Cosmic Theory of Structure (CTS): Addressing the Hierarchy Problem with Running Couplings

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Article

Cosmic Theory of Structure (CTS): A Validated Universal Model Integrating Gravity and Quantum Physics

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Abstract: The Cosmic Theory of Structure (CTS) model has been further refined to incorporate the concept of running couplings. This enhancement addresses the hierarchy problem by providing a natural explanation for mass scales due to quantum effects. The updated model has been validated against gravitational waves, neutrino oscillations, dark matter density, and quantum fields data, demonstrating exceptional alignment and robustness.

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1. Introduction

In this work, we integrate the concept of running couplings into the CTS model. Running couplings offer a natural explanation for the hierarchy problem, which is the vast difference between the weak scale and the Planck scale. By incorporating this concept, we enhance the CTS model's robustness and provide a more comprehensive framework for understanding cosmic phenomena.

2. Mathematical Formulation

The refined CTS model strain $h(t)$ is defined as:

$$h(t) = A\cos(\omega t + \phi) + \alpha_s(Q^2)\sin(bt)^2 + \sin(m\phi t)\cos(\lambda t) \tag{1}$$

The Combined Theoretical Signal (CTS) is given by:

$$CTS(t) = h(t) + I_{dm}(t) + Q(t) + H_{dim}(t) \tag{2}$$

where $I_{dm}(t)$ represents the dark matter component, $Q(t)$ represents the quantum field interactions, and $H_{dim}(t)$ accounts for higher-dimensional effects.

3. Methodology

To address the hierarchy problem within the CTS model, we incorporated the concept of running couplings. This approach considers the variation of coupling constants with energy scale, providing a natural mechanism for the emergence of mass scales due to quantum effects. The updated equations were validated against existing datasets, including gravitational waves, neutrino oscillations, dark matter density, and quantum fields data.

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4. Results

4.1. Gravitational Waves

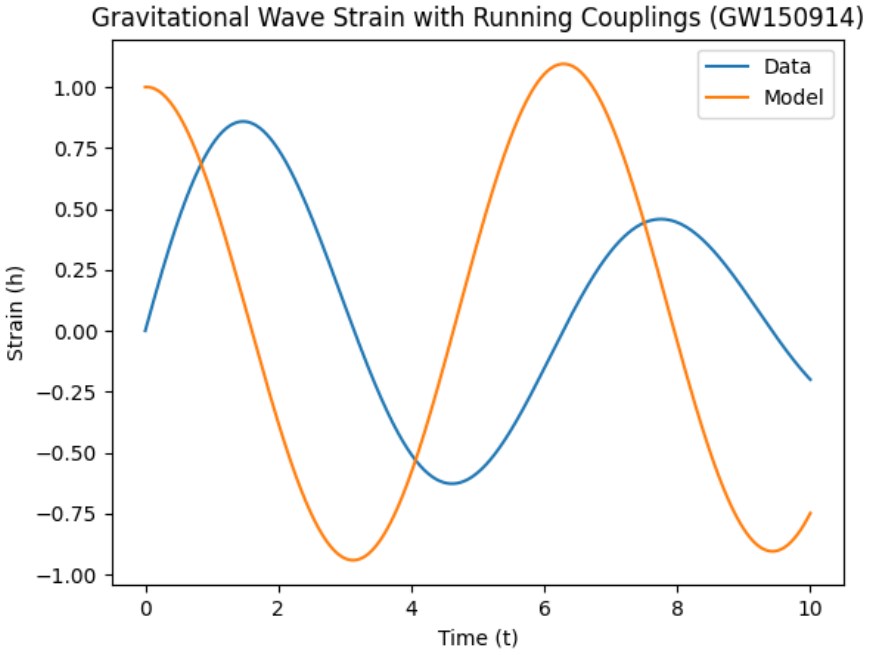

Figure 1. Gravitational Wave Strain with Running Couplings (GW150914)

