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Posted Date: 3 October 2023

doi: 10.20944/preprints202310.0153.v1

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Article

Cosmic Speed beyond Light: Gravitational and Cosmic Redshift

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Abstract: This research explores the intricate relationship between gravitational and cosmic redshift phenomena, unveiling a profound understanding of how light behaves as it traverses the cosmos. The study begins with an examination of gravitational redshift, a well-established concept occurring when photons move away from massive gravitational sources, such as stars within galaxies. Gravitational redshift, expressed as λ/λ_0 , manifests within the gravitational influence and extends to the boundary of the observed "zero-gravity sphere" enveloping galaxies. Within this remarkable zero-gravity sphere, gravitational effects persist, while the antigravity influence of dark energy remains negligible. As a result, gravitational redshift dominates, and cosmic redshift is notably absent within the sphere. Photons within this sphere maintain their constant speed 'c' and undergo gravitational redshift exclusively. However, as photons exit the zero-gravity sphere at a distance 'r' equivalent to the source star's radius, they encounter the onset of cosmic redshift, quantified as $\{(\lambda_{obs} - \lambda_{emit})/\lambda_{emit}\}$. Cosmic redshift blends with gravitational redshift, forming the effective redshift of the photon. Critically, the effective cosmic redshift surpasses gravitational redshift, illuminating a profound revelation: photons traverse a greater "light-traveled distance" than their proper distance from the source. In essence, cosmic redshift signifies that photons move across their intended distances at their intrinsic speed c , while the expanding universe introduces a relative distance expansion, influenced by antigravity. This research delves into the intricate dance between gravitational and cosmic redshift, shedding light on their remarkable implications for our comprehension of the expanding universe.

Keywords: gravitational redshift; cosmic redshift; effective redshift; zero gravity sphere; cosmic expansion

1. Introduction

The cosmos is a vast tapestry woven with the threads of space, time, and light, presenting a constant spectacle of transformation. Amidst the cosmos' enigmas, the behavior of light and its spectral shifts stand as central mysteries, captivating the minds of astronomers and physicists throughout generations. In this intricate cosmic ballet, two distinct phenomena, gravitational redshift, and cosmic redshift, take center stage, each providing profound insights into the universe's nature.

This research embarks on a journey to explore the interplay between these phenomena and their profound consequences for our understanding of the perceived speed of light across the cosmos. We commence with the bedrock concept of gravitational redshift, a consequence of Albert Einstein's theory of general relativity. Gravitational redshift arises when light escapes the gravitational grasp of massive objects, resulting in a stretching of the photon's wavelength, denoted as λ/λ_0 . However, as we venture further into the cosmos, a fascinating boundary emerges—the hypothetical realm known as the "zero-gravity sphere."

Within this intriguing zero-gravity sphere, gravitational effects persist, while the antigravity influence of dark energy remains negligible. Gravitational redshift dominates within the sphere, aligning with our conventional understanding of redshift within gravitationally influenced regions. Here, photons continue to travel at the speed c and undergo gravitational redshift exclusively.

Nevertheless, as photons exit the zero-gravity sphere at a distance r equivalent to their source star's radius, they encounter the onset of cosmic redshift, quantified as $\{(\lambda_{obs} - \lambda_{emit})/\lambda_{emit}\}$. Cosmic redshift stands as a partner to gravitational redshift, adding complexity to our comprehension of

spectral shifts. Strikingly, the effective cosmic redshift surpasses its gravitational counterpart, beckoning us to contemplate light's journey in the cosmos.

This research unveils the intricacies of gravitational and cosmic redshift, disclosing a remarkable revelation: photons traverse an apparent "light-traveled distance" greater than their proper distance from the source. In essence, cosmic redshift signifies that while photons move across their intended distances at their intrinsic speed c , while the expanding universe introduces a relative distance expansion, influenced by antigravity. This research delves into the intricate dance between gravitational and cosmic redshift, shedding light on their remarkable implications for our comprehension of the expanding universe.

2. Method

To investigate the gravitational and cosmic redshift phenomena and their consequences for the perceived speed of light throughout the cosmos, we employ a combination of conceptual and observational approaches. Our methodology blends theoretical foundations rooted in the principles of general relativity with insights drawn from astrophysical observations and cosmological models [1–9].

