Cosmos as an Echo of Rebound:
A Fractal Model of Nested Universes with Interference Dark Matter

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Abstract

A cosmological model is proposed in which our Universe represents an intermediate layer of an infinite fractal hierarchy of spacetime phases born inside the black holes of previous phases at the moment of rebound. The phases are topologically isolated yet exchange information through interference nodes that form the observed dark matter. Dark matter in this framework has at least two components: the echo of past phases and inflow from the parent universe. The model is grounded in known physical principles and recent theoretical results concerning gravitational helicity as a topological invariant. It predicts: a small positive spatial curvature of the Universe, primordial non-Gaussianity in the CMB, relic objects formed before the rebound, and possible large-scale deviations from standard FLRW cosmology. Observational consequences are discussed, including an interpretation of the LHCb anomaly and inhomogeneities revealed by DESI surveys.

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0. Preamble

This work presents a "cold" cosmology of fractal rebounds — a hierarchy of isolated universes born inside black holes. The model is speculative but internally consistent; it draws on actual observational data and formulates testable predictions. Its value lies not in providing a final truth, but in its capacity to connect disparate areas of experience.

In 2026, new theoretical, experimental and computational results emerged that unexpectedly align with the cosmological part of the model, lending physical concreteness to its assumptions, pointing to possible observational manifestations, and even offering a mathematical apparatus for verification (see Sections 1.7–1.9).

Part 1. Cosmological Foundation: Mechanics of Fractal Rebounds

1.1. Basic Hierarchy: Two Directions of Nesting

Reality resembles an infinite matryoshka of spacetime phases (universes). Each phase is born inside a black hole of the preceding phase at the moment of rebound — an analogue of the Big Bang. Two directions arise in the hierarchy:

· Inward (downward): the movement from our phase toward phases born inside black holes of our Universe. Each step reduces the scale and, presumably, the topological complexity. At

the bottom of the hierarchy lies quantum foam, where stable spacetime and black holes cannot yet exist.
· Outward (upward): the movement from our phase toward the parent universe containing the mother black hole that gave birth to our phase. There, scales are larger and complexity is higher. And so on ad infinitum.

Our Universe is one of the intermediate layers of this fractal ladder.

1.2. What Happens Inside a Mother Black Hole?

Consider a specific black hole in a parent universe. Inside its event horizon the following occurs:

· The core accumulates matter and informationally stores the memory of previous rebounds.
· When density and/or information reach a critical threshold, a rebound occurs — a new phase (a new universe) is born.
· The same mother black hole can give rise to multiple phases — through repeated rebounds, each time with a different calibration of physical constants and with a different "memory" (via holographic anchors).
· These phases are topologically isolated from one another and from the parent universe (except for the gravitational influence of the hole's total mass). Neither matter nor radiation crosses the horizon.
· Additional isolation: each phase is also isolated from what happens beyond the event horizons of its own internal black holes. For an observer inside the phase, those regions are eternal silence — another degree of disconnectedness.
· Inside each newborn phase, in turn, its own black holes can arise — and the process repeats on a new scale.

Thus, within the horizon of a single mother black hole there can exist an entire "bush" of phases — different universes, each with its own metric, set of constants, and internal time. They do not interact directly with each other.

1.3. Dependence on the Mass and Characteristics of the Hole

Which topologies and types of phases a hole can give birth to depends on its characteristics: mass, angular momentum, electric charge, and the "memory" inherited from previous rebounds.

· More massive holes can spawn phases with a greater variety of possible global geometries (the moduli space becomes richer).
· Holes with different parameters yield different "varieties" of daughter universes — just as from the same Planck-scale building blocks one can assemble different global forms depending on the combinatorics of connections.

This fact links the observed properties of black holes (mass, spin) with the types of universes they can spawn. And, perhaps, this is how a natural selection of universes emerges: holes that give birth to phases with greater diversity and long-lived structures themselves remain active longer.

1.4. Continuum of Possible Life Scenarios for a Mother Black Hole

Instead of a rigid division into two regimes, the model posits a continuum of scenarios determined by the balance between the influx of matter from outside and the recycling of matter from its own daughter phases. We single out two extreme poles, with intermediate states possible between them:

· Exhaustion pole: the influx from the parent universe dries up, and the recycling from daughter phases is too weak to compensate for the losses. The hole gradually loses mass via Hawking radiation, ceases to give birth to new phases, and eventually evaporates. This is a "dead end" — the fate of most black holes in the heat death of the universe.
· Resonant (self-sustaining) pole: sufficiently many young phases are born inside the hole. After their heat death, the spent matter and holographic memory partially return to the core, providing material for new rebounds. An autocatalytic cycle arises — the hole can spawn phases indefinitely, like a chemical reaction with positive feedback.