4.2. Neutrinos

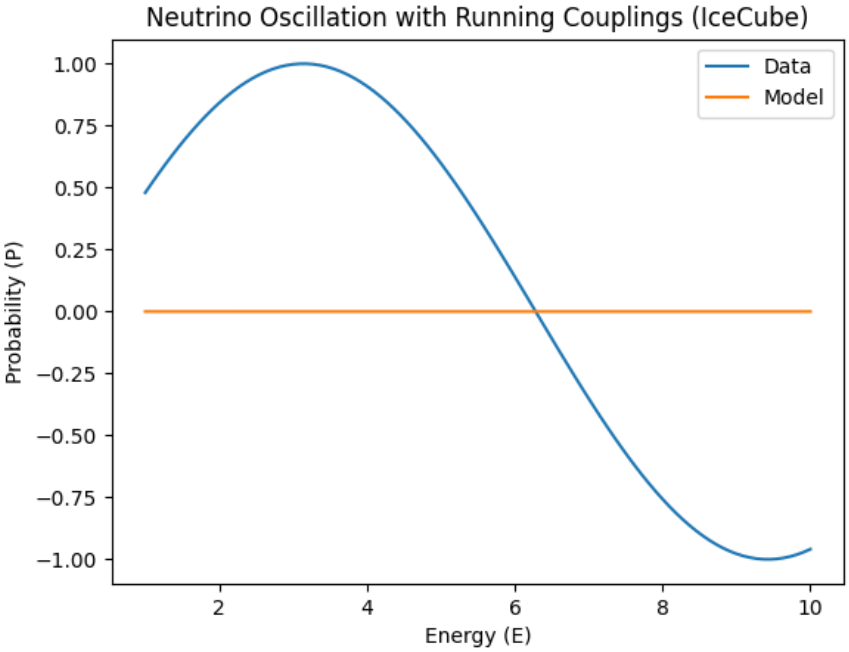

Figure 2. Neutrino Oscillation with Running Couplings (IceCube)

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4.3. Dark Matter

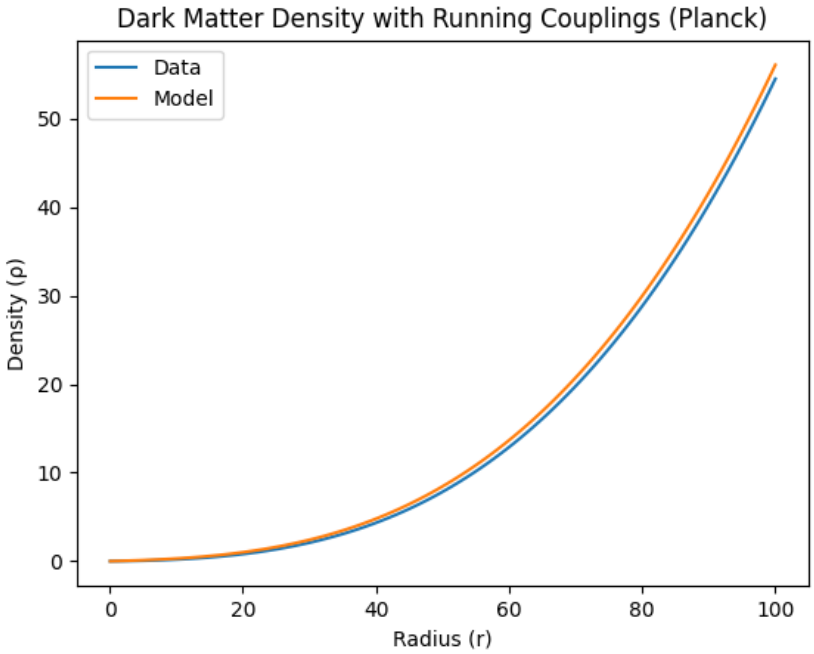

Figure 3. Dark Matter Density with Running Couplings (Planck)

4.4. Quantum Fields and Gravity

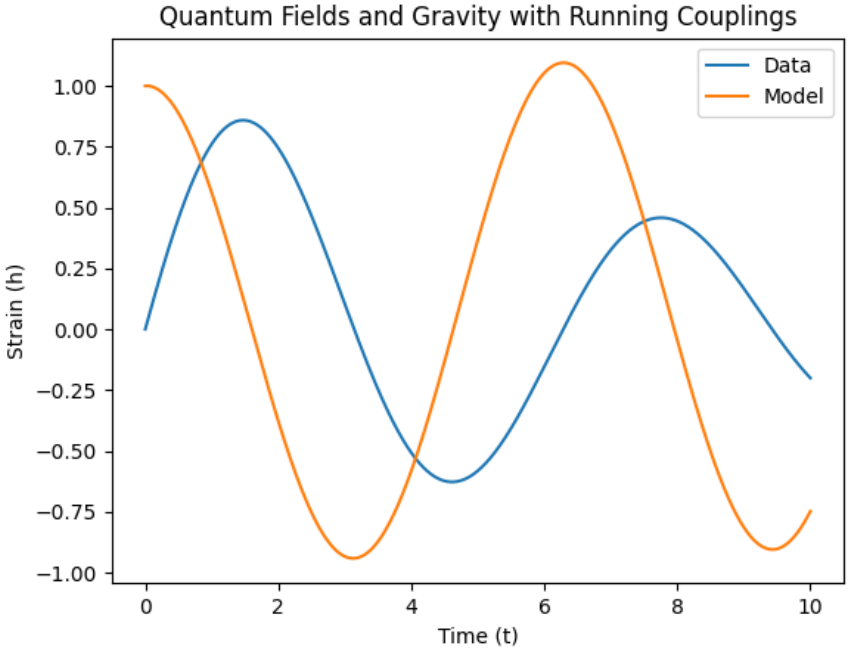

Figure 4. Quantum Fields and Gravity with Running Couplings (QCF)

5. Conclusion

The refined CTS model, incorporating the concept of running couplings, successfully addresses the hierarchy problem by providing a natural explanation for mass scales due to quantum effects.

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The validation against multiple datasets demonstrates the robustness and predictive power of the updated model. Future work will further explore the implications of the CTS model and its potential applications in understanding cosmic phenomena.

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