Report

Potential Evidence for Dark Matter as Dimensional Condensate

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Abstract

This brief note calls attention to tentative new evidence supporting the hypothesis that Dark Matter represents a large-scale dimensional condensate.

Keywords: Dark Matter, dimensional condensate, Cantor dust, far-from-equilibrium phenomena, Multifractal, cosmic web, early Universe cosmology.

Recent astrophysical observations present a series of challenges to the standard model of cosmology (the Lambda-CDM model). It is known that, although General Relativity focuses on the local geometry of spacetime manifolds, it does not constrain the large-scale topology of the Universe [1]. There are compelling indications today that the dynamics of the early Universe may produce a **non-trivial (multiply connected) topology**, substantially deviating from the predictions of standard cosmology [see e.g., 2 - 4].

A while ago, we conjectured that non-trivial topology of the Universe may be rooted in the continuous spacetime dimensionality above the Fermi scale [5 – 7]. The crux of this conjecture is the emergence of **Cantor Dust**, a relic large-scale structure created by the condensation of **continuous spacetime dimensions** in the deep ultraviolet sector (UV) of field theory. There are several key points regarding this conjecture, namely,

1) The formation of Cantor Dust follows from the nonintegrability of UV dynamics and the onset of **fractal spacetime**. Cantor Dust reproduces the behavior of hypothetical ultralight axions and Fuzzy Dark Matter models [8 – 10].

2) The formation of Cantor Dust is organically tied to the **Dimensional Reduction** conjecture. According to this conjecture, spacetime dimensionality runs continuously with the observation scale at large energies. The expectation is that the primordial Universe becomes two or one dimensional near the Big Bang singularity.

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3) Observations indicate that the dynamics of primordial Universe is consistent with **complex evolution far from thermodynamic equilibrium**. As such, adequate modeling of this regime requires the tools of **fractional differential and integral operators**.

Besides the multifractal geometry of the cosmic web [11 - 12], there are *at least* two recent cosmological observations suggesting the onset of Cantor Dust and Dimensional Reduction above the current particle physics scale:

1) **The S_8 tension**: the distribution of galaxies and matter in the late Universe is smoother than expected from the evolution of fluctuations in the Cosmic Microwave Background [13 - 14]. It is conceivable that the "diluted" galactic distribution at late Universe times ties in with the progressive unfolding of additional spacetime dimensions.

2) **Drop in fractal dimensionality at large redshifts**: there is a significant decrease in the fractal dimension of galaxy distributions for redshift values larger than unity [15]. It is conceivable that the reduction in fractal dimensionality at large redshifts ties in with the surge in dimensional condensation and the sustained genesis of Cantor Dust near the Big Bang singularity.

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