigations into the behaviour of photons in various gravitational scenarios, particularly in extreme environments such as near black holes and during the universe's expansion. These avenues hold the potential to bridge gaps in current theories and contribute to the ongoing quest for a unified framework that reconciles the principles governing light and gravity.

In summary, by presenting an alternative perspective on photon interactions with external gravitational fields, this study aims to enrich the scientific dialogue surrounding these fundamental concepts, ultimately guiding us toward a more comprehensive understanding of the universe.

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