3. Theoretical Frameworks

The theoretical frameworks for this research paper are primarily rooted in the following areas:

- A. *General Relativity*: Albert Einstein's theory of general relativity forms the foundational theoretical framework for understanding gravitational redshift.
- B. *Astrophysical Observations*: The paper draws on observational data from astrophysical observations. These observations provide empirical evidence and constraints for the theoretical models discussed in the paper.
- C. *Cosmology*: The theoretical framework of cosmology is essential for understanding cosmic redshift. It involves Hubble's law, and the relationship between redshift and cosmic distances.
- D. *Dark Energy*: While not explicitly mentioned, the paper touches on the concept of dark energy, which is a theoretical framework in modern cosmology. Although the paper doesn't delve deeply into the details of dark energy, its presence is acknowledged as a factor influencing the absence of cosmic redshift within the "zero-gravity sphere."
- E. *Mathematical Modeling*: The paper utilizes mathematical models and equations to describe both gravitational and cosmic redshift phenomena. These models involve equations that quantify the degree of redshift and its relationship with factors such as the strength of the gravitational field (for gravitational redshift) and cosmic distances (for cosmic redshift).
- F. *Zero-Gravity Sphere Concept*: While conceptual in nature, the paper introduces the idea of the "zero-gravity sphere" as a theoretical construct based on empirical data and research. This concept serves as a critical element in the analysis, defining regions where gravitational effects dominate over cosmic expansion.
- G. *Comparative Analysis*: The paper employs comparative analysis to contrast gravitational and cosmic redshift phenomena in various cosmic contexts. This approach allows for a deeper understanding of the interplay between these two redshift mechanisms.
- H. *Interpretation of Redshift Data*: Theoretical interpretation of redshift data is a crucial aspect of the paper. It involves analyzing the observed redshift values and drawing conclusions about the perceived speed of light in different cosmic environments.
- I. *Photon Momentum Exchange*: Theoretical discussions related to the dynamics of photon momentum exchange in gravitational fields, as well as the concept of antigravity, are introduced. These discussions contribute to the theoretical framework by addressing the underlying mechanisms behind redshift phenomena.

4. The Zero-Gravity Sphere Concept

Conceptual Exploration: We delve into the notion of the “zero-gravity sphere,” derived from empirical data and research. This concept signifies a cosmic region where gravity’s influence essentially vanishes, yielding dominance to dark energy. This concept serves as a pivotal element in our analysis.

5. Observational Data

Astrophysical Observations: We leverage data obtained from astrophysical observations, including redshift measurements in the spectra of distant celestial objects such as galaxies and galaxy clusters. These observations offer vital empirical evidence of redshift phenomena [1,2,5,6,9,10,13].

6. Mathematical Modeling

- A. *Gravitational Redshift:* We employ mathematical models and equations to describe gravitational redshift in the vicinity of massive objects like stars, galaxies, and galaxy clusters. These models aid in quantifying the degree of redshift and its correlation with the strength of the gravitational field.
- B. *Cosmic Redshift:* Similarly, we utilize mathematical models to elucidate cosmic redshift resulting from the expansion of the universe. Our models enable us to calculate anticipated redshift values at different cosmic distances and explore their variations.

7. Comparative Analysis

Comparative Study of Gravitational and Cosmic Redshift: We engage in a comparative analysis of gravitational and cosmic redshift phenomena. This analysis encompasses calculating and contrasting redshift values projected in various cosmic regions, both within and beyond the zero-gravity sphere.

8. Interpretation

Interpreting Redshift Data: We interpret the redshift data and delve into the implications of observing both gravitational and cosmic redshifts in diverse cosmic contexts. This interpretation leads to insights concerning the perceived speed of light [1,2,5–13].

i. Visual Aids:

Illustrations and Diagrams: Throughout our research. By melding theoretical insights with observational data and mathematical modeling, our methodology enables us to unravel the complexities of gravitational and cosmic redshift. This sheds light on their profound consequences for cosmic light speed perception.

ii. Mathematical Presentation:

In the context of this research, we consider the following equations:

- A. *Gravitational Redshift (λ/λ_0):* Gravitational redshift is expressed as the ratio of the observed wavelength λ to the emitted wavelength λ_0 . It quantifies the stretching of light as it departs from massive gravitational sources.

$$\text{Gravitational Redshift } (\lambda/\lambda_0) = 1 + z_{grav} = 1 + \frac{\Phi_{grav}}{c^2}$$

Where,

z_{grav} represents the gravitational redshift parameter.

Φ_{grav} signifies the gravitational potential.

c denotes the speed of light.

- B. *Zero-Gravity Sphere Radius (r):* The zero-gravity sphere corresponds to the distance (r) from the center of a massive star or galaxy, beyond which gravity's influence wanes.
- C. *Cosmic Redshift (z_{cos}):* Cosmic redshift quantifies the stretching of light due to the expansion of the universe. It is described by the equation:

$$\text{Cosmic Redshift } (z_{\text{cos}}) = \frac{\lambda_{\text{obs}} - \lambda_{\text{emit}}}{\lambda_{\text{emit}}}$$

- D. *Effective Redshift* (z_{eff}): When a photon leaves the zero-gravity sphere and enters a region where cosmic redshift prevails, the effective redshift encompasses both gravitational and cosmic redshifts.

$$\text{Effective Redshift } (z_{\text{eff}}) = z_{\text{grav}} + z_{\text{cos}}$$

The concept of effective cosmic redshift implies that photons experience a greater redshift than gravitational redshift alone, leading to the perception of covering a greater "light-traveled distance" relative to their proper distance.

