Localized Matter Genesis in an Infinite Pre-Existing Space

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Abstract

I propose a cosmological model in which space is infinite and pre-existing, independent of the emergence of matter and energy. In this framework, the Big Bang represents a localized event within infinite space, marking the beginning of matter-energy fields at a finite time ($t = 0$), while space itself remains timeless and boundless. Prior to $t = 0$, the matter-energy tensor $T\mu\nu$ is zero, indicating the absence of matter and energy throughout infinite space. Post $t = 0$, matter density emerges locally, consistent with general relativity, leading to the curvature and evolution of spacetime. This model decouples the existence of space from the existence of matter and may provide a foundation for reinterpreting cosmological inflation and vacuum genesis phenomena.

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1. Introduction

The standard Big Bang model describes the early universe as originating from a hot, dense singularity where space, time, and matter-energy simultaneously emerged. In this alternative framework, I propose that infinite space pre-existed the Big Bang event, with the Big Bang signifying not the creation of space itself, but the localized genesis of matter and energy. This view separates the existence of space from the emergence of material content, aligning with intuitive notions of infinity and resolving conceptual difficulties associated with "something from nothing" interpretations.

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2. Mathematical Formulation

We model the pre-existing space as an infinite, flat three-dimensional manifold:

$$\lim (r \to \infty) V(r) = \infty$$

where $V(r)$ is the volume enclosed within radius r.

Prior to $t = 0$, the matter-energy tensor is:

$T\mu\nu(x, y, z, t) = 0$ for $t < 0$

At $t = 0$, matter and energy locally emerge according to:

$T\mu\nu(x, y, z, t) = f(x, y, z, t)$ for $t \geq 0$

The full evolution of spacetime curvature is then governed by the Einstein field equations:

$G\mu\nu(x, y, z, t) = 8\pi G \times T\mu\nu(x, y, z, t)$

where:

- $\lim (r \to \infty) V(r) = \infty$
- $T\mu\nu(x, y, z, t) = 0$ for $t < 0$
- $T\mu\nu(x, y, z, t) = f(x, y, z, t)$ for $t \geq 0$

Thus, matter and energy are introduced at a single moment in an infinite pre-existing space, and spacetime dynamically curves and evolves thereafter.

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3. Discussion

This model suggests that the Big Bang corresponds to a localized event rather than the origin of all existence. It offers a natural reconciliation between the infinite extent of space and the finite temporal origin of matter. It further opens the possibility of viewing cosmic inflation, vacuum fluctuations, or false vacuum decay as mechanisms for localized matter genesis within a broader infinite structure.

Future development of this model would require specifying the form of $f(x,y,z,t)$ and exploring its compatibility with quantum field theories in curved spacetime. Investigating whether vacuum instabilities or quantum fluctuations could trigger such a local matter emergence represents a promising direction for further research.

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4. Bridging General Relativity and Quantum Field Theory

The framework proposed in this model offers a natural bridge between General Relativity (GR) and Quantum Field Theory (QFT), two foundational pillars of modern physics that are traditionally difficult to reconcile.

In General Relativity, spacetime is dynamic — its curvature responds to the presence of matter and energy through Einstein’s field equations. In contrast, Quantum Field Theory assumes a fixed, static spacetime background where quantum fields operate and fluctuate. This mismatch

between dynamic and static spacetime treatments presents a major conceptual hurdle in unifying these theories, especially in extreme conditions like the early universe.

In the Localized Matter Genesis model, infinite space exists independently of matter-energy fields. Prior to $t = 0$, the energy-momentum tensor $T\mu\nu$ is zero, and spacetime is flat, satisfying General Relativity in the absence of sources. Simultaneously, this infinite, unchanging spacetime background naturally accommodates the assumptions of Quantum Field Theory, allowing quantum fluctuations without requiring initial curvature.

Thus, the emergence of matter and energy at $t = 0$ can be seen as a local quantum event within an infinite pre-existing spacetime, triggering the dynamical curvature described by General Relativity without violating the assumptions of either framework. This approach offers a clean conceptual bridge between quantum field dynamics and gravitational curvature at the universe's origin, without requiring a singularity or the simultaneous creation of spacetime itself.

References

[1] A. Einstein, "The Foundation of the General Theory of Relativity," Annalen der Physik, 49(7), 1916.