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Contributory: Non-Trivial Cosmology from Fractal Spacetime, Memory Effects, and Modified Gravity

Tuesday, 17 November 2026 16:30 (15 minutes)

The success of the Λ CDM model and General Relativity has established the standard paradigm of modern cosmology, yet the fundamental nature of spacetime remains an open question. This talk explores three complementary directions for extending the geometric foundations of modern cosmology. I first consider inflation in a fractal spacetime, where non-integer spatial dimensions modify the inflationary dynamics and the Mukhanov–Sasaki equation through an effective momentum k_{eff} , leading to corrections in the scalar power spectrum and spectral index n_s . Confronting the Starobinsky model with Planck 2018 observations constrains the effective dimension to the range $D \approx [2.7, 3]$, while fractal corrections render Natural Inflation phenomenologically viable with sub-Planckian axion decay constants. I then extend the semiclassical Wheeler–DeWitt framework by incorporating a causal non-Markovian memory, leading to an effective non-integer temporal dimension that introduces an additional contribution to the primordial power spectrum with a $k^{3/4}$ scaling, enhancing high- ℓ CMB temperature anisotropies and producing scale-dependent modifications of primordial non-Gaussianity. Finally, I present a De Donder–Weyl formulation of Einstein–Cartan cosmology, where torsion generalizes the underlying spacetime geometry, yielding torsion-modified Friedmann equations and demonstrating the limitations of conventional power-law cosmological solutions. Together, these studies investigate the cosmological consequences of extending spacetime through non-integer spatial and temporal dimensions and torsion, providing new perspectives on physics beyond the standard cosmological paradigm.

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