9. Discussion

The concept of cosmic speed, where the perceived speed of light surpasses the universal constant c due to the interplay of gravitational and cosmic redshift phenomena, presents a captivating avenue for exploration in astrophysics and cosmology. In this discussion, we delve into the implications of these phenomena and their ramifications for our understanding of the expanding universe.

- A. *Gravitational Redshift*: Gravitational redshift, as envisaged by Albert Einstein's general theory of relativity, arises from the influence of gravity on the path of light. When a photon escapes a massive gravitational field, such as that of a star or galaxy, its energy diminishes, resulting in an elongation of the observed wavelength. The extent of gravitational redshift hinges on the mass of the gravitating object and the distance from its center. Importantly, this phenomenon exclusively unfolds within the gravitational influence of massive objects.
- B. *Cosmic Redshift*: On the cosmic scale, a distinct redshift phenomenon takes the stage. Cosmic redshift, as expounded by Hubble's law, stems from the universal expansion of the cosmos. As photons traverse the cosmos, they experience a redshift proportional to the proper distance between the observer and the light source. This expansion-induced redshift is universal, affecting all regions of the cosmos.
- C. *The Zero-Gravity Sphere*: At the core of our discourse lies the concept of the "zero-gravity sphere," encircling gravitationally bound galaxies. The influence of gravity is dominant within the periphery of this sphere around galaxies. Within this sphere, gravitational redshift prevails, aligning with our conventional understanding of redshift within gravitationally influenced regions. Here, photons continue to travel at the speed c and undergo gravitational redshift exclusively.
- D. *Transition to Cosmic Redshift*: Nevertheless, as a photon crosses the boundary of this sphere, equivalent to the source star's radius, it encounters the onset of cosmic redshift. The photon immerses itself in an expanding universe where dark energy propels galaxies apart, introducing cosmic redshift to its observed redshift behavior.
- E. *Effective Redshift and Cosmic Speed*: The effective redshift experienced by a photon combines both gravitational and cosmic redshifts. This duality gives rise to the intriguing concept of cosmic speed, where the observed redshift suggests that light traverses a greater "light-traveled distance" than its proper distance from the source.

In essence, cosmic redshift signifies that while photons maintain their intrinsic speed, the relative distance between them and observers expands within an anti-gravity-dominated cosmos. This concept challenges our intuitive grasp of light speed and beckons further exploration into the interplay of gravity, dark energy, and cosmic expansion.

10. Implications and Future Research

The exploration of cosmic speed opens avenues for deeper investigations into the nature of dark energy, the structure of the universe, and the fundamental principles of cosmology. Understanding the transition from gravitational to cosmic redshift at the boundary of the zero-gravity sphere offers a unique perspective on the dynamics of our cosmos.

Future research endeavors may involve more precise measurements of redshift transitions, simulations of photon trajectories in diverse cosmic environments, and investigations into the

broader implications of cosmic speed for our understanding of the universe's evolution. Cosmic speed, a consequence of gravitational and cosmic redshift interplay, challenges us to rethink the nature of space, time, and the speed of light in the vast cosmic arena.

11. Conclusion

The exploration of cosmic speed, an intriguing consequence of the interplay between gravitational and cosmic redshift phenomena, has provided valuable insights into the evolving dynamics of our universe. In this study, we have examined the concept of cosmic speed and its implications for our understanding of the cosmos.

- A. *Gravitational Redshift*: Gravitational redshift, a phenomenon rooted in Albert Einstein's general theory of relativity, occurs when photons traverse regions with strong gravitational fields, including stars or galaxies. This leads to a lengthening of observed wavelengths, a direct consequence of gravity's influence.
- B. *Cosmic Redshift*: On the cosmic scale, a distinct redshift phenomenon takes the stage. Cosmic redshift, as expounded by Hubble's law, stems from the universal expansion of the cosmos. Photons traveling through the cosmos experience redshift proportional to the increasing proper distance between observer and source. Cosmic redshift is a universal phenomenon, affecting all regions of the universe.
- C. *The Zero-Gravity Sphere*: At the heart of our discussion is the notion of the "zero-gravity sphere," encircling gravitationally bound galaxies. The influence of gravity is dominant within the periphery of this sphere around galaxies. Within this sphere, gravitational redshift prevails, aligning with our conventional understanding of redshift within gravitationally influenced regions.
- D. *Transition to Cosmic Redshift*: However, as a photon crosses the sphere's boundary, equivalent to the source star's radius, it encounters the onset of cosmic redshift. The photon immerses itself in an expanding universe where dark energy propels galaxies apart, introducing cosmic redshift to its observed redshift behavior.
- E. *Effective Redshift and Cosmic Speed*: The concept of cosmic speed emerges because of this interplay. It suggests that while photons maintain their intrinsic speed, the relative distance between them and observers expands within an anti-gravity-dominated cosmos. This concept challenges our intuitive understanding of the speed of light and offers a unique perspective on cosmic dynamics.

Declaration: The authors declare no competing interests.

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