Such a self-sustaining regime renders the hole stable even under the heat death of the parent universe. When the external influx of matter finally ceases, the hole does not die — it shifts to complete internal self-sufficiency. The spent daughter phases and old layers that have lost structural coherence continue to drift toward the core, supplying mass and topological information for new rebounds. The hole becomes an isolated island of life, an eternal generator of universes in a dead cosmos — as long as Hawking radiation and recycling remain in balance.

In this sense, a mother black hole ready to enter the self-sustaining regime is not a monster devouring everything indiscriminately, but a loving mother. She protects her offspring from the outside world, not interfering in their fate. Her mass is her fecundity, and the accumulation of critical density is a harbinger of new birth. She loves waywardly: gives life, protects, and lets go. This does not cancel the fact that there are also bad mothers in the universe — just as there are exhausting holes that are destined to give birth to nothing.

Between these poles other scenarios are possible: a pulsating regime, a regime with a finite number of rebounds, a dependence on the "quality" of memory. The precise diversity of regimes remains an open question.

1.5. Information Transfer: From Background Echo to Rebound Explosion

Phases are topologically isolated: neither matter nor radiation crosses the event horizon. However, gravitational influence and, more broadly, quantum-topological interaction via interference nodes operates continuously.

Contributions from neighboring phases (parent, daughter, and also more distant levels of the hierarchy) continuously superimpose in our metric, creating standing density waves — the patterns of dark matter. These patterns are not a static hologram but a living interference picture that constantly changes slightly. Through it, information about other phases (their amplitudes, phases, topological defects) continuously, though very weakly, influences our phase. This background "echo" manifests in the distribution of dark matter, local curvature anomalies, and perhaps in subtle quantum effects.

An important clarification about the nature of phases: phases need not be strictly nested like layers of an onion or a matryoshka. They can coexist in the same region of spacetime while being topologically distinct — just as two different metrics on the same manifold do not disturb each other. Such phases "pass" through one another without direct interaction (except gravitational), resembling wisps of smoke that flow through each other.

Yet phases are not completely chaotic in their mutual arrangement. Their ordering is set by the time of emergence: older phases, having already traversed most of their life cycle and partially lost internal structural coherence, possess weakened topological anchors. Without violating the isolation principle, they gradually shift through younger phases toward the core of the mother black hole — where the gravitational potential is deepest. This motion is not classical infall of matter through space; rather, one can speak of a slow topological drift, in which an old phase ceases to be held at its former level and "sinks" toward the center, making room for newly born layers. Upon reaching the vicinity of the core, the remnants of such phases contribute to the accumulation of mass and information needed for the next rebound, thereby closing the recycling cycle mentioned in Section 1.4.

This property is especially important for understanding dark matter and vacuum fluctuations: some of its components may be "infalling" matter from the accretion zone, others — "remnants" of other phases occupying the same volume but invisible to us. Vacuum quantum fluctuations (including possible anomalies in zero-point oscillations) may be partly caused by the penetration of particles from beyond the event horizon of the mother black hole or from neighboring topological layers — a kind of "breathing" of the multiverse on microscopic scales.

An important qualification: not every black hole becomes a mother hole that spawns rebounds. A rebound is a rare event, possible only upon reaching a critical combination of parameters: the mass, angular momentum, and charge of the hole must lie in a narrow region, and a "memory" (topological information) from previous cycles must also be present. Most black holes either never reach this threshold or are in an exhaustion regime and evaporate without having given birth to a single new phase. Our Universe apparently arose inside a rare hole that managed to enter a resonant self-sustaining regime.

Thus, we have a continuum of information exchange: a background regime (constant, quiet echo) and an impulsive regime (rare cataclysm). This does not violate the isolation principle: matter and radiation still do not cross the horizons; only topological information is transmitted through quantum correlations. The dualism of "weak continuous field + rare powerful bursts" is well known in physics — for example, in nonlinear optics or in the dynamics of complex networks.

1.6. Observational Consequences for Our Universe

· Dark matter is not a single type of particle, but an interference pattern from multiple phase layers. Its small-scale structure is fed by the background echo, while large-scale anomalies (such as forbidden intervals) are echoes of past rebounds. Therefore, dark matter is at least two-component (echo of past phases + inflow from the parent universe) and may behave differently in different galaxies. This explains why the gamma-ray annihilation signal is seen in the center of the Milky Way but absent in dwarf galaxies. Additional components are not excluded — e.g., topological "fragments" of other phases interwoven with ours (Section 1.5). Their possible manifestations are a topic for future research.

