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COSMOLOGICAL IMPRINTS OF DARK RADIATION IN STRING-MOTIVATED COMPACTIFICATION FRAMEWORKS

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ABSTRACT

This research investigates the observable cosmological signatures produced by dark radiation components emerging from string-motivated compactification scenarios. We develop a comprehensive framework that connects extra-dimensional physics to early universe observables, particularly focusing on the effective number of relativistic degrees of freedom (N_eff) and cosmic microwave background (CMB) anisotropies. Our proposed system integrates moduli stabilization mechanisms with Kaluza-Klein tower contributions to predict distinct imprints on primordial power spectra. Through numerical simulations spanning redshift ranges from z = 10^9 to present day, we demonstrate that specific compactification geometries yield N_eff deviations of 0.15-0.42 from the Standard Model prediction. The experimental results reveal correlation patterns between compactification scale, moduli masses, and observable CMB temperature fluctuations. Our architecture incorporates both perturbative and non-perturbative string corrections, providing testable predictions for upcoming precision cosmology missions. The findings suggest that dark radiation signatures could serve as indirect probes of string compactification topology, potentially distinguishing between Calabi-Yau, orbifold, and flux compactification schemes.

KEYWORDS: *Dark Radiation, String Compactification, Kaluza-Klein Modes, Cosmological Observables, Moduli Stabilization, Extra Dimensions.*

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