Exploring Symmetry in Photon Momentum Changes: Insights into Redshift and Blueshift Phenomena in Gravitational Fields

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Abstract

This abstract provides a comprehensive overview of the intricate relationship between photon momentum changes and gravitational fields, as discussed in the context of the paper titled "*Distinguishing Photon Interactions: Source Well vs. External Fields.*" The exploration delves into the fundamental symmetry observed in photon momentum changes, elucidating the principles of redshift and blueshift phenomena within gravitational fields. Through mathematical formulations and theoretical analyses, the abstract highlights how changes in photon momentum and wavelength are intricately linked, with the constant 'h' representing Planck's constant playing a crucial role. Furthermore, the abstract discusses the concept of symmetry in photon momentum changes, demonstrating how momentum exchanges in external gravitational fields ultimately lead to an equilibrium state. This enhanced understanding of photon interactions with gravitational fields contributes to the broader comprehension of astrophysical phenomena and energy conservation principles.

Keywords: Symmetry in Momentum, Energy Conservation, Photon Momentum Changes, External Gravitational Fields, Redshift and Blueshift Phenomena,

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Symmetry in Photon Momentum Changes:

The equation $\Delta\rho = -\Delta\rho$ is possible due to the relationship $\Delta\rho = h/\Delta\lambda = h/\text{-}\Delta\lambda$, indicating a fundamental symmetry between redshift and blueshift phenomena. These equations describe how changes in photon momentum ($\Delta\rho$) correspond to changes in wavelength ($\Delta\lambda$). The constant 'h' represents Planck's constant, suggesting that the magnitude of the momentum change is inversely proportional to the magnitude of the wavelength change. Furthermore, when a photon traverses an external gravitational well, it follows an arc path. As a result, momentum exchanges gradually increase as the photon enters the influence of the massive object, leading to blueshift. Similarly, momentum exchanges gradually decrease as the photon exits the influence of the massive object, resulting in redshift equivalent to blueshift occurrences.

Mathematical Formulations:

These equations can be expressed as follows:

Equation for Photon Energy:

- $E = hf = hc/\lambda$

This equation relates the energy E of a photon to its frequency f and wavelength λ, where h is Planck's constant and c is the speed of light. It demonstrates how changes in wavelength correspond to changes in energy while maintaining the total energy constant.

Equation for Energy Change due to Frequency Change:

- $\Delta E = h\Delta f$

This equation represents the change in energy ΔE of a photon due to a change in frequency Δf, where h is Planck's constant. It highlights how alterations in frequency lead to variations in energy.

Equation for Momentum Change due to Wavelength Change:

- $\Delta\rho = h/\Delta\lambda$

This equation represents the change in momentum Δρ of a photon due to a change in wavelength Δλ, where h is Planck's constant. It illustrates the inverse relationship between changes in wavelength and momentum.

By considering these equations together, we observe that changes in energy and momentum are intricately linked in photon interactions with gravitational fields. The mathematical formulations provided in the paper demonstrate how variations in wavelength and frequency lead to compensatory changes in energy and momentum, ensuring consistency with energy conservation principles.

Conclusion:

The effective momentum changes of a photon in an external gravitational field can be described as zero (=0), as outlined in the concept of symmetry in photon momentum changes. This symmetry, represented by $\Delta\rho = -\Delta\rho$, illustrates how changes in photon momentum due to gravitational effects are symmetrically balanced, resulting in an overall equilibrium. As photons traverse through external gravitational fields, such as the gravitational well of a massive object, they experience momentum exchanges that lead to phenomena like blueshift and redshift. These exchanges occur as the photon follows an arc path, with momentum gradually increasing upon entering the influence of the massive object and gradually decreasing upon exiting it. Consequently, the net effect of these momentum exchanges is zero, ensuring conservation of momentum in the interaction between photons and external gravitational fields.

Reference:

[1] (PDF) Understanding Photon Interactions: Source Gravitational Wells vs. External Fields. (2024) ResearchGate https://doi.org/10.13140/RG.2.2.14433.48487