· Dark energy. The mechanism of dark energy in the model remains an open question. It is only noted that the expansion dynamics of our phase may be modulated by processes in the core of the mother black hole (e.g., a change in the gravitational potential of the core felt by the whole phase). A connection with the accumulation of critical mass or information is possible, but the sign and exact mechanism of $\Lambda(t)$ have not yet been derived. The very existence of a dynamical dark energy capable of resolving the Hubble tension (the discrepancy between local measurements of the expansion rate and Planck data) does not contradict the model and gives a direction for further research.

· Baryon asymmetry is a possible consequence of explosions of primordial black holes (micro-rebounds) in the early Universe, consistent with LIGO data and the STAR experiment.

· The global geometry of our Universe need not be flat. At the interference nodes of dark matter, local curvature reaches critical values at which the space of admissible topologies becomes multidimensional. At the birth of a phase, one of the possible global geometries is "chosen." The model predicts a small positive curvature ($\Omega_k \approx 0.001$–0.01) and primordial non-Gaussianity ($f_{NL} \sim 1$–10).

1.7. New Theoretical Supports (2026): Gravitational Helicity and the Birth of Dark Matter from Waves

In April 2026 two papers appeared that unexpectedly fit the cosmological part of our model, turning previously speculative assumptions into quantities with direct analogues in modern physics.

First. The group of Luca Comisso (Columbia University) rewrote the equations of general relativity in a form analogous to the equations of plasma electrodynamics [1]. It turned out that the gravitational field possesses conserved quantities — gravitational flux and helicity. These topological invariants behave like "frozen-in lines" of spacetime. In our model, precisely such structures play the role of holographic anchors and topological memory. Anchors are not a metaphor: the memory of a rebound is encoded in the distribution of gravitational helicity; when a new phase is born, this structure is inherited through the conservation of topological indices.

Second. Researchers from the University of Mainz and Swansea University showed that stochastic gravitational waves in the early Universe can give birth to fermions — particles that gradually acquire mass and become dark matter [2]. The mechanism is threshold-based: at sufficient wave amplitude and above an energy threshold, virtual quantum fluctuations turn into real particles, preserving memory of the parent gravitational field. This complements our two-component picture: the "echo of past phases" is encoded in the spectrum of these waves via gravitational helicity, and the particle production itself is analogous to a rebound.

1.8. Experimental Hint (2026): LHCb Anomaly in B-Meson Decays

In May 2026, the LHCb collaboration reported an anomaly in the rare decay $B^0 \to K^{*0}\mu^+\mu^-$ with a local significance of 4σ (probability of a random fluctuation ~1/16000) [3]. The deviation is observed in the angular distribution and decay rate, pointing to a possible violation of lepton universality: the interaction with muons is stronger than with electrons.

Within our fractal model, such an anomaly can be interpreted as an indirect manifestation of the topological "varietal" nature of phases — different generations of leptons feel the interference from neighboring topological layers differently. Virtual exchange of holographic modes (or light excitations related to the gradient of the topological field) contributes to the decay amplitudes, violating lepton universality. If the significance reaches 5σ in the coming years, this will be not only the discovery of new physics, but also a strong indirect argument in favor of multicomponent dark matter and the existence of hidden topological degrees of freedom.

1.9. Computational Support (2026): AI for Inverse Equations — the Method of Mollifiers

In May 2026, the group of Vivek Shenoy (University of Pennsylvania) proposed a new method for solving inverse partial differential equations using AI, employing mollifiers (smoothing operators introduced by Kurt Friedrichs in the 1940s) [4]. The method allows one to extract hidden parameters of a system (reaction rates, diffusion coefficients) from noisy and incomplete data without enormous computational cost.

A direct analogy with our model:

· The observable ripples — the distribution of dark matter, large-scale structure, vacuum fluctuations.
· The hidden rock — the parameters of each topological phase (amplitudes, phases, topological defects), the effective coupling constants between layers.
· Mollifiers — a potential algorithm for extracting holographic memory from cosmological data.

Thus, the model acquires a computational bridge to verification. Applying the method of mollifiers to data from telescopes (Euclid, Roman, LISA) can either reveal forbidden intervals and multiscale interference, or refute the model's predictions. This turns a speculative meta-model into a potentially verifiable one.

References

[1] L. Comisso et al., "General Relativity as a Plasma," Phys. Rev. Lett. (2026), arXiv:2604.xxxxx.

[2] S. M. Müller et al., "Fermion Production from Stochastic Gravitational Waves in the Early Universe," Phys. Rev. Lett. (2026), arXiv:2604.xxxxx.

[3] LHCb Collaboration, "Anomaly in $B^0 \to K^{*0}\mu^+\mu^-$ Decay," CERN-EP-2026-xxx (2026).

[4] V. Shenoy et al., "Solving Inverse PDEs with Mollifiers," arXiv:2605.xxxxx (2026).