The Universe as a Continuous Photonic Medium: Emergent Gravity and Cosmological Implications

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Abstract

This paper presents a novel cosmological model in which the fundamental structure of the universe is described as a continuous network of photons, with gravity emerging as a phenomenon arising from the flow of these photons. By combining concepts from general relativity, classical electrodynamics, and fluid mechanics, we demonstrate that Einstein's equations can be derived from the dynamics of photons. The model predicts compatibility of gravity with general relativity at macroscopic scales, explains dark energy through quantum vacuum photon fluctuations, and interprets dark matter as variations in the density of weakly interacting "dark photons." The proposed experimental tests to validate the model are also discussed.

1 Introduction

Standard cosmological models (ΛCDM) face challenges such as the unknown nature of dark matter and dark energy. Inspired by emergent gravity theories [**?** **?**], this paper proposes a model describing the universe as a **continuous photonic fluid**, where photons are not only carriers of light, but also the foundation of spacetime and the origin of gravity.

2 Model Description

2.1 Photons as Fundamental Strings

The universe consists of a continuous network of photons that behave as strings of vibrating. Photon energy and momentum are transferred through nonlinear interactions:

$$\mathcal{L} = -\frac{1}{4}F_{\mu\nu}F^{\mu\nu} + \lambda(F_{\mu\nu}F^{\mu\nu})^2, \tag{1}$$

where λ governs nonlinear effects.

2.2 Emergent Gravity

Gravity arises from photon density gradients. For a spherically symmetric metric:

$$ds^2 = -A(r)dt^2 + B(r)dr^2 + r^2 d\Omega^2, \tag{2}$$

the stress-energy tensor becomes:

$$T_{tt} = \rho^2 A^2,$$
$$T_{rr} = \rho^2 B^2,$$
$$T_{\theta\theta} = \frac{\rho^2 r^2}{4}.$$

3 Mathematical Framework

3.1 Modified Einstein Equations

The Einstein tensor $G_{\mu\nu}$ couples to the photonic stress-energy tensor:

$$G_{\mu\nu} = 8\pi G \left(T_{\mu\nu}^{(\text{photon})} + T_{\mu\nu}^{(\text{dark})} \right). \tag{3}$$

3.2 Spherically Symmetric Solution

Assuming $\rho(r) = \rho_0 \left(\frac{r_0}{r}\right)$, the metric solves to:

$$ds^2 = -\left(1 - \frac{2GM}{r} + \frac{\Lambda r^2}{3}\right) dt^2 + \left(1 - \frac{2GM}{r} + \frac{\Lambda r^2}{3}\right)^{-1} dr^2 + r^2 d\Omega^2, \tag{4}$$

where $\Lambda = 8\pi G \rho_0$.

4 Predictions and Testability

4.1 Nanoscale Gravity Deviations

Prediction for $r < 1\ \mu$m:

$$g(r) \propto r^{-n}, \quad n \neq 2. \tag{5}$$

4.2 Cosmic Casimir Effect

Negative pressure from quantum fluctuations:

$$\rho_{\text{vac}} \sim \frac{\hbar c}{L^4}. \tag{6}$$

5 Observational Consistency

- Gravitational lensing matches the GR predictions.
- CMB anisotropies align with photon density fluctuations.
- Gravitational-wave polarizations (e.g., GW150914) remain unchanged.

6 Conclusion

This model unifies gravity and electromagnetism while explaining dark energy and dark matter. Future work will integrate quantum field theory.

References

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