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PROBING DARK RADIATION VIA EARLY-UNIVERSE SIGNATURES IN STRING-INSPIRED COMPACTIFIED SCENARIOS

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ABSTRACT

This research investigates the observable signatures of dark radiation emerging from string-inspired compactified dimensions during the early universe. We develop a comprehensive theoretical framework that connects extra-dimensional physics with cosmological observables, specifically focusing on the effective number of relativistic species (N_eff) and primordial power spectrum modifications. Our proposed architecture integrates Kaluza-Klein tower contributions with thermal history computations to predict testable signatures in cosmic microwave background (CMB) data and big bang nucleosynthesis (BBN) constraints. Through numerical simulations spanning compactification scales from 10^15 to 10^18 GeV, we demonstrate that string-inspired dark radiation can produce distinctive angular power spectrum features and modify the primordial helium abundance by 0.2-0.8%. Our results indicate that upcoming CMB-S4 observations could potentially distinguish between standard cosmology and string-motivated scenarios with compactification scales near the GUT threshold. The experimental analysis reveals strong correlations between moduli stabilization mechanisms and observable dark radiation contributions, providing a novel probe of string phenomenology through precision cosmology.

***KEYWORDS**: Dark Radiation, String Theory, Compactification, Early Universe, CMB Signatures, Extra dimensions.*

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